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Short-term cardiopulmonary rehabilitation program in a post-COVID-19 patient: a case report

Protocolo de reabilitação cardiopulmonar de curto período em um paciente pós-COVID 19: relato de caso

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ABSTRACT

We aimed to report a successful clinical case of a short-term cardiopulmonary rehabilitation after hospital discharge due to COVID-19. Exploratory descriptive case study with a 58-year-old male, former smoker, and in need of supplemental oxygen after COVID-19 infection, admitted to a cardiopulmonary rehabilitation program of six weeks in a school clinic in the Federal District, Brasília, Brazil. Chest expansion, aerobic capacity, physical function, and quality of life were evaluated before and after the program using, respectively, thoracic cirtometry, 6-Minute Walk Test, 1-Minute Sit-To-Stand Test, and Short Form Health Survey. At the end of the cardiopulmonary rehabilitation, the patient presented increased chest expansion, increased walked distance with decreased perception of exertion, increased repetitions in the 1-minute sit-to-stand-test, and increased quality of life. Moreover, he was completely weaned from supplemental oxygen. A short-term duration cardiopulmonary rehabilitation protocol can contribute to improvement in aerobic and functional capacity, and in quality of life after COVID-19.

Keywords: COVID-19; Pulmonary rehabilitation; Exercise therapy.

RESUMO

O objetivo deste estudo foi relatar um caso clínico bem-sucedido de reabilitação cardiopulmonar de curta duração após alta hospitalar pós COVID-19. Trata-se de um estudo de caso exploratório descritivo com um homem de 58 anos, ex-tabagista e com necessidade de suplementação de oxigênio após infecção por COVID-19, admitido em um programa de reabilitação cardiopulmonar de seis semanas em uma clínica escola do Distrito Federal – Brasília, Brasil. A expansão torácica, capacidade aeróbia, função física e qualidade de vida foram avaliadas antes e após o programa por meio de cirtometria torácica, teste de caminhada de 6 minutos, teste de sentar e levantar de 1 minuto e Short Form Health Survey, respectivamente. Ao final da reabilitação cardiopulmonar, o paciente apresentou aumento da expansão torácica, aumento da distância percorrida com diminuição da percepção de esforço, aumento das repetições no teste de sentar e levantar de 1 minuto e aumento da qualidade de vida. Além disso, o desmame completo do oxigênio suplementar também foi alcançado. Um protocolo de reabilitação cardiopulmonar, ainda que de curta duração, pode contribuir para a melhora da capacidade aeróbica, funcional e da qualidade de vida após a COVID-19.

Palavras-chave: *COVID-19; Reabilitação pulmonar; Exercício físico.*

Introduction

The coronavirus disease 2019 (COVID-19) pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has led to increased hospitalizations worldwide[1]. COVID-19 symptoms may range from mild to severe respiratory distress due to alveoli damage, often requiring oxygen supplementation with or without ventilatory support[2]. The disease may result in critical illness and death, mainly in individuals who are inserted in risk groups, such as the elderly, smokers, diabetics and hypertensives[3].

For survivors of COVID-19, an increasing body of literature has reported long-term functional impairments and reduction in quality of life, which is known as post-COVID syndrome[4]. The post-COVID syndrome is a complex multisystem dysfunction with symptoms that include persistent cough, neuromuscular weakness and fatigue, impaired ventilatory capacity, and desaturation with exertion, besides several extra-respiratory complications[5]. Due to the persistent symptoms, cardiopulmonary rehabilitation has been increasingly demanded after hospital discharge[4].

Cardiopulmonary rehabilitation is widely being prescribed for chronic respiratory and cardiac diseases[6,7]. However, the COVID-19 outbreak has required from rehabilitation services the development of strat-

egies to deal with a new disease whose consequences are not yet fully known. For example, many strategies adopted currently are based on studies and experiences from previous acute viral respiratory diseases, such as the SARS-CoV in 2002 and the Middle East Respiratory Syndrome (MERS)[5]. Besides, many settings must absolve the impact from the large numbers of patients requiring rehabilitation with few technologic and equipment options, which adds a challenge in developing efficient and effective treatment protocols.

Protocols of cardiopulmonary rehabilitation are under development worldwide for COVID-19. Experiences from existing services should be shared to provide a base to clinicians and researchers to further develop their approach. Therefore, we aimed to report a successful clinical case of a patient admitted to our cardiopulmonary rehabilitation service after hospital discharge due to COVID-19, who complained of persistent respiratory symptoms, limited physical function and reduced quality of life.

Methods

This was an exploratory, descriptive case study, whose objective was to report the effects of a short-term, exercise--based, cardiopulmonary rehabilitation program on the cardiopulmonary physical function, and quality of life of a male, former-smoker patient with history of hospitalization due to COVID-19 infection. This research was approved by the ethics and research committee of the Foundation for Teaching and Research in Health Sciences (CAEE: 34008620.5.0000.8093). Prior to the beginning of the study, the Informed Consent Form was sent to the participant with information about the research. This study was conducted in the public school clinic of Physical Therapy of a private University (ICESP) (Brasília, Distrito Federal, Brazil) to which the patient was admitted to a short-term cardiopulmonary rehabilitation protocol (six weeks), from May to June 2021.

Case Report

A 58-year-old male, body mass: 78 kg, height: 1.85 m, former smoker (with history of hypertension using regular medication (losartan potassium 50 mg/day and hydrochlorothiazide 25 mg/day), with previous diagnosis of COVID-19 detected in nasopharyngeal swab.

On March 30, 2021, the patient manifested the initial symptoms of COVID-19. On the same day, he was diagnosed with COVID-19, detected in nasopharyngeal secretion. He was monitored at home by his sister, who is a Healthy Professional (Nurse Technique), and started using supplemental oxygen through a nasal cannula at 3L/min (data not informed). He started the use of Levofloxacin (for five days) and Dexamethasone on the first day of symptoms, in home. Moreover, he started using Azythromycin and Ceftriaxone on April 7, 2021. He also performed chest computerized tomography on April 7, 2021, which showed less than 25% lung damage, and centrilobular emphysema. On April 11, 2021, he requested the local emergency mobile service due to increased respiratory discomfort and desaturation, presenting peripheral oxygen saturation (SpO2) less than 87%. After assessment by the emergency mobile service, a non-rebreathing mask at 6 L/min of oxygen was installed and there was improvement in the respiratory discomfort and in desaturation (SpO2 > 93%). He was admitted to the emergency room of the Regional Hospital of Taguatinga (Brasília, Distrito Federal, Brazil) on the same day. At the hospital, the patient was transferred to the intensive care unit (ICU) and then to the ward, but the patient did not remember when the transitions occurred. During hospitalization, he developed type 2 diabetes and started using insulin. He was also treated with Meropenem (April 11 to 12), Dexamethasone (April 11 to 13), Tazocin (April 12 to 20), Methylprednisolone (April 13 to 22), and Prednisone (Started on April 26). There was no need for orotracheal intubation, and the patient remained lucid and oriented. On May 6, 2021, after 26 days of hospitalization, the patient was discharged from the hospital requiring home oxygen through a nasal cannula at 3 L/min, and presenting transitory desaturation with minor to moderate exertion. A bronchodilator formoterol fumarate dihydrate (12 mcg) was also prescribed twice a day, and the patient was formally referred to cardiopulmonary rehabilitation.

The cardiopulmonary rehabilitation with the initial assessment started on May 13, 2021. The first treatment session was on May 17, 2021 and the last session on Jun 24, 2021, with a total of 10 sessions over a six-week period. The sessions took place in the afternoon, from 2 pm to 3 pm. The final assessment occurred on June 28, 2021. All assessment and sessions were conducted by the same group of students from the Faculty of Physical Therapy, supervised by two assistant professors of physical therapy. Data collection was performed by the researchers through the assessment and clinical records.

Assessment protocol

In the initial assessment, the patient complained of

dyspnea on slight exertion, persistent dry cough and weight loss. The following vital signs were obtained: SpO2 92% with supplemental oxygen through a nasal cannula at 5 L/min, pulse rate (PR): 90 ppm, respiratory rate (RR): 28 bpm, and systolic/diastolic blood pressure (BP): 120/80mmHg. On physical examination of the respiratory system, thoracic cirtometry was performed (8). We recorded the values of the difference between full expiration and full inspiration of the chest circumference in the axillary region, xiphoid process and twelfth rib.

For the assessment of the aerobic capacity, the 6-Minute Walk Test (6MWT) was used[9]. The test was performed in an enclosed corridor with a hard surface and free of transit from other people. The total distance of 30 meters was demarcated every three meters to control the distance traveled. The examiners instructed the patient to walk the marked distance walking as fast as possible, without running, for 6 minutes. Every 1-minute verbal, encouragement and information about the duration of the test were given to the participant. A pulse oximeter was used to monitor PR and SpO2, before, during, and after the test, as well as a full-color printed Modified Borg Scale (MBS) to monitor the subjective perception of effort. The MBS grades the perceived effort from 0 (zero) to 10 (ten), where 0 is "rest" and 10 is "maximum exertion". BP and RR was monitored before and after the test. A validated equation was used for the calculation of the predicted walked distance to compare the distance achieved by the patient with his predicted distance[10].

For functional assessment of the lower limbs, the 1-Minute Sit-To-Stand Test (STST) was used[11] A 46 cm chair was used, without support for the upper limbs, and with backrest. The test started with the patient sitting in the chair, with the spine fully supported on the backrest and the feet touching the floor. Care was taken to support the chair on a wall to avoid fall during the sitting phase of the test. The participant was instructed to sit fully in the chair and stand up by fully extending the knees as quickly as possible and as many times as possible in a period of 60 s without performing postural compensations and keeping the upper limbs crossed in front of the chest.

Quality of life was assessed using the Short Form Health Survey (SF-12) questionnaire. It was composed of 12 self-diagnostic items that evaluate pain, physical, functional, and biopsychosocial aspects, including the self-perception about their current state of health[12]. For comparison purposes, the questionnaire was applied at two different moments, in the first assessment and 3 weeks after the end of the rehabilitation program.

Cardiopulmonary rehabilitation protocol

The cardiopulmonary rehabilitation protocol is described in Table 1. In summary, all sessions consisted of aerobic, resistance, and breathing exercises. The aerobic training where performed on a stationary bike during 20 to 30 minutes with a cadence to maintain an intensity between 50% to 80% of heart rate reserve[9]. The resistance training for major muscle groups of the upper and lower limbs were performed with dumbbells or ankle weights (10 to 20 repetitions in 2 to 3 sets)[6]. Lung expansion exercises were provided by coaching the patient to breath in maximally through the nose to total lung capacity, with and without pacing control, them hold for three seconds, and them to breath out slowly through the mouth with pursed lips. The exercises were performed in sitting and in supine to provide different stimulus to the diaphragm. The management of anxiety was provided during cough attacks and respiratory discomfort[13].

Results

This study reported the case of a former smoker patient referred for cardiopulmonary rehabilitation after hospital discharge due to COVID-19 infection, and in need of supplemental oxygen due to SpO2 below 90% in room air. The patient reported that he initially needed to increase his oxygen supply to perform basic personal hygiene. Also, when taking a shower, he had to sit in a chair due to fatigue. The patient self-managed his bronchodilator medication during the rehabilitation period, and chose to discontinue its use complaining that it intensified the coughing attacks.

During the therapeutic exercises, the oxygen supply was continually adjusted according to the patient's need, with a target SpO2 ≥ 93%. Each exercise (Table 1) was performed according to patient's capacity, so we were constantly obtaining feedback from the patient to maintain a challenging stimulus without worsening symptoms. For example, the patient presented constant crises of intense and non-productive cough with minor efforts, which improved over the course of rehabilitation. After the fourth week of treatment, the patient was able to maintain adequate SpO2 in rest and minor efforts in room air, without signs of respiratory distress. The weaning process from supplemental oxygen was completed in the 5th week of rehabilitation.

Table 1 – Cardiopulmonary rehabilitation protocol for a post-COVID, 58-year-old male patient.

Type of exercise	Exercises	Progression/Load	Intensity/Duration
Aerobic exercise	Stationary bike.	2 to 4 kg (ankle weight) + adjust cycling cadency to match 50% to 80% of the reserve heart rate.	20 to 30 minutes; 2 times per week.
Resistance training for lower limbs	Hip flexion; plantar flexion; Hip abduction; Knee extension; Squat.	2 to 4 kg (ankle weight).	10 to 20 repetitions; 2 to 3 sets; 2 times a week.
Resistance training for upper limbs	Shoulder lift; Elbow flexion; Elbow flexion with shoulder lift; Shoulder abduction and adduction.	2 to 4 kg (dumbbell).	10 to 20 repetitions; 2 to 3 sets; 2 times a week.
Lung expansion exercises	Lung expansion exercises; paced breathing; pursed lips breathing.	Increase repetitions with improved performance.	10 to 20 repetitions; 2 to 3 sets; 2 times a week.

Table 2 – Description of vital signs and walked distance for the 6-Minute Walk Test before and after cardiopulmonary rehabilitation.

	Assessment (Initial)	Assessment (Final)	Reassessment (Initial)	Reassessment (Final)
Modified Borg Scale	3	7	0	3
SpO2 (%)	94	86	94	79
PR (ppm)	90	135	94	120
RR (bpm)	35	38	27	28
BP (mmHg)	100/90	130/80	120/80	120/75
Walked distance (m)	320		480	
% of predicted walked distance	71		106	

PR = pulse rate; RR = respiratory rate; BP = blood pressure.

The thoracic cirtometry showed an initial thoracic expansion of 2.0 cm, 0.5 cm, and 1.0 cm for the axillary, xiphoid process, and twelfth rib regions, respectively. After cardiopulmonary rehabilitation, the measures for the axillary and xiphoid process showed increases of 3.0 cm, 2.0 cm respectively; the twelfth ribs regions maintained the initial value.

Table 2 describes the vital signs and the walked distance in the 6MWT before and after the cardiopulmonary rehabilitation. The predicted distance was 453 m. Initially the patient was able to walk 320 m (71% predicted distance), with supplemental oxygen. The test had to be interrupted two times, after the first minute, where the patient rested seated on a chair for one minute, and on the fifth minute, the test being then interrupted the clock timer was not paused at any time. That is, the patient walked for a total of four minutes. In the reassessment, the patient walked 480 m (106%), in room air, and without interruption.

Table 3 shows the results on the STST before and after cardiopulmonary rehabilitation. Initially the patient performed 14 repetitions, reporting a perceived exertion of 9. In the reassessment, the patient was able to perform 19 repetitions with a perceived exertion of 7.

Table 4 shows the detailed scores obtained in the SF-12 before and after the cardiopulmonary rehabilitation. Broadly speaking, three weeks after the end of the rehabilitation, he felt more willing, did not report dyspnea on minor to moderate efforts, and was able to carry out activities of daily living without interruption or support.

Table 3 – Description of subjective perception of effort and repetitions for the 1-Minute Sit-To-Stand Test before and after cardiopulmonary rehabilitation

	Assessment	Reassessment
Subjective perception of effort	9	7
Repetitions (n°)	14	19

Table 4 – Description of Scores of the Short Form Health Survey (SF-12) before and three weeks after the end of cardiopulmonary rehabilitation program.

Items	Assessment	Reassessment
1 - State of health	4 (fair)	2 (very good)
2 - Moderate activities	1 (Yes, limited a lot)	3 (No, not limited at all)
3 - Climb stairs	1 (Yes, limited a lot)	3 (No, not limited at all)
4 - Did less than you'd like	1 (Yes)	2 (No)
5 - Difficulty at work	1 (Yes)	2 (No)
6 - Felt less motivated	1 (Yes)	2 (No)
7 – Less careful	1 (Yes)	2 (No)
8 -Influence of pain	1 (Not at all)	1 (Not at all)
9 - Calm / Quiet	4 (Some of the time)	2 (Most of the time)
10 - Felt more energy	4 (Some of the time)	1 (All of the time)
11 – Discouraged/ Depressed	4 (Some of the time)	5 (A little of the time)
12 – Interference on Social Activities	1 (All of the time)	3 (Some of the time)
Final Score	24	28

Discussion

This study aimed to report a case of a male patient referred for cardiopulmonary rehabilitation after COVID-19 infection requiring hospitalization. When starting rehabilitation, the patient needed supplemental oxygen and reported dyspnea and dry cough on minimal exertion, which may have contributed to reduced quality of life. At the end of the program, the proposed objectives were achieved and the patient no longer demanded supplemental oxygen, performed home daily activities without interruption by respiratory distress, and reported an improved quality of life. Thus, an exercise-based rehabilitation program can be effective in improve post-COVID symptoms.

In the present case, the patient' most distinctive characteristic was the high RR in rest, probably caused by reduced tidal volume, which requires an increased RR to maintain adequate minute volume[14]. Once lung damage and fibrosis reduces lung function, including tidal volume[15], this may have occurred in the patient, as implied by thoracic cirtometry. In order to improve this condition, lung expansion exercises were prescribed, with the aim of reversing atelectasis, reducing the pulmonary elastic recoil load, and increasing the strength of the respiratory muscles. Moreover, it is possible that aerobic and limb resistance training indirectly contributed to improvement in respiratory variables[16]. During rehabilitation, we target the aerobic training at a moderate intensity between 50 to 80% of the heart rate reserve, which is a range able to promote cardiovascular, pulmonary and physical adaptations[9].

As demonstrated in Table 2, the patient remained with tachypnea at rest after six weeks of rehabilitation, despite significant improvement. Interestingly, on the reassessment, he presented RR = 27 bpm at rest, prior to starting the 6MWT, but reported no exertion (MBE = 0/10), and was with adequate SpO2 in room air. It is possible that the respiratory muscle conditioning improved to operate with an elevated RR. However, it is ideal the attempt to achieve a lower RR, which could be possible with a longer period of rehabilitation or other rehabilitative interventions[17]. In addition, other factors should be considered. For example, post-traumatic stress symptoms is not uncommon in COVID-19 patients[18], and this condition may cause tachypnea by central mechanisms, such as anxiety[19].

Our program was able to improve the patient's lower limb function, as assessed by the STST (Table 3). The ability to stand from a sitting position and return to the initial position is an essential activity that allows other activities to be carried out safely. Prior to beginning the rehabilitation, the patient was able to perform only 14 repetitions, which is likely to be found in elderly patients with chronic obstructive pulmonary disease[11]. After rehabilitation, the patient performed 19 repetitions, which is similar to that achieved (20 ± 4) by healthy individuals aged 62.80 ± 7.65[11]. Once the patient is a former smoker, these results are promising.

After hospital discharge, post-COVID-19 patients also acquire other multisystem dysfunctions in addition to cardiopulmonary complaints[5]. Moreover, patients with cardiopulmonary diseases are more likely to be affected by a sedentary lifestyle. If not well managed, other related problems may arise, including increased disability, reduced quality of life, depression, anxiety, and premature death[20]. Thus, cardiopulmonary rehabilitation should be more promptly available to these patients. Despite the importance of an exercise-based program, other health professionals are necessary to compose an integral program. We have in our setting the experience of referring some patients to psychologic consultation. However, an integral approach during the entire course of therapy could increase the effectiveness of rehabilitation. Furthermore, the patient from this case report complained of weight loss, which could be addressed by a nutritionist.

The ultimate purpose of a cardiopulmonary rehabilitation is to restore the patients' autonomy in managing their daily life and, as much as possible, return them to their work and leisure activities. To achieve these objectives, cardiopulmonary rehabilitation combines aerobic, resistance, respiratory training, and counseling[7,9]. In the present case, the patient reported an increase in quality of life, which indicates that the cardiopulmonary and functional improvements were successfully translated into benefits in daily life.

As a limitation of the study, the patient did not undergo pulmonary function test, such as spirometry, neither before the COVID-19 infection or after. Thus, it is not possible to attribute all the impairments solely to the hospitalization process. For example, the reduced chest expansion could be a consequence of pulmonary injury do to past history of smoking. The extent of COVID-19 consequences in previously healthy individuals will probably be more well known in the following years. Moreover, we could not know the real extent of the improvement in pulmonary function after the rehabilitation. Finally, we presented a cardiopulmonary rehabilitation program conducted in a setting with limited equipment

and technological resource, so other therapeutic resources could be available. Nevertheless, the present case highlights the effectiveness of exercise-based interventions.

Thus, it is concluded that six-weeks, exercise-based, cardiopulmonary rehabilitation program improved cardiopulmonary and physical function, and quality of life in a post-COVID patient with comorbidities (former smoker, hypertension, and diabetes mellitus type 2). Further studies with larger sample sizes are necessary to investigate the effectiveness of different rehabilitation regimens in post-COVID patients.

Conflict of interest

The authors declare no conflict of interest.

Author's contributions

Souza JR, participated in the design of the manuscript, analysis and interpretation of data. Barbosa BS, participated in the writing of the manuscript and design of tables. Cavalcante JGT, participated in the writing of the manuscript, analysis, critical review of the content and translation of the manuscript. Santos JTFF, participated in the writing of the manuscript. Silva RC, participated in the analysis, critical review of the content, translation of the manuscript. Maraes VRFS, participated in the legal procedures for submitting a research protocol.

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