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Rehabilitation Methods for Post-COVID-19 Patients

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Abstract The purpose of the study was to assess the impact of the physical rehabilitation program on the exercise tolerance and the functional state of the cardiovascular system of patients with COVID-19. Exercise tolerance was assessed with a six-minute walk test, the Borg scale was assessed using the mmrc scale to assess the degree of shortness of breath after exercise, to determine satiety during rest and after a six-minute walk test, to assess the heart rate before and after the test, and the severity of shortness of breath during the day. The effectiveness of the developed physical rehabilitation program for COVID-19 survivors has been scientifically proven.

Keywords COVID-19, Physical rehabilitation, Shortness of breath, “Long-term covid”, Respiratory rehabilitation

1. Introduction

The 2019 coronavirus (COVID-19) pandemic caused by the SARS-CoV-2 virus continues to spread, and to date, the number of sick people in the world has exceeded 418 million, with more than 14 million people affected in our country. According to the operational staff, the number of patients with severe forms of the disease reaches 15%. It should also be noted that the vast majority of people who have faced a new coronavirus infection have complications in the form of pneumonia associated with COVID-19 and need affordable and qualified rehabilitation [1].

Medical rehabilitation is an integral part of the treatment and diagnostic process when providing medical care to COVID-19 patients. Particular attention should be paid to the so-called "long-term" COVID-19 symptoms that lead to a decrease in physical activity and quality of life, often lasting several months [2]. To more effectively restore impaired body functions, it is necessary to individually establish rehabilitation programs for patients with pneumonia of various degrees associated with COVID-19. In this regard, the issue of developing a rehabilitation program for people who have experienced pneumonia associated with COVID-19 remains relevant.

The purpose of the study is to assess the impact of the physical rehabilitation program on the exercise tolerance and the functional state of the cardiovascular system of patients with pneumonia associated with COVID-19.

2. Research Material and Methods

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The study was carried out at the Department of rehabilitation and physiotherapy of the multidisciplinary clinic of the Tashkent Medical Academy. The rehabilitation program lasted 14 days.

The study was conducted in accordance with the principles of the World Health Organization's Declaration of Helsinki. All patients gave voluntarily informed written consent to participate in the study and process the information received for scientific purposes. The study involved 20 patients with pneumonia associated with COVID-19.

For comparative analysis, patients are divided into 2 groups: control (kg) and experimental (eg), each of which consists of 10 people.

Research methods include:

1) analysis of medical documents, medical card, Anamnesis and chest tomography for the analysis of individual contraindications for rehabilitation and participation in the study;
2) saturation (SAO2) and heart rate (HR) were measured using Oxytest-1 portable transport pulse oximeter, designed for non-invasive continuous detection and monitoring to assess the functional state of the cardiorespiratory system;
3) the level of exercise tolerance was determined by a six-minute walk test before and after rehabilitation [3].

After measuring SPO2 and heart rate, the patient was offered a six-minute walk test. For testing, a 30-meter-long gym was used every 10 meters. The patient had to pass as much time as possible in 6 minutes, which could slow down or stop if necessary, while the stopwatch continued to calculate the time. During the test, the patient was observed by a nurse and a physiotherapy teacher. After recording the

distance traveled, the patient made repeated measurements of SPO2 and heart rate. If the patient experiences: pain behind the sternum, severe shortness of breath (>8 points on the Borg scale), muscle spasms of the lower extremities, imbalance, profuse sweating, sudden pallor, a decrease in saturation to 86%, dizziness, the test should be stopped immediately.

For healthy people, the six-minute walking speed depends on age, which is about 600 meters for men and about 500 meters for women. In patients with chronic diseases of the respiratory system, a difference of 25-33 meters is very important. For clinically significant difference in patients with COPD – ≥ 70 meters. The test values that indicate high risk are: = 317 meters for COPD, 254 meters for interstitial lung diseases, 337 meters for primary pulmonary hypertension. It should be noted that the clinically significant minimum change is about 30 meters between the first and second test that the person has already noticed.

Also, according to clinical recommendations, the severity of shortness of breath during daily activities was assessed using a modified Medical Research Council (mMRC) scale before and after rehabilitation [3].

4) the severity of psychological disorders caused by coronavirus infection and which may affect patients ' commitment to the rehabilitation program was assessed using the hospital anxiety and depression scale (HADS) [3].
5) statistical data processing was carried out using the Microsoft Office Excel 2013 program. The minimum and maximum values, the average values of the parameters, the standard deviation and the student's t-criteria are calculated. At $P < 0.05$, the differences were considered significant.

3. Research Results

Experimental group work program

The program aims to increase exercise tolerance and improve the functional state of the cardiovascular system in patients with covid-19-related pneumonia, bring patients back to the full life they had before the disease, and improve the cognitive functioning of the body.

The developed rehabilitation program includes physical exercises aimed at the effective functioning of the respiratory muscles and the entire musculoskeletal system, breathing exercises aimed at correcting breathing patterns, elements of Buteyko breathing exercises, neurological exercises, exercises to improve proprioception, myofascial relaxation of the respiratory muscles, respiratory synchronization and mobilization exercises for the chest.

Training took 40-50 minutes 5 times a week. In the morning, 2-2.5 hours after breakfast. Before the start of classes, patients were given recommendations on "brake lights", which should inform the teacher and stop the lesson. These include: chest tightness, dizziness, headache, fuzzy mind, sweating, feeling of lack of air, discomfort, dizziness, etc. During training, saturation and heart rate were measured (the heart rate should not exceed 50% of its original value, and saturation should not be lower than 95%).

Sample set of exercises for the experimental group

Lying on the right side, the legs are bent at an angle of 90 degrees at the knee and hip joints, the roll under the head, the arms are stretched out in front of you, on the left side. Breathe-pull your left hand back, looking at it, turn around in the thoracic spine, the legs are pressed to the ground, the pelvis is still. Breathe and return to repeat on the left side. 10-12 times in each direction. Do it slowly, without sudden movements.

Lying on your back, the legs are bent at an angle of 90 degrees at the knee joints, the legs are shoulder-width apart, the arms are spread at an angle of 45 degrees to the body. Breathe-turn your head to the right, your legs to the left, press your knees to the floor. Take a breath and go back. Repeat in the other direction. Do 10-12 times in each direction. Do it slowly without sudden movements.

The main focus is on the knees, the back is in a neutral position. Breathe-bend the left arm to the elbow joint and stretch the right arm to the left. Exhalation-stretch with the right hand to the right and up, straighten the left hand (push it off the floor), form a straight line from the hands, the pelvis is still. Right-handed look. Do it slowly without sudden movements. Do it 10-12 times in each direction.

Lying on his back, one hand is bent on his stomach, the other on his chest, his legs are bent at his knees. Breathing - the abdomen gradually rises, the chest rises in 7 seconds, exhaling-the abdomen falls, the chest falls in 7 seconds. Perform 5-6 cycles.

Sitting in a chair, the back is in a neutral position, the legs are on the floor, the arms are on the ribs. Breathe-spread the ribs with your hands (the chest expands). Exhalation-chest returns to exhalation is 2 times longer than breathing. Perform 3-4 cycles. Complexity: in exhalation, add the pronunciation of the sound "W" and perform the maximum exhalation. Repeat 3-4 times.

Sitting in an empty position, Show "class" with your right hand, "phone" with your left hand, play a little and replace "class" with "phone". Speed up. Do the exercise for 1-2 minutes.

While standing, in a free position, draw a triangle clockwise with one hand, and a square in contrast to the clock area with the other. Then change direction. Do it for 1-2 minutes.

While sitting or standing, touch your hands, chest and back with the pronunciation of the sound "a" while exhaling. 1-2 minutes.

In a neutral position, pay attention to the knees, back. Breathing-tighten the abdomen, exhale-longer than breathing, belly return to position.

Sit or lie down. Breathing-4 seconds, breathing-6 seconds, pause -5 seconds. Do the exercise for 5 minutes. Gradually, you can increase your breathing, breathing and pause time.

In their free time from exercise, patients performed aerobic exercises 3 times a week: walking on a treadmill, walking on an ellipsoid simulator, starting from 5 minutes,

up to 20-30 minutes, with an interval load of 2-3 minutes in a 3-4 alternating period. On the Borg scale, the intensity is less than 5 points [6. A., Kadykov]. Recommendations were also made for outdoor walks at a comfortable speed for 30-60 minutes a day.

The experimental group used vocal breathing exercises. Its purpose is to train the respiratory muscles, to increase the uniformity of ventilation. Mechanism of action: the vibration of the vocal cords during exercises to pronounce certain sounds and/or their combinations in a clearly defined way leads to relaxation of the spasmodic muscles, passing into the smooth muscles of the bronchi/lungs and chest. The frequency of vibration depends on the strength of the air flow that occurs when pronouncing certain sounds. This technique can be used to train the respiratory muscles and therefore the diaphragm (the largest respiratory muscles) [4,7].

An example of an exercise is I. P. sitting in a chair with a straight back, the hands are lowered along the body. Inhale with the sound "a" (2 seconds) and exhale (5-6 seconds if possible). Perform 5-6 cycles. In the next option, Add a "stroking" to the sternum with a fist while exhaling, and the teacher can also help to stroke the chest from the back.

Patients were also taught "full yoga breath", which performed at the end of the workout to relax, as well as homework.

Purpose: to increase the uniformity of the lungs, to form the correct breathing pattern. Mechanism of action: performing "full breathing" in combination with the formation of the correct breathing pattern. The basis of the exercise is successive and as complete ventilation of different parts of the lungs as possible, so that the ratio of ventilation and perfusion can be normalized.

Doing this exercise [4]:

1. The starting position is to sit in a chair with the back straight and leaning on the back, or lie on your back with bent legs, one arm on the chest and the other on the stomach.
2. Before you start exercising, relax your chest by lifting your shoulders and then placing them back and forth.
3. Squeeze the nasopharynx a little and inhale through the nose (inhale with air, such as sniffing).
4. At the first stage of breathing, the lower parts of the lungs are ventilated. To do this, when the diaphragm contracts and falls, the anterior abdominal wall moves forward.
5. The upper parts of the lungs are then ventilated smoothly, without delay. To do this, in the second stage of breathing, the chest expands due to the work of the intercostal muscles. The maximum possible breathing is done by the extra respiratory muscles without significant effort.
6. Not necessarily, but passively breathe through loose or elongated lips under the weight of the chest.
7. It is necessary to perform 10-15 cycles 3 times a day.

In the developed rehabilitation program, the technique of forced expiratory maneuvering was used. The purpose of the technique is to increase the uniformity of the lungs, stimulate the coughing of sputum, which is difficult to distinguish, and correct atelectasis. Preferred type of behavior [4]:

1. After 3-5 slow, deep breathing movements, take a deep breath through your nose. Use diaphragm breathing to breathe through closed lips (one intake).
2. Take a deep breath and hold it for 1-3 seconds; breathe in the medium/low volume of the lungs (to clear the peripheral bronchial tree of secretions).
3. Take a simple breath; then squeeze the air out of the lungs using the abdominal and chest muscles while exhaling, with the glottis Open, say the sound "ha-af-fa". Repeat several times (3-4 times).
4. Perform a few relaxing diaphragm movements before the next cough movement.

In the experimental group program, used the" active cyclic breathing (ACB) method.

Its purpose is to increase the uniformity of the lungs, stimulate the coughing of sputum, which is difficult to distinguish, and eliminate atelectasis. Mechanism of action: based on a combination of three breathing techniques: "breath control", "breast enlargement control", "forced breathing maneuver" [4].

Breathing control (BC) is a technique for controlling breathing/breathing with a diaphragm to relax the airways and muscles. When performing RC, the patient controls the upper part of the chest, breathing with normal breathing rate (NBR) with normal breathing volume (before). The effectiveness of the technique is assessed by the subjective feeling of "swelling" in the lumbar area during breathing, which is associated with the fall of the diaphragm, which disappears during exhalation. In fact, BC is the connecting basis between periods of active breathing technique (ABT).

Breast enlargement control (BEC) is a deep/full slow breathing technique, with short - term breathing (1-2 seconds) followed by calm breathing. BEC allows air to enter the extreme parts of the patient's bronchial tree. In addition, the Central Election Commission increases airflow to the peripheral airways (PA), significantly increasing the volume of air that mobilizes tracheobronchial secretion. 3-4 cycles of BEC are considered sufficient, which helps to avoid muscle fatigue and hyperventilation.

Forced breathing maneuver (FBM) is a technique for performing 2 consecutive forced (acute) open glottis and oral exhalation mimicking a "ha-ah-ah-fa" sound. Sputum can be expectorated (coughed) during FBM, and therefore this method usually completes the cycle of breathing techniques.

In the classes in the experimental group, special attention was paid to neurological exercises. As the group members were 57-63 years old, it was necessary to adapt to training, concentrate, join the work and be aware of your body. These exercises also help develop new neural connections, improving cognitive functions such as attention and memory. Because in patients with coronavirus infection, cognitive disorders are observed. It is also a great exercise to raise the mood and feel better, which is a very important factor

after an illness, especially after heavy form and prolonged isolation.

An example of such exercises:

1) While sitting or standing, draw a triangle clockwise in the air with one hand, draw a square with the other hand at the same time, as opposed to the clock area - do it for 30-40 seconds.
2) Sitting or standing, make a "ring" from the fingers with one hand, a "gun" with the other hand, clap our hands and replace the "ring" and "gun". Do it in 30 seconds, the faster the better. To complicate the work, can add the execution on one leg or with our eyes closed.

The control group performed respiratory Gymnastics elements according to Strelnikova (Table 1), exercises for joints in a lying-sitting-upright position and aerobic exercises on cardio machines (stationary bike, ellipsoid simulator and treadmill). Training was conducted 5 times a week for 40-50 minutes. In the morning, 2-2.5 hours after breakfast. In their free time from training, the control group walked in the fresh air without any special recommendations.

Table 1. A set of breathing exercises by A. N. Strelnikova

№	The name of the exercises of the main part	The name of the exercises of the additional part
1	Palms	Sit down, stand up!
2	Shoulder straps	Spring
3	Pump	Lifting the pelvis
4	Ears	
5	Head turns	The metronome
6	Cat	
7	Hug your shoulders	
8	Steps	
9	Rolling hills	
10	The big pendulum	

Below are some exercises performed by the control group from Strelnikova's breathing exercises [5,6]:

Exercise "palms": Standing, with legs shoulder-width apart, hands bent at the elbows (elbows lowered), palms pointing forward. When breathing rhythmically through the nose, you need to squeeze your hands into the fists. Take 4 breaths without stopping, then lower your arms down, rest for 4-5 seconds. Breathe 4 times 24 times.

Exercises "straps": While standing, feet shoulder-width apart, squeeze your hands into fists and press on your stomach at waist level. Lower your fists to the floor as you exhale (do not squeeze your shoulders, straighten your arms to the end). Then return the brushes to waist level. Usually perform 12 sets of 8 movements.

Cat exercises: involve turning the body to the right and dancing with short breaths. Then do the same with a left turn. Don't lift your feet off the ground. Breathe on your own. Bend your knees slightly and then straighten them. During the turn, the hands perform grip movements. In this case, the back is straight, bent in the waist area. Usually 12 sets of 8 moves are performed.

Exercise "big pendulum": Standing or sitting, feet shoulder-width apart. Bend forward, touch the floor with your hands and exhale. Immediately lean back and hold your shoulders with your hands. Take another breath. Breathe in random order between breaths. Usually 12 sets of 8 moves are performed.

Exercises "steps": Standing, feet shoulder-width apart. Bend your left leg and raise it to the level of your abdomen. From the knee, the foot must be straightened, the Toe is pulled. In this case, you should sit a little on your right leg and take a short breath. Return your legs to their original position after squatting. Then, do the same by lifting the other leg forward. Keep the body straight. This algorithm can be repeated by pulling the legs back one by one. Usually inhale at least 8 times.

4. Conclusions

An analysis of scientific literature was carried out on the topic of a new coronavirus infection and found out the relevance of the problem of physical rehabilitation of people who have experienced pneumonia associated with COVID-19.

A physical rehabilitation program for people with COVID-19-related pneumonia has been developed and theoretically based.

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