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Tremendous Improvement of the Functional Capacity in Patient with Chronic Heart Failure after 12-Weeks of Exercise Training Program

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Abstract

Cardiac rehabilitation is recommended for patients with chronic heart failure (CHF) with preserved, or reduced left ventricular ejection fraction (LVEF). A cardiac rehabilitation program generally includes physical exercise, diet counseling, educational classes on lifestyle changes, and disease management as well as psychosocial support for patients and their families. Exercise training is a core component of the comprehensive cardiac rehabilitation program and is strongly recommended in combination with pharmacological treatment to patients with CHF, due to cardiorespiratory, metabolic, and autonomic cardiac response. Exercise-based cardiac rehabilitation affects positively functional capacity, exercise tolerance, and quality of life in CHF patients. The physical inactivity rate in Arabian Peninsula countries is extremely high, and exercise training of habitually physically inactive individuals should result in marked improvements of physical capacity. We present a case that demonstrates such a significant improvement in the physical capacity of a patient with CHF and a review of literature.

Keywords

Cardiac Rehabilitation, Chronic Heart Failure, Low-Intensity Interval Training, Functional Capacity

1. Introduction

Cardiac rehabilitation (CR), according to the World Health Organization guidelines, is defined as "the comprehensive and coordinated use of medical, social, educational and professional resources to accommodate patients to a new lifestyle and enable them to achieve the best performance" [1].

The cardiac rehabilitation program consists of physical exercise sessions, dietary counseling, educational classes on lifestyle changes, and psychosocial support to patients and their families.

Supervised exercise training remains a core component of the cardiac rehabilitation program, focusing on aerobic, resistance, neuromotor and flexibility components. Exercise training is strongly recommended for patients with chronic heart failure (CHF) at a class 1 evidence level [2].

The benefits of exercise-based cardiac rehabilitation (in terms of improved functional capacity, exercise tolerance and quality of life) have been widely recognized [3]. The exercise-based program has positive effects on reduction of the re-hospitalization rates and mortality [4]. Many studies of CHF patients have demonstrated improvements of 18% to 25% in peak oxygen uptake [5]. In a retrospective study by Martin, a cohort of 5400 patients with CHF was categorized into low, moderate and high cardiorespiratory fitness groups based on an initial exercise test. After 12-weeks of exercise training, an improvement of 1.4, 1.0, and 0.8 METs, respectively, were observed, with a greater improvement in the lowest fitness group [6]. The physical inactivity rate in the Kingdom of Saudi Arabia is extremely high, mainly due to weather and sociocultural barriers (frequent use of private drivers and housemaids, belief that exercise is not a social activity, lack of knowledge and/or motivation). Some-issues relate specifically to women as they are not expected to perform physical activity in public. Cardiac rehabilitation in the Kingdom of Saudi Arabia is still under development, therefore little is known about functional capacity improvement of habitually physically inactive Saudi patients. We observed a significant improvement of functional capacity (by 5.4 MET) in patient with CHF a severe impairment of the left ventricular systolic function (LVEF20%).

2. Case Report

A 40-year-old male patient, an active smoker (10 cigarettes a day), diagnosed with dilated cardiomyopathy, arterial hypertension, dyslipidemia, and mild mitral regurgitation was referred to the Cardiac Rehabilitation Unit at Prince Sultan Cardiac Center, Riyadh. He complained of shortness of Breath at New York Heart Association (NYHA) class II on presentation in March 2019. The patient's medication regimen included Concor 10 mg once a day, Aldactone 25 mg once a day, Lasix 40 mg once a day, Entresto 200 mg twice a day, Aspirin 81 mg once a day, and Lipitor 40 mg once a day. The patient has been clinically stable on this treatment for the preceding few months.

During a physical examination, his heart rate, blood pressure, and oxygen saturation were within normal limits (blood pressure 109/60 mmHg, heart rate 78 beats per minute, oxygen saturation 99% in room air).The lung examination showed no crepitations or rales. Chest x-ray revealed cardiomegaly, no interstitial edema or pleural effusion. The heart assessment revealed a grade 2 systolic murmur over the apex area. The transthoracic echocardiography revealed a moderately dilated left ventricle and severe impairment of left ventricular systolic function (severe global hypokinesis, end-diastolic volume of 155 ml, left ventricular fractional shortening 12%, ejection fraction of 20%). There was also grade II diastolic dysfunction and mild mitral regurgitation. An initial graded stress test on a treadmill utilizing a modified Bruce protocol had been stopped due to significant shortness of breath after reaching 5.0 METs, which indicated low functional capacity, according to the American Association of Cardiovascular and Pulmonary Rehabilitation guidelines. The patient's exercise training program included low-intensity aerobic interval training and stretching exercises. Resistance training was implemented after 2 weeks of well-tolerated aerobic component. Aerobic training consisted of 5 minutes of warm-up exercise, followed by low-intensity interval training (LIIT) on treadmill, with a subsequent 5-minute cool-down. The duration of the aerobic sessions was increased from 20 min in the first sessions to 40 min after 12 weeks. The duration of active phases as well as the recovery phases were 2 minutes, and after reaching 40 minutes of total training duration, training intensity was increased with an increase in speed for active phases of up to 3.5 km/h (starting from 2 km/h).The training heart rate zone during active phases was set as 95 - 100 bpm. Training was monitored in terms of the patient's heart rate, electrocardiogram, and symptoms. Blood pressure was monitored before and after training. Resistance training was initiated after 2 weeks and included an initial work-to-rest ratio of 1:2, *i.e.* 30 - 60 seconds of exercise with a subsequent 1 - 2-minute rest. Full resistance training progression was reached after 4 weeks. Patient before presentation to Cardiac Rehabilitation Unit underwent already respiratory (inspiratory muscle) training 3 times as week 20 min for 8 weeks. All exercise training components have been demonstrated in **Table 1** Following the 12-week program, both physical capacity and echocardiographic parameters of the left ventricular systolic function significantly improved. The control echocardiogram revealed end-diastolic volume of 147 ml, left ventricular fractional shortening of 15%, and left ventricular ejection fraction of 27%. Control graded stress test on treadmill utilizing the modified Bruce protocol had been terminated due to significant shortness of breath after reaching 10.4 METs. Both exercise tests were terminated at similar heart rate levels (125 bpm and 128 bpm, respectively).

3. Discussion/Review of Literature

3.1. Role of Exercise Training in Patients with CHF

The loss of physical function in a patient with heart failure is well documented and contributes to difficulties in performing daily living tasks. The impairment of functional capacity in CHF individuals is a result of impaired cardiac output response to exertion, impaired vasodilation, and increased systemic vascular resistance [7]. Skeletal muscle dysfunction (reductions in muscle mass, strength, and endurance) also contributes to the increased fatigue and exercise intolerance

Table 1. Training components.

Training mode	Duration	Frequency	Intensity	Type
Aerobic (with warm-up and cool-down)	Initial: 20minutes Final: 40 minutes	Twice a week	Initial: 40% - 50% of heart rate reserve Final: 50% - 60% of heart rate reserve	Walking On teadmill
Resistance (after stretching)	Initial: 10 minutes Final: 20 minutes	Twice a week	30% - 40% of 1-repetition maximum 1 set 8 - 12 repetitions 8 muscle groups	Using dumbbells and elastic bands
Stretching (after aerobic and resistance part)	5 minutes in total 2 × 30 - 60 sec stretches	Twice a week	Stretch to a point of feeling tightness or slight discomfort	Static flexibility

in this population. Exercise training is strongly recommended for patients with CHF; and as the non pharmacological intervention has become widely accepted, with both aerobic and resistance exercise being shown to be efficacious in CHF patients. Exercise training in patients with CHF is associated with reduction of sympathetic activity (reduced levels of plasma norepinephrine and muscle sympathetic nerve activity) and an increase in parasympathetic tone (increase in heart rate variability and baroreflex sensitivity).

Besides, regular exercise improves endothelium-dependent vasodilatation and has anti-inflammatory effect [8].

Beneficial effects of exercise training include an increase in the maximal oxygen uptake by (2.1 ml/kg/min), prolonged exercise duration (by 2.3 min), increase in peak work (by 15 Watts) or walking distance in a 6 min walk test [9].

3.2. Exercise Prescription for Patients with CHF

An appropriate exercise prescription in patients with heart failure is complex and requires knowledge about underlying causes, recent pharmacotherapy, and the current status of the patient's functional capacity. The initial exercise intensity should be optimally based on the cardiopulmonary exercise test (CPET) with an initial training intensity set at 40% - 50% of peak oxygen uptake, which can eventually be progressed to 70% - 80%. If CPET is unavailable, an intensity of 40% - 70% of the heart rate reserve and Borg scale 10 - 14 are recommended. Ideally, an initial work-to-recovery time ratio of 1:2 or 1:1 is recommended. Active phases can be as short as 10 - 30 sec initially, and recovery phases should be rather passive (0 Watts for cycle ergometer, 1 - 2 km/h speed for treadmill).

Training intensity can be increased in the total time and/or a change in the work-to-recovery time (*i.e.*, prolonged duration of active segments and/or by shortening the recovery time).

3.3. Review of Literature

As mentioned earlier, studies in CHF patients have demonstrated improvements of 18% to 25% in peak oxygen consumption and 18% to 34% in peak exercise duration with improvement in symptoms, functional class, and quality of life [10]. It is related to increased cardiac output (by prolonged ventricular filling and higher stroke volume) and oxygen extraction by working the muscles. Exercise training in patients with CHF and reduced left ventricular ejection fraction (<35%) was associated with a reduced incidence (11%) of the combined all-cause mortality or hospitalization [11]. As discussed earlier, the lower the initial cardiorespiratory fitness the greater the final improvement. It has been documented that aerobic exercise can lead to improvement of LVEF by 2.5% [12].

3.4. Training Results and Discussion

In the case of our patient, aerobic training had been interval in nature, which is consistent with the finding that the interval training group showed higher oxygen consumption, more pronounced reverse left ventricular remodeling, or an increase in EF compared to continuous moderate-intensity exercise training in CHF patients [13]. We implemented resistance training after 2 weeks of well-tolerated cardiorespiratory (aerobic) component. As mentioned earlier, after 12 weeks of exercise training, the functional capacity of the patient tremendously increased from 5.0 to 10.4 METs. There was also a significant improvement of left ventricular systolic function (LVEF improved by 7%). The physical inactivity rate in Arabian Peninsula countries is extremely high, with the highest prevalence in the Kingdom of Saudi Arabia, with, specifically, 61% of males and 73% of females being physically inactive [14] [15]. Two of the most reported barriers to physical activity are weather and sociocultural barriers.

Therefore exercise training of habitually physically inactive individuals may result in such significant improvement of physical capacity, and in prominent reduction of cardiovascular mortality. Obviously the development of cardiac rehabilitation services throughout the Kingdom of Saudi Arabia could be a real milestone in the treatment of patients with cardiovascular diseases. Although case reports are lowest level of evidence, we observe at our center on regular basis such a significant improvement of physical capacity in patients with CHF.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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