ORIGINAL ARTICLE

CONTENTS

Landscape therapy: rehabilitation potential in patients with post-infarction cardiosclerosis

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ABSTRACT

Aim: To evaluate the rehabilitation potential, effectiveness and safety of landscape therapy in the complex rehabilitation treatment of patients with post-infarction cardiosclerosis (PC) complicated by chronic post-infarction cardiac aneurysm (CPCA) at the sanatorium stage.

Materials and Methods: We examined 62 patients with PC complicated by CPCA aged 38 to 65 years. Patients were randomized into two groups: the 1st group was undergoing the "Progressive gait" physical activity protocol in the city, and the 2nd group - in the rehabilitation department in a sanatorium. Survey, six-minute walk test, electrocardiography, echocardiography, coronary angiography were performed.

Results: The average distance that 2nd group patients walked in 6 minutes increased from 301.00 ± 17.00 to 467.00 ± 32.00 m ($p<0.05$). Only in patients of 2nd group during 3 weeks of complex rehabilitation there was a decrease in body mass index from 23.70 ± 1.60 to 18.90 ± 1.50 and the diameter of the calf muscle significantly increased from 33.90 ± 2.30 cm to 38.10 ± 3.10 cm ($p < 0.05$). Ejection fraction in the 2nd group was 51.00 ± 4.50% compared to the 1st group - 44.70 ± 3.60% ($p < 0.05$), which was accompanied by a decrease in the functional class of heart failure in patients of the 2nd group.

Conclusions: The rehabilitation potential of landscape therapy in the complex rehabilitation treatment of patients with complicated PC at the sanatorium stage is determined by a significant improvement in myocardial contractility and physical endurance of patients, and improving the quality of life.

KEY WORDS: landscape therapy, rehabilitation potential, post-infarction cardiosclerosis

Wiad Lek. 2024;77(4):696-702. doi: 10.36740/WLek202404113 DOI

INTRODUCTION

Restorative treatment is a modern direction of medicine, the task of which, in addition to clinical and preventive, consists in increasing the adaptive capabilities of a person, increasing the health potential and maintaining the body at a high level of functioning [1-5]. Climate therapy and landscape therapy occupy a special place in the large arsenal of rehabilitation methods. It is these important components that are concentrated in sanatorium-resort treatment facilities in Vinnytsia, which is geographically located on the territory of Eastern Podillia of Ukraine, the 320-kilometer-long valley of the Southern Bug, which is rich in picturesque landscapes, mineral springs, historical, cultural and architectural heritage. The components of recreational areas of Vinnytsia are climate, natural landscape, objects of garden and park art, and anthropomorphic architecture. An exceptional part of this heritage is the ancient palace and park estates, many of which are adapted into sanatorium-type medical institutions, where patients of all ages and nosological categories are treated annually. The components of landscape art in rehabilitation treatment include dendrological, floristic and landscape compositions (alpine slides, terracing, parterres, lawns), sculpture and water features (fountains, ponds, waterfalls) [1].

The problem of real implementation of physical rehabilitation in everyday clinical practice of treating patients with post-infarction cardiosclerosis (PC) is extremely multifaceted. On the one hand, the rapid development of heart failure (HF), high mortality, low quality of life, and negative attitude towards others are characteristic of this clinically severe contingent of patients [6]. On the other hand, physical training of patients who have suffered a myocardial infarction (MI), thanks to an increase in tolerance to physical exertion, increases the maximum consumption of oxygen by the heart muscle, reduces the demand of the myocardium for the latter and contributes to a more economical consumption of oxygen. At the cellular level, the

functional failure of the muscle is characterized by the restructuring of mitochondria [7, 8].

The above-mentioned processes are manifested, first of all, by the inability to develop sufficient effort. Kiilavori K. et al. [9] found that the maximum effort of the transverse striated muscle in patients with III-IV functional classes of HF is 2.8 times less than in a healthy person, i.e. the value of the maximum effort developed by the transverse striated muscles is inversely proportional to the HF class, and the feeling of fatigue that occurs in a patient with HF during dosed physical activity is directly correlated with the degree of functional muscle failure [10, 11].

Thanks to improved methods of treating acute MI, it is now possible to rehabilitate patients even with complicated forms of PC. Post-infarction cardiac aneurysm (CPCA) is one of the variants of post-infarction cardiac remodeling, and patients with this pathology require comprehensive rehabilitation measures. A prerequisite for the comprehensive rehabilitation of patients with CPCA, especially in view of the deficit of the muscle component [1], is physical rehabilitation at different stages of complex treatment. In this regard, it is at the sanatorium and resort stage of rehabilitation of patients with CPCA that a successful combination of drug correction and physical training aimed at the main links in optimizing the provision of exercise programs becomes possible. One of the current areas of development of methods for rehabilitation of patients with PC is the study of the influence of individual patient characteristics on the optimal rate of activation.

AIM

The aim of our study was to evaluate the rehabilitation potential, effectiveness and safety of landscape therapy in the complex rehabilitation treatment of patients with PC complicated by CPCA at the sanatorium stage.

MATERIALS AND METHODS

We examined 62 patients with PC complicated by CPCA aged 38 to 65 years. The diagnosis was verified according to international criteria [1]. All patients underwent coronary angiography at the pre-sanatorium stage. All patients received conventional therapy for chronic HF [12]. Patients in both groups were activated according to the first stage of the "Progressive gait" physical activity protocol [1], which included: frequency of training - 5 times a week, distance - 10 km per week, speed - 1 km in 13 minutes. During the study, patients were randomized into two representative groups. The 1st group - 32 patients who were undergoing the "Progressive gait" physical activity protocol in the city under the supervision of the National Pirogov Memorial Medical University clinic specialists, and the 2nd group - 30 patients who were undergoing physical rehabilitation according to the "Progressive gait" protocol in the rehabilitation department of the Khmilnyk sanatorium in Vinnytsia region. The components of landscape therapy include climate, mineral springs, natural landscape, dendrological, floristic and landscape compositions (alpine slides, terracing, parterres, lawns), sculpture, water features (ponds, waterfalls) and anthropomorphic architecture [13].

Time since the last MI till the start of the rehabilitation program in patients of both groups was on average 2.34 ± 1.70 years. The majority of patients (90% of patients) were diagnosed with HF class III. Patients of both groups were in a stable condition (body weight fluctuations not exceeding 0.5 kg) for 60 days before being included in the study. All patients before the development of MI, which was complicated by CPCA, worked in their profession in full. All examinations were performed at the beginning of the comprehensive rehabilitation program and at the end of the third week of follow-up.

Electrocardiographic examination in 12 standard leads was performed on a Hungarian electrocardiograph "Heart Screen 112 D". Daily ECG monitoring was performed using a Hungarian-made Cardio Tens monitor complex. The day before the examination, the patients were discontinued all antianginal drugs, except for the sublingual form of nitroglycerin in angina attacks.

Exercise tolerance was assessed based on the results of a six-minute walk test. This test was performed according to the recommendations of the European Society of Cardiology and the Society of Heart Failure Specialists (2001) [14].

The test scores correlate well with the NYHA HF functional class. Each functional class corresponds to its own walking distance, and each class is significantly different from the others, with differences in walking distance reaching 100 meters between "neighbouring" classes.

The type of motor activity of the aneurysm, geometric, structural and hemodynamic characteristics of the heart muscle were determined by echocardiography, which was performed in standard positions on an ultrasound system manufactured by Aloka SSD-630 (Japan) with a mechanical transducer with a frequency of 3.5 MHz.

The quality of life of patients was determined using the Medical Outcomes Study 36-Item Short Form health survey (SF-36) [15]. To ensure the reliability of the results, a control group of 20 healthy volunteers was formed. The SF-36 reflects patients' satisfaction with their physical and

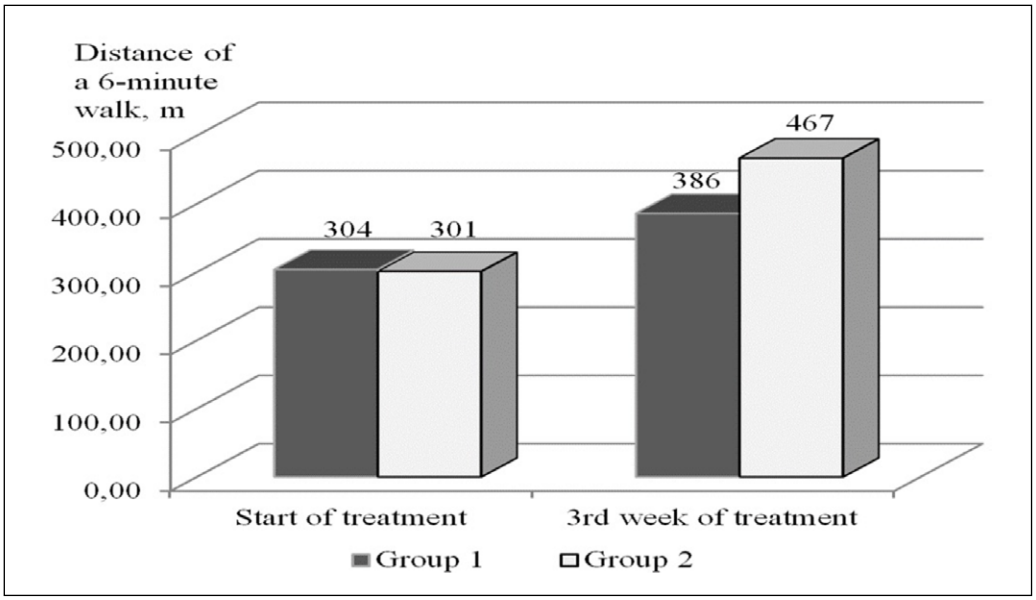

Fig. 1. Dynamics of the 6-minute walk test in patients with post-infarction cardiosclerosis complicated by chronic post-infarction cardiac aneurysm at the stage of physical rehabilitation.

mental state, social functioning, and self-assessment of pain severity. A higher score indicates better health. The following indicators were quantified:

PF - physical functioning, which reflects the extent to which health limits the performance of physical activities, as well as the tolerance of significant physical activity;

RP - the impact of the physical condition on role functioning;

BP - pain intensity and its impact on the ability to perform daily activities, including work in and outside the home;

GH - general health status - the patient's assessment of their current health status and treatment prospects, resistance to the disease;

VT - vitality - feeling full of strength and energy or, opposite, being exhausted;

SF - social functioning, is determined by the degree to which the physical and emotional state limits social activity;

RE - the impact of the emotional state on role functioning, involves assessing the degree to which the emotional state interferes with work or other usual daily activities, including large time expenditures, reduced workload, and reduced quality of work;

MH - is a characteristic of mental health.

Final value of the indicator = [(sum of final values of the items - the lowest value)/possible range of values] x 100.

Data analysis was performed in SPSS Statistics v.23. Summary statistics of mean, standard deviation and percentiles were used for quantitative measurements. The association between measures was assessed using the correlation test and t-test. The probability value was estimated at 0.05 confidence level (P=0.05).

RESULTS

The duration of coronary artery disease before the development of transmural infarction, which led to the formation of CPCA, ranged from several hours to 6 years in patients of both groups, with an average of 1.67 ± 1.59 years. The average functional class of angina in group 1 was 2.97 ± 0.13, in group 2 - 2.87 ± 0.11. The mean left ventricular ejection fraction in group 1 was 42.58 ± 3.39 %, in group 2 - 42.90 ± 3.10 %.

During the 3-week rehabilitation course, all patients significantly improved their health: shortness of breath, the number of angina attacks decreased, and a subjective impression of increased endurance of physical activity appeared. However, only in patients of 2nd group, who underwent physical rehabilitation in a sanatorium surrounded by a landscape park, these changes were accompanied by an improvement in the six-minute walk test.

The average distance that these patients walked in 6 minutes increased from 301.00 ± 17.00 to 467.00 ± 32.00 m ($p<0.05$) (Fig. 1).

Among the patients of the 1st group, 12 patients avoided the physical training protocol (irregular performance, violation of the duration of the training regimen). In the process of communicating with these patients, it was found that the monotony of covering the required meters according to the protocol every day was perceived primarily by these individuals as a heavy burden in the psychological aspect.

The maximum distance according to the test with a six-minute walk among these 12 patients was 325.00 ± 12.00 m compared to the baseline of 304.00 ± 14.00 m. Among the other patients of group 1 who followed the Progressive Gait protocol, only a tendency to increase the volume of loads was registered, the increase in the

Table 1. The effect of physical rehabilitation on the quality of life of patients with PC complicated by CPCA in the dynamics of complex rehabilitation treatment (M ± m)

Quality of life indicators	Control group of healthy volunteers (n=20)	1st group (n=32)		2nd group (n=30)	
		Before treatment	After 3 weeks of treatment	Before treatment	After 3 weeks of treatment
PF	96,1 ± 20,1	41,20 ± 6,20	48,00 ± 7,80*	41,00 ± 6,40	52,40 ± 6,30*
RP	91,0 ± 18,9	20,10 ± 4,10	26,10 ± 8,40*	19,90 ± 4,30	33,10 ± 8,70*#
BP	88,9 ± 19,3	41,30 ± 6,50	47,30 ± 8,70*	40,90 ± 6,70	55,60 ± 7,40*#
GH	74,3 ± 18,4	33,50 ± 7,60	35,40 ± 9,60	32,30 ± 7,80	45,30 ± 10,30*#
VT	64,2 ± 15,1	45,70 ± 3,50	45,40 ± 9,20	44,30 ± 3,70	54,10 ± 6,20*#
SF	86,0 ± 19,0	59,30 ± 5,00	60,20 ± 5,30	58,90 ± 5,20	66,30 ± 6,70*#
RE	67,0 ± 14,8	40,80 ± 9,50	42,60 ± 9,80	39,90 ± 9,70	49,70 ± 10,10*#
MH	68,3 ± 15,1	53,00 ± 5,40	54,70 ± 5,10	52,20 ± 5,60	64,10 ± 4,40*#

Notes:

1. * - the difference is significant compared to the indicators before treatment, $p < 0.05$.
2. # - the difference is significant compared to the indicators of the 1st group, which underwent physical rehabilitation in the city after 3 weeks of treatment, $p < 0.05$.

maximum distance in the six-minute walk test was 385.00 ± 27.00 m.

Due to the stimulating effect of landscape therapy on extracardiac mechanisms of compensation for hemodynamic disorders, patients in group 2 showed a greater degree of increase in the tolerance to physical activity, less severity of unpleasant subjective sensations compared to patients in group 1.

Only in patients of 2nd group during 3 weeks of complex rehabilitation there was a decrease in body mass index from 23.70 ± 1.60 to 18.90 ± 1.50 ($p < 0.05$), first of all, due to a decrease in the thickness of the fat layer at the level of the belly button from 3.90 ± 0.70 cm to 2.10 ± 1.30 cm. In patients with initially low body weight (less than 90% of the ideal), no decrease in body weight was observed during physical activity. Thus, regular physical activity does not lead to the progression of cachexia, but modifies the patient's body weight by reducing fat content and increasing muscle mass.

Only in patients of 2nd group, as a result of the program of complex rehabilitation, the diameter of the calf muscle significantly increased from 33.90 ± 2.30 cm to 38.10 ± 3.10 cm ($p < 0.05$).

The dynamics of the clinical picture, morphometric parameters and physical endurance fully corresponded to the changes in Echo-CG parameters characterizing the contractile function of the heart. A significant ($p < 0.05$) increase in cardiac contractile function was observed in patients of group 2 compared with baseline and group 1.

Thus, at the end of the 3rd week of treatment in the rehabilitation department of the Khmilnyk sanatorium, the ejection fraction in the 2nd group was 51.00 ± 4.50% compared to the 1st group - 44.70 ± 3.60% ($p < 0.05$), which was accompanied by a decrease in the functional class of HF in patients of the 2nd group. Regular physical activity resulted in a decrease in heart rate, ST depression depth decreased from 2 mm to 1 mm, and the duration and frequency of painless ischemia decreased by an average of 71.00% ($p < 0.05$).

Clinical and instrumental data were fully consistent with reliable quantitative changes in the quality of life of our patients: there was an increase in vitality (surge of vitality), social activity, energetic state, mental state and general health assessment compared to the group of patients who mastered the "Progressive gait" physical rehabilitation protocol in urban settings (Table 1).

Indicators of physical functioning, its impact on role functioning; pain intensity and its impact on the ability to engage in activities of daily living were significantly increased in both the 1st and 2nd groups of patients.

However, such components of quality of life as indicators of the impact of physical condition on role functioning; pain intensity and its impact on the ability to perform daily activities at the end of 3 weeks of rehabilitation were significantly higher than the same indicators in patients of the 2nd observation group.

At the end of the stay in the rehabilitation department for all patients of group 2, according to the protocol, a scheme of gradual increase in physical activity at the outpatient stage was developed, which included physical activity in accordance with the first stage for another 3 weeks and the transition to the second stage (6 weeks) - a gradual increase in distance to 21 km per week, walking speed of 1 km in 11.5 minutes. In case of poor exercise tolerance during this period, patients are recommended to return to the first stage regimen, which should be followed for life. In case of good exer-

cise tolerance within 16 weeks - lifetime preservation of the proposed regimen.

DISCUSSION

The results of our study proved that the positive dynamics of the six-minute walk test was reliable only in the 2nd group of patients at the end of the rehabilitation course. The component of a favourable psychological microclimate played an important role in this process, in particular, it was specifically the patients of the 1st group who, in their explanations of the reasons for avoiding the physical training protocol, complained about the monotony of the visual picture during exercise.

The creation of visual, psychological and climatic comfort, which is important for the rehabilitation of any directions, is directly related to the architectural environment, which is organized according to the artistic system of humanistic orientation, in which the main dimension of composition, function and imagery is a "human being".

Such architecture is built and perceived as anthropomorphic, everything in it is proportional to a real person, everything in it is understandable to a person, which ultimately creates a favourable psychological microclimate.

Mass loss is one of the processes that determine the condition of the transverse striated muscles. Its loss of more than 10% leads to a clinically significant decrease in maximum oxygen consumption [2, 16], i.e., a decrease in maximum effort and progression of functional failure. The study of peripheral muscle function [17] in patients with HF has revealed that their condition may be associated with two processes - dysfunction and weight loss. Regular physical activity leads to an increase in volumetric blood flow in the muscle group to be trained [18, 19]. The dysfunction of the transverse striated muscles is caused by a decrease in the number of active capillaries per unit volume; the formation of a predominantly anaerobic pathway of energy production [18]. An equally important problem of transverse striated muscle dysfunction is the progression of fibrosis, which is caused by a significant increase in collagen synthesis [20]. With an excessive amount of collagen, the muscle bundle moves away from the capillary, this impairs its nutrition and contributes to functional muscle failure.

It should be noted that the effectiveness of rehabilitation programs is determined by the positive results of not only the hemodynamics of the heart muscle, but also by the functional adaptation of the skeletal muscles. A significant increase in the diameter of the calf muscle, which was found only in patients of the 2nd group, correlates with the studies of E. Hambrecht, who found that 24-week training leads to a significant increase in volumetric blood flow in the calf muscles, maximum oxygen consumption, that is, to the maximum increase in the developed force [21].

A distinctive feature of our study was the intention to improve not only physical functioning but also the quality of life of patients, as the main paradigm of modern medicine.

Harmonization of the body's condition is impossible without unity with the natural environment, of which the human being remains a part at all times. Greek sculptors were well aware of the correspondence of the correct proportions of the human body to the number 0.618. Ancient architects used it in their immortal creations. For example, the ratio of the height of the Parthenon temple in Athens (5th century BC) to its length is 0.618. The Renaissance genius Leonardo da Vinci called this ratio the "golden ratio". However, the connections between medicine, architecture, and landscape art are not only historical, but also purely scientific. In the early 40s of the nineteenth century, garden and park planning and floristry were an integral part of medical education at leading German universities. Future doctors were taught to choose samples so that the garden and park compositions they created would not only bring aesthetic pleasure but also benefit health. Today, the rehabilitation of patients surrounded by picturesque nature gives amazing results not only in the subjective plane of the patients' feelings, but also in the objective plane of evidence-based medicine. The therapeutic effect of landscape therapy is associated with the harmonization of the environment and human perception of the world, the ability to create a psychological microclimate for life and treatment, and to inspire and motivate patients to physical rehabilitation [21]. Thus, landscape therapy as a stage of treatment is an optimal opportunity to initiate physical rehabilitation of patients with PC and to successfully combine physical training and drug correction [22-24].

The proposed scheme of complex rehabilitation of patients with CPCA at this stage of treatment is effective and safe; all patients of group 2 adequately withstood the regimen of the first stage of physical activity according to the "Progressive gait" protocol [25].

CONCLUSIONS

The rehabilitation potential of landscape therapy in the complex rehabilitation treatment of patients with complicated PC at the sanatorium stage is determined by a significant improvement in myocardial contrac-

tility and physical endurance of patients, overcoming myocardial detrainability, reducing the duration and frequency of painless ischemia, reducing HF and angina, and improving the quality of life.

The therapeutic effect of landscape therapy is associated with climatic comfort combined with the humanistic orientation of anthropomorphic forming, harmonization of the environment with natural objects and design tools, and the ability to create both a positive psychological microclimate and motivate patients to physical rehabilitation.

Continuation of comprehensive rehabilitation in the next stages of the program will significantly improve the prognosis and global quality of life of patients with PC, including its complicated course.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 15.11.2023
ACCEPTED: 19.03.2024