The Effect of Exercise-Based Pulmonary Rehabilitation on Quality of Life in Recovered COVID-19 Patients; a Quasi-Experimental Study

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Abstract: Introduction: The coronavirus disease 2019 (COVID-19) is associated with a variety of physical and emotional disorders, and subsequently lower Quality of Life (QOL). This study aimed to investigate the effect of a 2-week exercise-based pulmonary rehabilitation on clinical characteristics and QOL of severe COVID-19 patients after discharge from intensive care unit (ICU). Methods: In this quasi-experimental study, eligible severe COVID-19 cases, who had survived and were discharged from ICU were selected using convenience sampling method. Oxygen Saturation (SpO2), pulse rate, dyspnea, and QOL were evaluated and compared before and after two weeks of exercise-based pulmonary rehabilitation (PR). Results: 35 cases with the mean age of 57.86 ± 11.73 (18-75) years were studied (51.4% female). The mean SpO2 increased from 90.41 ± 3.97 to 95.11 ± 1.96% after two weeks of pulmonary rehabilitation (p<0.0001). In addition, the mean pulse rate (98.97±16.23 to 88.91±14.03 pulse/minute; p<0.001) and the mean dyspnea severity (5.6±1.97 to 3.45±1.97; p<0.0001) decreased after two weeks of intervention. Besides, the mean total QOL and its dimensions, including general health (p<0.0001), physical status (p<0.0001), emotional status (p = 0.036), and social function (p<0.0001) of patients, had significantly increased after intervention. Conclusion: Based on the findings of this study, it seems that two-week exercise-based pulmonary rehabilitation could be effective in increasing the SpO2, decreasing dyspnea and pulse rate, and improving the QOL of patients with severe COVID-19 after discharge from ICU.

Keywords: COVID-19; Exercise Therapy; Lung; Rehabilitation; Quality of Life

1. Introduction

The coronavirus disease 2019 (COVID-19) appeared in Wuhan, China in December 2019, and three months later, the World Health Organization declared it a pandemic. At that time, Iran was ranked the third most-affected country in the world. Patients diagnosed with COVID-19 may experience a wide range of clinical manifestations, which are categorized into no symptoms, mild, moderate, severe, and critical symptoms. Fever, dry cough, sore throat, restlessness, muscle and joint pain, nasal congestion, sneezing and running nose, respiratory failure, general systemic dysfunction, and acute respiratory syndrome are some of the known signs and syndromes related to COVID-19 (1-6). It proves that treatment and outcomes of COVID-19 depend on the disease severity (4). Outpatients diagnosed with COVID-19 may experience symptoms for more than four weeks, which is called long COVID-19 (7). Fatigue, dyspnea, muscle pain, weakness, and psychological distress are the most common symptoms in patients with long COVID-19 (6, 7). A vast range of physi-
cal and psychological disorders, along with decreased quality of life (QOL), are associated with SARS-CoV-2 infection (4, 7-10).

Based on previous studies and guidelines, rehabilitation programs would be effective for patients diagnosed with COVID-19, especially in patients who were hospitalized (2, 5, 11, 12). All these programs, including aerobic exercises, strengthening, and stretching exercises of respiratory muscles may improve cardiorespiratory tolerance and physical function of patients, as well as their quality of life (13). In addition, respiratory exercises, such as diaphragmatic, bud lip, and resistance breathing will help in reducing active coughing in such patients (2, 14). This study aimed to investigate the effect of a 2-weeks exercise-based pulmonary rehabilitation on clinical characteristics and QOL of severe COVID-19 patients after discharge from intensive care unit (ICU).

2. Methods

2.1. Study design and setting

This quasi-experimental study with before-after design, was performed on severe COVID-19 cases, who had survived and were discharged from intensive care unit of Shohadaye-Tajrish Hospital, Tehran, Iran, during 2021. O2 saturation (SpO2), pulse rate, dyspnea, and QOL were evaluated and compared before and after two weeks of pulmonary rehabilitation (PR) in enrolled patients.

The study protocol was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences (Ethics code: IR.SBU.RETECH.REC.1400.531) and also registered in Iranian Registry of Clinical Trials (IRCT20211201053238N1). Written informed consent forms were signed to participate in the research. Personal information was kept confidential and patients were given an identification code in the questionnaire form, instead of mentioning their name.

2.2. Participants

Being aged between 18 and 75 years, recovered from severe COVID-19, hospitalized to ICU (between 3 to 18 weeks), satisfied to participate in the research, and referred to the department of physical medicine and rehabilitation by pulmonologist and intensive care specialist due to respiratory failure, as well as not receiving any PR before the study were among the inclusion criteria. Patients who had problems with pulmonary massage, including active wounds, fractures and skin disorders in the chest area (15), a history of uncontrolled cardiovascular problems, chronic obstructive pulmonary disease (COPD), renal, neurological, and cognitive problems, acute rheumatic diseases, hypertension, hemoptysis, psychology disorder, and cancer which lead to not being able to do exercises were excluded.

2.3. Data gathering

The data regarding demographic characteristics, SpO2, pulse rate, dyspnea, and QOL were collected for all patients before and after two weeks of pulmonary rehabilitation by trained occupational therapist in Physical Medicine and Rehabilitation clinic. Measurements of SpO2 and pulse rate was done using pulse oximeter (ChoiceMed made in China [with Coefficient of Variation (CV): 0.01]). The level of dyspnea was calculated using valid and reliable Modified Borg scale, which is subjective and rated by the patient from one up to 10 (16). The QOL was measured using SF-36 questionnaire, which has been proven reliable and valid for Iranians by Montazeri with Intra Class Reliability and Coefficients: <0.05 (17). Generally, SF-36 questionnaire investigates the patient in 8 areas (physical status, physical role, body pain, emotional status, emotional role, social function status, fatigue, general health), and consists of eleven parts and 36 multiple choice questions. In this study, general QOL and its’ 4 dimensions, including physical status (physical status, physical role, body pain, fatigue), emotional status (emotional status, emotional role), general health, and social function were evaluated.

2.4. Intervention

PR included training to stay in one of 5 sitting or standing comfortable positions and getting head and shoulders down and breathe in and blow out at first through the mouth and after that doing diaphragmatic breathing for 5 minutes to ease shortness of breath, getting lung massages (with cupping and vibratory techniques) (18) and doing 10 kinds of exercises. The exercises consisted of 3 respiratory exercises, including pursed lip in diaphragmatic, shoulder shrugging and rib breathing, 2 upper extremity exercises, reaching arms to the sky and elbows touch, and 5 lower limbs exercises, including hip hiking, knee abduction/adduction in crock lying, foot rocking in sitting, stepping, and squatting in standing position (18, 19) with 10 repeat, in two face to face sessions in the first week (Sundays and Tuesdays for 60 minutes) and the follow up during all the second week. All the enrolled patients were followed up for two weeks.

2.5. Statistical analysis

The study sample size was calculated as 35 based on two variables; SpO2 and QOL, with 95% confidence interval, Power = 80%, and d=0.02 (19). After data gathering and coding, analysis of variances with Wilcoxon and repeated measurement were used to analyze the data in 26-SPSS. SpO2, dyspnea, and emotional status and social function of QOL did not have normal distribution and the Wilcoxon method was used instead of paired t-test. The findings were reported as mean ± standard deviation or frequency (%). P < 0.05 was considered as level of significance.
3. Results

3.1. Baseline characteristics of patients

35 cases with the mean age of 57.86 ± 11.73 (18-75) years were studied (51.4% female). The mean Body Mass Index (BMI) of studied cases was 23.31 ± 3.63 kg/m² and the mean time interval between the start of disease to the initial assessment in hospital was 56.01 ± 25.06 days. Baseline characteristics of patients are presented in Table 1.

| Variable           | Value |
|--------------------|-------|
| Gender             |       |
| Female             | 18 (51.4) |
| Male               | 17 (48.6) |
| Start of disease to the initial assessment (days) |       |
| 21-36              | 18 (51.4) |
| 37-91              | 14 (40.0) |
| 92-126             | 3 (8.6)  |
| Marital Status     |       |
| Single             | 4 (11.4)  |
| Married            | 22 (62.9) |
| Widowed/Divorced   | 9 (25.7)  |
| Education          |       |
| Illiterate         | 4 (11.4)  |
| Primary school     | 14 (40.0) |
| High school        | 11 (31.4) |
| University         | 6 (17.1)  |
| Job                |       |
| Housewife/none     | 23 (65.7) |
| Employed           | 12 (34.3) |

Data are presented as frequency (%).

3.2. Outcomes of Interventions

The mean SpO2 increased from 90.41 ± 3.97 to 95.11 ± 1.96% after two weeks of pulmonary rehabilitation (p<0.0001). In addition, the mean pulse rate (98.97±16.23 to 88.91±14.03; p<0.001) and the mean dyspnea severity (5.6±1.97 to 3.45±1.97; p<0.0001) decreased after two weeks of intervention.

Besides, the mean total QOL and its dimensions, including general health (p<0.0001), physical status (p<0.0001), emotional status (p = 0.036), and social function (p < 0.0001) of patients had significantly increased after intervention. Table 2 compares the measured outcomes before and after two weeks of pulmonary rehabilitation in studied cases.

| Variable                  | Value |
|---------------------------|-------|
| Value                     |       |
| 18 (51.4)                 |       |
| 14 (40.0)                 |       |
| 22 (62.9)                 |       |
| 9 (25.7)                  |       |
| 4 (11.4)                  |       |
| 22 (62.9)                 |       |
| 9 (25.7)                  |       |
| 4 (11.4)                  |       |
| 14 (40.0)                 |       |
| 11 (31.4)                 |       |
| 6 (17.1)                  |       |
| 23 (65.7)                 |       |
| 12 (34.3)                 |       |
| Male                      |       |
| Female                    |       |
| Start of disease to the initial assessment (days) |       |
| 21-36                     |       |
| 37-91                     |       |
| 92-126                    |       |
| Marital Status            |       |
| Single                    |       |
| Married                   |       |
| Widowed/Divorced          |       |
| Education                 |       |
| Illiterate                |       |
| Primary school            |       |
| High school               |       |
| University                |       |
| Job                       |       |
| Housewife/none            |       |
| Employed                  |       |

4. Discussion

Based on the findings of this study, it seems that two-week exercise-based pulmonary rehabilitation could be effective in improving the O2 saturation, decreasing dyspnea and pulse rate, and improving the QOL of severe COVID-19 patients after discharge from intensive care unit.

Restrictive pulmonary changes and reduced diffusion capacity in patients diagnosed with moderate to severe COVID-19 may lead to long-term functional limitations, as well as reduced QOL in such patients. Considering the previous studies, it appears that pulmonary rehabilitations may be helpful for patients diagnosed with acute respiratory distress syndrome as a consequence of COVID-19 (15, 21-23). Overall, beneficial impacts of rehabilitation have been clearly exhibited in a wide range of health conditions, and in patients with pulmonary diseases such as COPD, rehabilitation reduces dyspnea and improves health-related quality of life (24). Since short-term benefits have been reported for PR by patients, to ensure long-term effects, maintenance of physical activity and healthy lifestyles should be enforced by providing personalized home-based rehabilitation programs or referring the patients to long-term rehabilitation outpatient centers with an integrated model of care (6).

A variety of studies revealed that pulmonary rehabilitation improved the SpO2 in patients who survived COVID-19 (5, 18, 19, 25, 26). The present study results were consistent with the mentioned studies. In this study, like the Huang (27) and McGregor (28) studies, the mean pulse rate significantly decreased after rehabilitation programs. Also, the average pulse rate reduced, in line with the studies by Alahmri (21) and Huang et al. (2004), which showed that the patients recovered pulse rate after rehabilitation (27). Additionally, in this study, the average of dyspnea reduced, which was in line with Huang (27) and McGregor et al.’s findings (28). This improvement was probably not only related to PR but also to the natural recovery process of the disease (29).

Moreover, in terms of quality of life, a significant increase was reported in patients enrolled in the study after two weeks of the exercise-based pulmonary rehabilitation. Like the present study, recent studies demonstrated that pulmonary rehabilitation may improve the quality of life in patients diagnosed with COVID-19 (19, 28, 30). A study conducted by McGregor revealed that pulmonary rehabilitation could improve the general health status of patients with COVID-19 (28). In the present study, exercise-based pulmonary rehabilitation improved the general health status of enrolled patients, as well as other sub-domains of QOL questionnaire. In recent studies, physical status, emotional status, and social function of patients were improved in patients who underwent pulmonary rehabilitation (24, 28, 30, 31).

Severe COVID-19 cases required prolonged ICU stay and intubation; therefore, they had more physical and psychosocial impairments post-ICU, but recovered following PR. Further controlled and long-term studies are required to better understand the role of PR post-COVID-19 (29).

Unfortunately, in this study we faced some restrictions. The
Table 2: Comparing the status of studied variables before and after two weeks of exercise-based pulmonary rehabilitation

| Variable                  | Mean ± SD       | P value  |
|---------------------------|-----------------|----------|
| SpO2 (%)                  |                 |          |
| Before                    | 90.71 ± 3.97    | <0.0001  |
| After                     | 95.11 ± 1.96    |          |
| Pulse Rate (/minutes)     |                 |          |
| Before                    | 98.97 ± 16.23   | <0.001   |
| After                     | 88.91 ± 14.03   |          |
| Dyspnea severity*         |                 |          |
| Before                    | 5.6 ± 1.97      | <0.0001  |
| After                     | 3.45 ± 1.94     |          |
| Quality Of Life (total)#  |                 |          |
| Before                    | 35.5 ± 13.73    | <0.0001  |
| After                     | 51.05± 20.30    |          |
| General Health            |                 |          |
| Before                    | 50.95 ± 17.88   | <0.0001  |
| After                     | 57.78 ± 17.09   |          |
| Physical Status           |                 |          |
| Before                    | 1.37 ± 0.79     | <0.0001  |
| After                     | 38.85 ± 23.09   |          |
| Emotional Status          |                 |          |
| Before                    | 49.21 ± 23.61   | <0.036   |
| After                     | 57.14 ± 24.63   |          |
| Social Function           |                 |          |
| Before                    | 40.35 ± 21.88   | <0.0001  |
| After                     | 51.42 ± 24.00   |          |

*: using Borg scale; #: using SF-36 questionnaire. SD: standard deviation.

lack of awareness of patients and specialists regarding the role of outpatient's rehabilitation, caused late referral of patients to relevant centers for help and to reduce disease-related complications like dyspnea. Also, due to long-term and heavy hospitalization costs of medical treatment of patients with severe COVID-19 in ICU and having physical and psychological fatigue related to the disease, and also being worried about re-infection or the spread of disease on the way to rehabilitation clinic, time-consuming PR exercises were not welcomed by some patients and they insisted on having just one training session instead of two weeks PR. However, giving educational brochures related to treatment sessions and encouraging the patients to work out through helping them feel recovered after exercises were the strengths of our study.

5. Limitations

It should be mentioned that our study had several limitations, which need to be considered when interpreting findings; firstly, the small sample size of COVID-19 patients that were rehabilitated and also the absence of follow-up after PR due to limited research time and the probability of losing samples; secondly, the lack of a control group of COVID-19 patients post-ICU who were not rehabilitated; and thirdly no causal role of rehabilitation can be assumed with certainty.

6. Conclusion

Based on the findings of this study, it seems that two-week exercise-based pulmonary rehabilitation could be effective in increasing the O2 saturation, decreasing dyspnea and pulse rate, and improving the QOL of severe COVID-19 patients after discharge from intensive care unit.

7. Declarations

7.1. Acknowledgments

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7.2. Authors’ contributions

Leila Angooti carried out the process of data gathering. Leila Angooti wrote the manuscript with support from Mansoor Rayegani, and Rama Bozorgmehr. Mansoor Rayegani, Rama Bozorgmehr helped supervise the project. Mansoor Rayegani, Rama Bozorgmehr, Leila Angooti and Amir Hossein Mahdi kaghazi performed the manuscript proofing.
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7.4. Conflict of interest
There is no conflict of interest.

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