Original Article

ISSN: 1735-0344 *Tanaffos 2022; 21(4): 466-471*

TANAFFOS

Role of Inspiratory Muscle Training on Pulmonary Rehabilitation in Patients with COVID-19: A Pilot Study

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Received: 23 November 2021
Accepted:13 July 2022

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Background: Inspiratory muscle training has been introduced as one of the effective methods in pulmonary rehabilitation, and attention to this technique in patients with COVID-19 is still being studied.

Materials and Methods: In the present study 52 patients who have undergone the period of the COVID-19 disease were randomly divided into two groups. In the control group, in addition to the routine treatment prescribed by a specialist physician, rehabilitation was performed by performing diaphragmatic breathing exercises, pursed-lips breathing, chest expansion, and simple stretching exercises. In the intervention group in addition to the rehabilitation program provided to the control group, patients used an inspiratory muscle training device. This pulmonary rehabilitation program was performed twice a day and 30 repetitions each time with a two-minute rest after every 10 exercises. After 4 weeks, patients in both groups were referred to the hospital for re-assessment of the distance of the 6-minute walk test, SF-12 questionnaire results, dyspnea, and S-index. To compare quantitative variables between the two groups we utilized a student t-test. Type one error was put at $P \leq 0.05$.

Results: The comparison of 6MWT values shows that the mean of this index in the intervention group is significantly higher than the control group ($p = 0.002$). Also, the S-index of the two groups showed a significant difference ($p=0.024$). Results show a significant increase in the SF-12 quality of life questionnaire in patients using IMT ($p=0.001$).

Conclusion: IMT improves pulmonary functions, 6MWT, and SF-12 Questionnaire in recovered COVID-19 patients.

Keywords: COVID-19; Inspiratory muscle training (IMT); Pulmonary rehabilitation; Respiratory disorders

INTRODUCTION

Outbreaks of severe acute respiratory syndrome coronavirus 2 (SARS-COV2) have resulted in widespread deaths worldwide. According to statistics, millions of people have been infected with this infection so far. Many discharged patients suffer from physical and psychological complications of this disease (1, 2). Meanwhile, due to the infectious nature of SARS COV- 2, the lungs are one of the most damaged organs and many people suffer from lung diseases caused by this disease. Therefore, paying attention to the physical conditions of each patient and providing appropriate instructions can play a significant role in improving the quality of life and returning the patient to social life. With the help of these strategies, the mental and physical conditions of the patient are optimized and additional costs imposed on the patient and the health system are avoided (3).

Inspiratory muscle training has been introduced as one of the effective methods in pulmonary rehabilitation in the last decade, which uses a portable device to strengthen the muscles involved in inhalation as the main components of respiration (4). The use of this method in the treatment of various diseases such as COPD (5), asthma (6), Duchenne muscular dystrophy (7), etc. has been approved. Inspiratory muscle training can help strengthen the respiratory muscles by applying controlled current resistance and greatly prevent the progression of respiratory failure (8). Because COVID-19 is a restrictive disease, it causes severe changes in lung volume, followed by shortness of breath and changes in breathing patterns. Therefore, in addition to the necessary medical measures to treat these patients, the implementation of pulmonary rehabilitation programs to reduce the complications of the disease can be beneficial. Therefore, in the present study, we investigated the effect of strengthening respiratory muscles with the help of an inspiratory muscle training device on pulmonary rehabilitation in patients with COVID-19 after discharge.

MATERIALS AND METHODS

The present study was performed as a clinical trial (with the code IRCT20200611047727N1) and approved by the ethics committee (with the code IR.SBMU.NRITLD.REC.1399.088), in the period July to October 2020.

In the present study, 65 patients with moderate to severe COVID-19 who underwent the course of the disease and were discharged were evaluated. After examination and approval of the inclusion criteria by a specialist physician, 52 patients were included in the study. Inclusion criteria included age 20 to 60 years, negative RT-PCR test, 7 to 10 days after discharge, lack of oxygen dependence, no underlying disease Including COPD, CHF, and neuromuscular diseases or movement disorders, PImax less than 60 %. Exclusion criteria also included the occurrence of any physical disorder or unwillingness to continue participating in the study. All patients who met the inclusion criteria and completed the consent form to participate in the study were invited for the initial trial. These tests included the following:

- Completion of personal information questionnaire
- Completion of SF-12 quality of life questionnaire
- Evaluation of the traveled distance during the 6-minute walk test

After initial tests, patients were randomly divided into two groups:

In the control group, in addition to the routine treatment prescribed by a specialist physician, rehabilitation was done by performing breathing exercises including diaphragmatic breathing exercises, pursed-lips breathing, chest expansion, and simple stretching exercises for the upper and lower limbs. When discharging patients, they were taught how to perform these exercises properly by the physiotherapy and pulmonary rehabilitation team. Also, a brochure containing the necessary instructions for the correct performance of the mentioned exercises collected by the pulmonary rehabilitation group taken from the instructions provided by the World Health Organization, was provided to each patient. The duration of these exercises was four weeks and twice a day.

In the intervention group, in addition to the routine treatment prescribed by a specialist physician and rehabilitation program provided to the control group, patients used an inspiratory muscle training device (Power breath model, England). This device is adjustable from grades 1 to 9, and with increasing grades, rehabilitation exercises become more advanced. The patient is taught how to perform exercises and use the device. The patient starts the exercises from grade 1. If the patient can perform an exercise program with one grade, he will be promoted to a higher grade after one week. This pulmonary rehabilitation program was performed twice a day (morning and evening) and 30 repetitions each time with a two-minute rest after every 10 exercises. The duration of this pulmonary program was 4 weeks.

After 4 weeks, patients in both groups were referred to the hospital for the reassessment of the distance of the 6-

minute walk test, SF-12 questionnaire results, and dyspnea. Also, because there are limitations for performing pulmonary function tests (spirometry and body box) for patients with COVID-19, the inspiratory muscle strength index(S-index) has been evaluated.

To present our data we applied both descriptive and analytic statistics. Quantitative variables were presented as relative frequencies and qualitative data were presented as Mean ± SD. To compare quantitative variables between the two groups we utilized a student t-test. Type one error was put at P≤0.05.

RESULTS

Among 65 patients with COVID-19 referred to the internal ward Hospital, 52 patients including 29 male and 23 female with a mean age of 50.02 had the inclusion criteria and were examined. Figure 1 shows the flowchart of participants and excluded patients. The desired quantitative indices were compared using a separate univariate analysis of variance (Table 1).

The results of the six-minute walk test showed that although the average distance traveled in this test at the beginning of the study in the control group was more than the intervention group (373.00±115.17 vs. 352.50±11.37), after four weeks in the intervention group (397.93±107.99) compared to the group Control (386.05±106.79) has increased significantly (P=0.002).

Table1. Independent T-TEST analysis of the significant difference between the variables by test and control group

Variable	Group	IMT group Mean ± SD	Control group Mean ± SD	p-value
6MWT	Before study	352.50±11.37	373.00±115.17	
	After 4 weeks	397.93±107.99	386.05±106.79	0.002
HR	Before study	91.60±14.85	87.90±16.49	
	After 4 weeks	87.90±15.21	84.40±73.72	0.906
SPO2	Before study	91.30±3.78	92.10±2.31	
	After 4 weeks	92.90±3.61	93.40±1.87	0.642
SF-12 Questionnaire	Before study	29.70±2.59	31.20±3.381	
	After 4 weeks	28.95±2.66	28.30±4.23	0.001
S-index	Before study	65.12±15.20	64.70±12.25	
	After 4 weeks	74.47±15.26	70.18±13.82	0.024

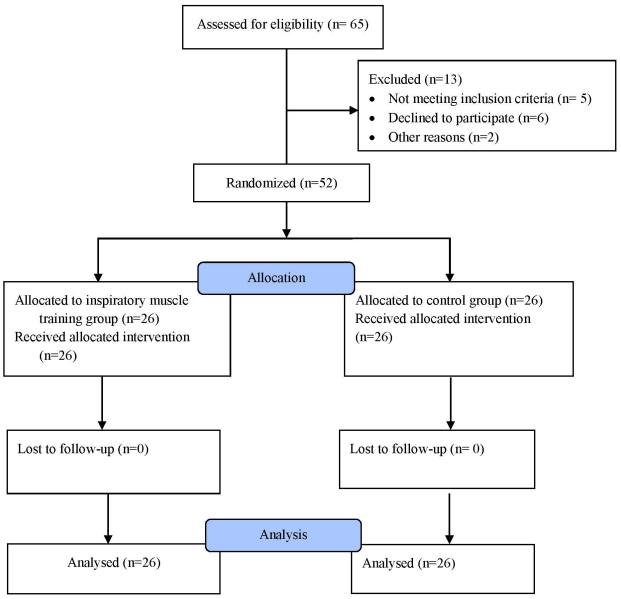

Figure1. Flow diagram of patients with covid-19 participating and excluded. No harmful complications were reported in the two groups

Also, the comparison of the S-index of the two groups showed that the mean of this index in the intervention group (74.47±15.26) and in the control group (70.18±13.82) had a significant difference (p=0.024).

The results of the SF-12 quality of life questionnaire showed that after 4 weeks, the mean score of this questionnaire in the intervention group was 28.95±2.66 and in the control group was 28.30±4.23. This difference shows a significant increase in this parameter in patients using inspiratory muscle training (p=0.001).

According to the results of the present study, the mean SpO2 in patients in the intervention group increased less than the control group after 4 weeks of IMT uses (92.90 ± 3.61 vs. 93.40±1.87). This result was not statistically significant (p=0.642).

The mean heart rate was 87.90±15.21 in the intervention group and 84.40±73.72 in the control group. The increase in heart rate in the IMT group was not statistically significant (p=0.906).

Examination of the mean difference of Dyspnea sequential qualitative variable based on the Mann-Whitney method showed that according to the reported p-value,

this difference before and after IMT use in the two groups was not significant (Table 2).

Table 2. Descriptive statistics and Mann-Whitney test results for dyspnea

Variable	n	Mean ranks (Test group)	Sum of ranks (Test group)	Z	Sig. (two-tailed)
Dyspnea pre	20	21.95	439.00	-0.784	0.445
Dyspnea post	20	22.65	453.00	-1.163	0.253

DISCUSSION

The present study investigated the role of inspiratory muscle training (IMT) in the respiratory status and quality of life of discharged COVID-19 patients. The main finding of our study was that the use of this method can improve the quality of life, the results of the six-minute walk test, and the S-index of patients. Various researches similar to our study have confirmed the positive role of IMT in improving the clinical conditions of post-COVID patients. Using inspiratory muscle exercises at home can cause a significant increase in peak VO2 in patients (9,10). The results of a clinical trial showed that home rehabilitation with the help of 8 weeks of IMT improves functional capacity, respiratory muscle strength, and health-related quality of life in post-COVID patients (11). In a clinical trial, Palau et al investigated the effect of 12 weeks of IMT adherence in patients with long-term COVID-19. These researchers found that using these exercises plays a significant role in improving patients' quality of life and physical activities (12).

With the outbreak of COVID-19, the use of IMT for rehabilitation has received more attention. Since one of the goals of the treatment of COVID-19 is to improve the respiratory symptoms and physical performance of patients after recovery and in the long term, using this method can facilitate the patient's return to daily activities and social life. IMT has the potential to be used to improve dyspnea and lung function in patients with COVID-19 (12, 13). The results obtained from these studies highlight the role of IMT as one of the main strategies of home rehabilitation in recovered COVID-19 patients. IMT improves respiratory patterns and ventilation during exercise and thus increases exercise tolerance in COVID-19 patients (14). Previously, the results obtained from examining the effect of using IMT in COPD patients showed that these exercises can improve the quality of life, respiratory symptoms such as dyspnea, and exercise capacity in these patients (15). A review has provided similar results regarding the use of this method in interstitial lung disease (16). Perhaps these successful results can be related to the improvement of the patient's breathing pattern following inspiratory muscle training and the improvement of the strength and power of the respiratory muscles. COVID-19 is associated with disorders such as respiratory muscle weakness and nerve failure (17). The mechanisms that support the improvement of these conditions have not yet been well clarified, but it seems that rehabilitation exercises at home, such as inspiratory muscle training, can play a significant role in dyspnea and respiratory muscle function, and as a result, improve the patient's quality of life (11). Despite the provision of different treatment lines for COVID-19, many patients still suffer from the complications of this disease, and there is a great potential to evaluate the role of pulmonary rehabilitation, especially in post-COVID patients. Various studies have reported the long-term stability of respiratory symptoms and respiratory dysfunction in patients with COVID-19 (18). One of the most important methods of support and respiratory assistance introduced for this purpose is pulmonary rehabilitation (19). Despite the great importance of pulmonary rehabilitation in improving the living conditions and reducing the clinical symptoms of patients with COVID-19, the long-term stay of patients in medical centers and benefiting from rehabilitation facilities imposes a very high cost on patients and the health system. Therefore, remote rehabilitation methods such as inspiratory muscle training with careful monitoring by the therapeutic team can play a significant role in optimizing existing treatment strategies.

This study had strengths and weaknesses. In our study, the effect of 4 weeks of inspiratory muscle training was evaluated in discharged COVID-19 patients. The results of our study showed that the patients were more satisfied after the training course and had a significant improvement in lung function and quality of life. One of the limiting factors of this study is the small sample size and single center. Our study was conducted during the peak of COVID-19 and the patients did not have much desire to participate in the research project and go to the hospital. Therefore, patients were selected to participate in the study according to their accessibility. On the other hand, in this study, patients were followed up for a limited period. Conducting studies with a larger sample size, comparing the data obtained from different medical centers and a longer follow-up can be effective in achieving conclusive results.

CONCLUSION

Along with the outcomes of the study, 4-week use of IMT improves inspiratory muscle strength, 6MWT, and SF-12 Questionnaire in recovered COVID-19 patients. IMT program should be encouraged to be included in the COVID-19 management protocols.

Acknowledgment

The authors thank all the colleagues who participated in the preparation of this manuscript.

Source of Funding

This study was funded by a grant from the National Research Institute of Tuberculosis and Lung Diseases (NRITLD), Shahid Beheshti University of Medical Sciences, Tehran, Iran

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