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Original article

REHABILITATION OF PATIENTS WITH CORONARY HEART DISEASE AFTER CORONARY ARTERY BYPASS GRAFTING AT THE STATIONARY STAGE

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ABSTRACT

Purpose: To study the application of low-intensity physical veloergometric loads according to a special method in the system of rehabilitation of coronary heart disease patients (CHD) after coronary bypass (CB) at the hospital stage.

Materials and Methods: We examined 84 patients (men) with CHD who underwent CB surgery: main group (n=52), the average age of 48.4 ± 0.8 years, the control group (n=32), the average age of 47.9 ± 1.11. All patients of the main group underwent exercises on a bicycle ergometer. The control group underwent rehabilitation without training but with a complex of therapeutic exercises. The following indicators are evaluated: the power of the threshold load in watt, Double product (DP), electrocardiography (ECG), heart rate (HR), respiratory rate (RR), blood pressure (BP).

Results: Training sessions on a bicycle ergometer, according to a special technique, can be carried out as a method of rehabilitation at the stationary stage, rehabilitation center, at home. The best is the effect of training in the group of patients involved in the clinic before surgery and immediately after surgery with continued classes for a year.

Conclusions: Analysis of the remote results shows that the use of physical training on this method makes it possible to improve the function of the myocardium and improve the prognosis of the disease.

Keywords: coronary heart disease, rehabilitation, physical training, coronary bypass,

INTRODUCTION

Exercise-based rehabilitation, with its numerous kinds and methods, is one of the central factors in gradual training of the cardiovascular (CV) system as part of post-CABG physical rehabilitation. The primary purpose of rehabilitation of CHD patients is gradual adaptation of the heart to exercise. This approach begins at early inpatient stage and continues throughout the rest of the rehabilitation stages [1, 2, 3, 4, 5]. The standard rehabilitation methods at the inpatient stage pre- and post-CABG consist of rehabilitation exercises, breathing exercises, cycle ergometer workouts in the sitting position, and different treadmill workouts [6, 7, 8].

The **purpose** of the study is to evaluate the effect of special-design low-intensity cycle ergometer workouts in the supine position with raised legs as part of rehabilitation program for CHD patients after CABG at the inpatient stage and to assess the long-term outcomes in 1 year by patient tests and surveys.

MATERIALSANDMETHODS

Eighty-four male patients with CHD who had a CABG surgery were examined at the inpatient stage. The tidy group included 52 patients, with an average age of 48.4±0.8 years and a disease duration of 4.3±0.4 years. The control group included 32 patients, with a mean age of 47.9±1.11 years and a disease duration of 5.1±0.7 years.

The study group was divided into three subgroups. Subgroup I (n=20) had cycle ergometer workouts in-patiently, both before the surgery and after CABG until the discharge. Subgroup II (n=22) had cycle ergometer workouts in-patiently only after CABG until the discharge. Subgroup III (n=10) had cycle ergometer workouts before CABG and completed a course of exercise-based rehabilitation with breathing exercises after CABG.

The methodology for cycle ergometer exercise consisted of workouts with a constant resistance power of 15–20 W, beginning after the CABG surgery at the early inpatient stage. The patient was in the supine position. The height of the pedal axis above the bed equaled 2/3 of the patient's thigh; the ergometer was positioned at a distance so as to allow the patient to stretch his legs, with his heel still contacting the pedal in the most distal position. The pedaling rate was 55–65 rpm. The workouts took place every day 1–2 times a day, 6 days a week, with a constant resistance power of 15–20 W. The workout duration was gradually increased while the resistance power remained constant. The starting workout duration was 10 minutes 2 times a day; by the moment of discharge, it was 20–40 minutes long (20 min on average).

The control group did only a course of exercise-based rehabilitation with breathing exercises after CABG. The course of exercise-based rehabilitation included 10–15 exercises in the standing or sitting position with a duration of 10–15 minutes 2 times a day. The patients were allowed to walk in the corridor and go up and down the stairs before discharge.

The patients from the study group had a history of myocardial infarction (MI): 14 patients had transmural MI; 23 patients had large MI; 15 patients had small MI; 24 patients had recurrent MI; 9 patients had a cardiac aneurysm.

All patients from the control group had a history of MI as well: 7 patients had transmural MI; 15 patients had large MI; 10 patients had small MI; 12 patients had recurrent MI; cardiac aneurysm was found in 6 patients.

Central hemodynamics was evaluated at a threshold load before the surgery, right after the surgery and at discharge. Stroke volume (SV, mL), stroke work (SW, kg·m/min), total peripheral resistance (TPR, dynes·sec·cm^{-5}), cardiac index (CI, L/min/m²), cardiac output per minute (CO per minute, mL), and average ejection rate (ER, mL/sec). During rehabilitation, peak load (W) and peak load double product (DP, calculated as HR×SBP/100) were registered.

The data were processed using ANOVA with SM-4.

RESULTS

Hemodynamics were evaluated at admission, after the surgery, and at discharge (Table 1).

Table 1. Changes in hemodynamic parameters at the threshold physicalloadat the stages of inpatient treatment

Parameters	Before operation		After operation		Beforedischarge	
	Main group	Control group	Main group	Control group	Main group	Control group
SV, ml	71,7 ± 3,58	73,1 ±3,9 p>0,05	59,8 ±2,19	70,3±4,0 p<0,05	72,7±3,11	84,5±4,7 p <0,05
SW, kg·m/min	106,0± 5,99	104,7± 7,2 p>0,05	74,1±2,75	90,6±4,6 p<0,05	90,5±3,01	101,5±5,3 p<0,05
CI, L/min/m²	2,83± 0,138	2,9± 0,2 p>0,05	2,66 ±0,94	3,1± 0,1 p<0,05	3,2± 0,12	3,4±0,2 p<0,05
ER, mL/sec	285,0 ±13,7	301,1± 15,5 p>0,05	274,4±8,54	315,3±14,6 p<0,05	328,0±11,4	361,4±21,7 p<0,05
TPR, dynes·sec·cm^{-5}	1667,0±104,2	1619,5±144 p<0,05	1570,5±66,7	1416,2±81,3 p>0,05	1309,4±52,9	1197,9±76,6 p<0,05
Peak load, W	35,4±3,66	21,0±2,61 p<0,05	32,3±2,25	24,6± 2,1 p<0,05	41,6±2,37	32,4±3,7 p<0,05

Note: p – the significance of differences between the main and control groups

The parameters of central hemodynamics shown in the table were registered at the threshold load (W) during the cycle ergometer workouts.

Exercise tolerance and physical capacity were measured in both study and control groups at admission and at discharge. To measure exercise tolerance, BP and HR were calculated, and an ECG was taken. At admission, exercise tolerance was 47.2±3.6 W in the study group and slightly higher, 49.2±4.2 W, in the control group (p<0.01). DP was 162.6±8.2 units in the study group and 141.6±4.95 units in the control group (p<0.05). It is accounted for by the fact that SBP and HR at the peak load are somewhat higher in the study group than in the control group. After the surgery, as a rule, BP lowers, and HR decreases on medication in the early post-surgery period. Therefore, DP in both groups was low but was relatively higher in the study group, which is a positive sign.In patients of Subgroup I (part of the study group), who had cycle ergometer workouts both before and after CABG, exercise tolerance before the surgery was 57.03±5.6 W. In Subgroup II patients, who had cycle ergometer workouts only after CABG, exercise tolerance before the surgery was as low as 32.1±3.69 W (p<0.01). The absence of cycle ergometer workouts before the surgery in Subgroup II affected their exercise tolerance. DP before the surgery was 171.8±13.3 units in Subgroup I (p<0.05) and 145.3±9.25 units in Subgroup II (p<0.05). Cycle ergometer workouts in the pre-surgery period allowed the patients to adapt to exercise loads. Thus, exercise tolerance before discharge in Subgroup I went up to 55.0±4.29 W (p<0.01), while it was lower in Subgroup II: 47.0±3.67 W (p<0.01). DP in Subgroup I (145.0±10.4 units; p<0.05) was higher than in Subgroup II (114.8±5.2 units; p<0.05). At discharge, Subgroup II demonstrated an increased exercise tolerance and a decreased DP (a sign of improved CV activity), which, however, was higher compared with the control group. Nevertheless, Subgroup I had better rehabilitation outcomes at discharge than Subgroup II. Cycle ergometer workouts in Subgroup I patients allowed to achieve movement coordination, positive mindset, and motivation for recovery and further rehabilitation. Thus, exercise tolerance at discharge in the study group (50.7±2.8 W, $p<0.01$) was higher than in the control group (30.8±2.7 W, $p<0.01$). DP in the study group (129.6±5.71 units, $p<0.01$) was also higher than in the control group (104.1±4.19 units, $p<0.01$).

DISCUSSION

The purpose of our study was to find out if it is expedient to use cycle ergometer workouts in post-CABG patients.

In their papers, *Bokeriya LA et al., [9] and Petrunina LV et al. [10]* also study the effects of cycle ergometer workouts after CABG at the inpatient stage. However, in the mentioned papers, the workout is in the sitting position, while in this study, the supine position was evaluated. Also, in the above papers, the patient's load is 25 W for 5 min, and it is increased with 25 W increments until the target pulse rate is achieved, then the load is gradually lowered (total workout time is 20–30 min). In this study, the resistance power is constant, while only the workout duration becomes longer. Also, VV. Bazylev and NV. Galtseva [11] studied post-CABG rehabilitation at the early inpatient stage, but they used a treadmill for workouts. Despite different machines used, we made the same conclusions that machine workouts combined with other aerobic exercises are the most effective for the rehabilitation of CHD patients after CABG. The combination thereof positively affects the exchange processes in the myocardium, lowers its oxygen demand, and stimulates anti-coagulation system activity, which prevents thrombosis [1, 3, 6]. The workouts allow achieving higher threshold loads (W) when tested before discharge and improve the physical and emotional state of the patients [12]. In her paper, O. Sudzhaeva [13] concluded that there is a greater and longer increase in the aerobic capacity observed with cycle machine workouts. Aerobic exercise promotes a more rapid heart rhythm recovery after exercising in patients with coronary heart disease and improves the endothelial function in humans, however, there are ongoing discussions on the optimal intensity and duration of workouts. Exercising may improve HR at rest and improve the response of the autonomous nervous system in obese men with metabolic syndrome [2, 7, 8].

CONCLUSIONS

Cycle ergometer workouts may be a part of exercise-based rehabilitation at the inpatient stage.

Exercise tolerance rises due to greater exposure time to mild load rather than due to higher workout intensity. This allows adapting patients to mild and moderate loads common for everyday life without putting a significant strain on them.

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