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ORIGINAL ARTICLE

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PECULIARITIES OF DIABETES MELLITUS IMPACT ON THE EFFECTIVENESS OF CARDIAC REHABILITATION OF PATIENTS WITH CORONARY HEART DISEASE AFTER MYOCARDIAL REVASCULARIZATION

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ABSTRACT

Aim: To investigate the impact of diabetes mellitus on the course of the disease, the quality of rehabilitation measures and the psycho-emotional state of patients.

Materials and Methods: The study involved 134 patients, who were divided into four groups depending on the method of revascularization and the presence or absence of diabetes mellitus. The patients underwent a 21-day rehabilitation programme, at the beginning and at the end of which they were assessed for left ventricular ejection fraction, exercise tolerance, maximum oxygen consumption, and treatment adherence. Throughout the study, the patients were under the supervision of a psychologist.

Results: The study found that patients with diabetes showed a significant improvement in the measured indicators, but to a lesser extent than patients without diabetes.

Conclusions: The mechanisms of poorer outcomes in patients with diabetes are mostly related to psycho-emotional factors as a result of the diagnosed disease, but they require further study.

KEY WORDS: cardiorehabilitation, diabetes mellitus, coronary artery bypass grafting, acute coronary syndrome, stenting

INTRODUCTION

Cardiovascular disease (CVD) is a leading cause of morbidity and one of the main causes of mortality in the world and in Ukraine [1]. Today, coronary heart disease (CHD) is one of the most common diseases worldwide and the leading cause of death among the population of different countries.

CHD is a chronic disease that combines angina, myocardial infarction (MI) and atherosclerotic cardiosclerosis. In the majority of cases (97-98%), coronary heart disease is the result of atherosclerosis of the coronary arteries. Without sufficient blood flow from the coronary vessels, the heart muscle does not receive enough oxygen and vital nutrients which are necessary for the heart to function properly.

CHD is a disease that progresses rather slowly and has several well-studied causes: it has been proven that the incidence of CHD is directly proportional to the level of total blood cholesterol; smoking (it increases the risk of developing CHD by 60%); arterial hypertension (AH); diabetes mellitus (DM) increases the risk of developing CHD by 50% in men and by 100% in women. This is associated with increased total blood cholesterol levels, platelet adhesion, and genetic predispositions [2].

For this reason, coronary heart disease and the methods of its correction and treatment are among the most important problems of the 21st century.

Almost 40 years of experience in the surgical treatment of coronary artery disease shows that patients with coronary artery disease and concomitant diabetes mellitus have worse morbidity and mortality rates compared to patients without diabetes. Macrovascular complications are one of the leading causes of death in patients with diabetes.

AIM

To determine the main features of cardiac rehabilitation in patients with concomitant diabetes mellitus after myocardial revascularization.

MATERIALS AND METHODS

PATIENTS

The study was conducted at the Rehabilitation and Planned Cardiology Department (RPC) of the Poltava Regional Clinical

Medical Cardiovascular Centre of the Poltava Regional Council (POCMCC PRC) between 1 March 2022 and 1 March 2023. The study involved 134 patients. The inclusion criteria were as follows: STEMI with PCI with coronary artery bypass grafting (CABG) and patients with chronic coronary artery disease (CAD) revascularised by cardiac surgery – CABG. The presence of diabetes mellitus influenced grouping patients. All patients were divided into 4 groups: Group 1 – patients with STEMI who were revascularised by CABG without concomitant diabetes mellitus; Group 2 – patients with STEMI who were revascularised by CABG with concomitant diabetes mellitus; Group 3 – patients with coronary artery disease revascularised by CABG without concomitant diabetes mellitus; Group 4 – patients with coronary artery disease revascularised by CABG with concomitant diabetes mellitus. The distribution of patients by gender and age, as well as their percentage distribution by group, is presented in Table 1.

CARDIAC REHABILITATION (CR) PROGRAMME

An innovative individualised rehabilitation model was introduced to all study patients. CR began with preoperative preparation of patients (for CABG) and from the first days of their stay in the intensive care unit (for patients with AMI) and continued during their hospital stay and for 21 days after their discharge (outpatient monitoring stage of rehabilitation).

The rehabilitation model we propose is based on an individualised multicomponent and multidisciplinary approach. The multidisciplinary team consists of a cardiologist (in most cases, the primary care physician), a physician of physical and rehabilitation medicine (PRM), a cardiovascular surgeon, a physiotherapist, an endocrinologist (for patients with diabetes), a psychologist, a physical therapist, an occupational therapist, and, if necessary, a spiritual director (according to the patient's religion). The rehabilitation model that was implemented included many components, namely [3-5]:

Prehabilitation: this component of the rehabilitation model was used in patients with coronary artery disease who underwent revascularization by CABG. Prehabilitation was technically impossible for patients with ACS (patients with ACS are patients with an acute coronary event who were taken to our institution by ambulance). Prehabilitation included preoperative preparation of the patient, namely,

Table 1. Gender and age distribution of the study patients

	Group 1 n=45	Group 2 n=45	Group 3 n=23	Group 4 n=21
Male n=84 (62,7%) 65,54±1,17 years	n=35 (26,1%) 66,74±1,48 years	n=21 (15,7%) 63,2±1,76 years	n=18 (13,4%) 65,83±1,52 years	n=10 (7,5%) 65,0±1,89 years
Female n=50 (37,3%) 64,63±1,83 years	n=10 (7,5%) 63,44±2,63 years	n=24 (17,9%) 66,52±2,18 years	n=5 (3,7%) 62,6±2,87 years	n=11 (8,2%) 65,54±2,35 years

Table 2. LVEF indices at the beginning and at the end of rehabilitation measures

	Group 1 n=45	Group 2 n=45	Group 3 n=23	Group 4 n=21
Initial examination, %.	48,8±1,8	46,9±2,1	48,1±2,1	46,4±2,5
Upon completion of the rehabilitation cycle, %.	56,4±1,7	53,9±2,3	54,8±2,3	53,5±2,1
	p<0,01	p<0,05	p<0,05	p<0,05

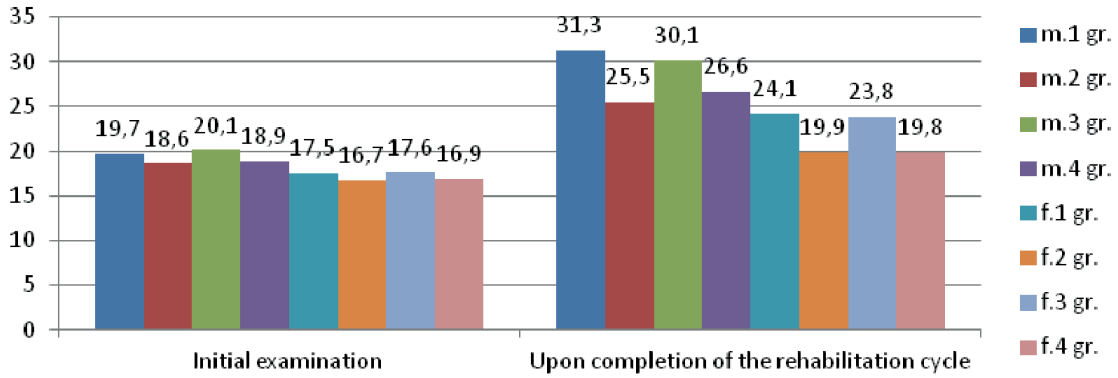

Fig. 1. Dynamics of VO_2 max(ml/kg/min) indicators in the process of rehabilitation by gender

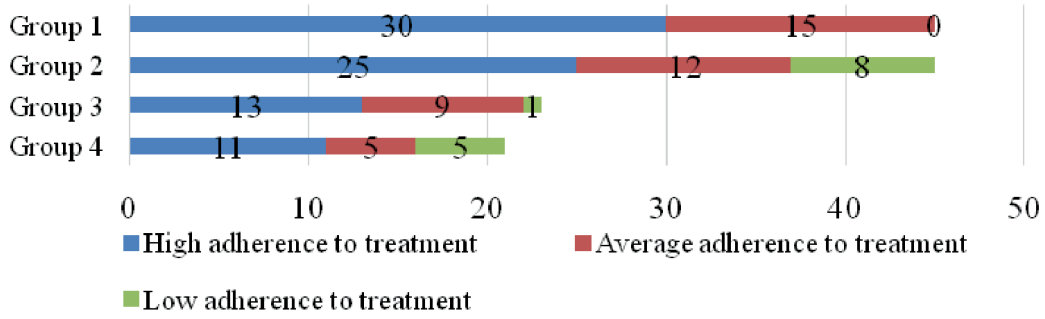

Fig. 2. Adherence to treatment of study patients after rehabilitation

primary conversation and familiarisation with the stages of surgery, stages of recovery, testing of rehabilitation methods which are planned for implementation in the early postoperative period, primary breathing exercises with explanation of the advantages and necessity of such exercises in the future, primary session with a physical and occupational therapist in order to master the basic physical exercises were later used, selection of an individual chest corset.

Educational component: during the CR, patients had regular educational discussions on secondary prevention, the benefits and necessity of lifestyle modification, rejection of bad habits, the basics of postoperative wound care after discharge from hospital, rules of the resumption of sexual activity after surgery, basic rules for using a breast corset and the terms of its use.

Respiratory component: we pay special attention to teaching patients how to breathe properly. We use breathing exercises that were mastered during the prehabilitation phase in patients after CABG. Patients after ACS start breathing exercises while they are still in the intensive care unit. Primary breathing exercises are performed under the supervision of a physical therapist and a physiotherapist, and further controlled breathing exercises are performed once a day. Subsequently, patients perform these exercises independently for 5-7 minutes every 2-3 hours. While they are performing breathing exercises, their attention is focused on the involvement of the diaphragm in the act of breathing, increasing diaphragmatic excursion, changes in the depth of breathing, which prevents congestion in the lungs. Breathing exercises include independent diaphragmatic breathing exercises, exercises to lengthen inhalation and exhalation, and breath-holding exercises. A modified and simplified Frolov breathing simulator was used to implement the respiratory component.

Physical component: every day, patients had physical therapy sessions with a physical therapist according to an individually designed schedule and selected load, taking into account the motor regime, degree of motor activity. Physical therapy sessions included: strength training with light resistance, as well as cardio training on an ergometer and a treadmill for 30-40 minutes 3 times a week. All training sessions were monitored: by blood pressure (BP), heart rate (HR), and electrocardiogram (ECG).

Medication component: medical cardioprotective support in accordance with the standards and protocols of the Ministry of Health of Ukraine.

Psychological component: at the prehabilitation stage, all patients before CABG are consulted by a psychologist, undergo primary testing and develop their psychological profile. Patients with ACS are consulted by a psychologist when they are transferred from the intensive care unit to the ACS. If necessary, psychotherapeutic work are conducted with patients to increase their motivation to modify their lifestyle and increase their adherence to treatment. The method of positive psychotherapy (PPT) was used. The method of positive psychotherapy is a globally recognised method of short-term psychotherapy aimed at mobilising a person's internal resources to make positive decisions in any, even the most difficult life situations, which also provides knowledge about a person, teaches not to fight the world around us, but to accept it in all its diversity [6] .

The method teaches how to influence the future through the perception of present situations. Recognising personal responsibility for one's life helps everyone take concrete steps to change their reality.

CONTROL METHODS

Assessment of the effectiveness of rehabilitation measures was carried out by determining exercise tolerance (ET) by determining the functional class (FC) of heart failure (HF) using the 6-minute walk test (6MWT), left ventricular ejection fraction (LVEF), determination of the maximum oxygen consumption (VO_2 max) based on heart rate, determination of the level of treatment adherence using the Morisky Medication Adherence Scale (MMSA), psychological profile was determined using the Hospital Anxiety and Depression Scale (HADS). Testing of the study patients was carried out at the beginning of rehabilitation activities and at the end of the outpatient control stage of rehabilitation.

LVEF was determined using a GE LOGIQ F8 ultrasound machine manufactured in the USA.

Mathematical processing of the results was carried out using Statistica 8.0 software (StatSoft Inc, USA, licence number STA862D175437Q). The mean value (M), variance, mean standard deviation and median (m), and significance level (p) were calculated. The logistic regression method was used. The results were processed by calculating the

Student's t-test. A difference of $p<0.05$ was considered statistically significant.

Written informed consent to participate in the study was obtained from all patients in accordance with the World Medical Association Declaration of Helsinki on the Ethical Principles of Scientific Medical Research Involving Human Subjects (1964-2008), European Society Directive 86/609 on the participation of human subjects in biomedical research, and Order of the Ministry of Health of Ukraine No. 690 of 23.09.2009, as amended.

The study was approved by the Ethics and Bioethics Committee of Poltava State Medical University. The study was performed as part of the research work of the Department of Internal Medicine No. 2 of Poltava State Medical University.

RESULTS

The results of the 6MWT test after completion of rehabilitation measures indicate a statistically significant higher index in patients without DM compared with patients with concomitant DM. Thus, the 6MWT index in patients of groups 1 and 2 was 355.3±11.2 and 310.7±11.3 m ($p<0.01$), and in patients of groups 3 and 4 – 315.4±9.3 and 284.6±10.1 m ($p<0.05$), respectively. These changes indicated a significantly higher rate of TFN in patients without concomitant DM, regardless of the method of revascularization. It should be noted a greater increase in the 6MWT test in patients without diabetes mellitus after completion of rehabilitation measures compared with the initial values. Thus, the increase in groups 1 and 3 was 69% (from 210.1±10.8 to 355.3±11.2 m) and 47% (from 214.2±9.8 to 315.4±9.3 m) compared with the indicators in groups 2 and 4, where the increase in TFP was less and amounted to 46% (from 212.4±10.4 to 310.7±11.3 m) and 34% (from 211.8±10.4 to 284.6±10.1 m), respectively.

According to the results of echocardioscopy, LVEF had a statistically significant ($p<0.05$) growth dynamics in all groups, which indicated the effectiveness of rehabilitation measures (Table 2).

The VO_2 max values at the beginning of rehabilitation activities in all study groups were considered very poor (according to the Cooper Institute's VO_2 max norms), which is associated with violation coronary circulation and low-level exercise tolerance. The obtained results of VO_2 max after the course of medical rehabilitation showed a statistically significant increase in VO_2 max in patients of all four groups, which indicated the effectiveness of cardiac rehabilitation measures. VO_2 max after cardiac rehabilitation in patients without DM (groups 1 and 3) had a statistically significantly higher value ($p<0.05$) compared with patients in groups 2 and 4 (patients with concomitant DM), which probably reflects a violation of the process of glycolysis intensity in patients with DM. The dynamics of VO_2 max with a gender distribution is shown in Fig. 1.

The analysis of HADS scores at baseline and at the end of the study revealed significantly higher rates of anxiety and depression in patients with concomitant diabetes mellitus compared with those in patients without diabetes. Thus, the proportion of patients in group 1 with signs of subclinical anxiety was 55.5% compared with 77.8% in group 2. The same indicator in groups 3 and 4 was 52.2% and 81.0%, respectively. The rate of subclinical depression in groups 1 and 2 was 8.9% and 15.5%, and in groups 3 and 4 the same rate was 13% and 14.3%. The proportion of patients with HADS test results that were within the normal range by group was 35.6% (in group 1) compared to 6.7% (in group 2) and 34.8% (in group 3) compared to 4.7% (in group 4). The proportion of people with diabetes mellitus who suffered from depression and had increased anxiety was significantly higher compared with patients without concomitant diabetes, regardless of the conditions and method of myocardial revascularization. This has two primary causes: impaired glucose metabolism and presence of a serious chronic disease.

Unfortunately, our mentality is dominated by the idea that the doctor is responsible for the patient's health, and if the doctor cannot help the patient, then the doctor is bad. At the same time, the actions of the patients, their conscious willingness to follow the recommendations, and even more so, their actual implementation, are not considered important. If you explain to people that it is THEIR lives and health, and they are responsible for themselves, the effectiveness of diabetes treatment increases significantly. In this regard, exercise therapy is the best way to help people cope with diabetes.

That is why psychologists working with patients with concomitant diabetes conduct psychotherapeutic work to increase motivation to strictly follow a diet, adhere to a diet regime, take regular medication and, most importantly, to ensure that this trend continues after discharge and during further outpatient recovery.

According to the MMSA treatment adherence questionnaire, at the beginning of the study, the following data were obtained: at the beginning of treatment and before rehabilitation measures, 100% of study patients (n=134) had a total score of 6 points on the MMSA scale, which indicated low treatment adherence. After completion of rehabilitation measures, repeated testing was performed, which showed that low adherence to treatment remained in 17.8% (n=8) of patients in group 2 and in 23.8% (n=5) of patients in group 4, which is most likely caused by the negative impact of diabetes on their general psychological state (Fig. 2).

DISCUSSION

In case of acute coronary events, patients undergo coronary angiography (CAG), stenting or angioplasty, while in case of multivessel coronary artery disease, coronary artery bypass grafting (CABG) is preferred. On average, about 40,000 heart attacks occur in Ukraine every year, 20,000 of which require emergency treatment (CABG and stenting) [2, 3].

Decision to myocardial revascularization in patients with diabetes has certain peculiarities. First of all, this is due to the fact that such patients usually have diffuse atherosclerotic lesions of the coronary arteries. In addition,in diabetes, there is a tendency to the development of restenosis after

percutaneous coronary intervention (PCI), shunt occlusion after CABG, and the formation of new stenoses as a result of atherosclerosis progression. All this is associated with a higher risk of complications in the future. Given the possible complications of the disease, diabetes mellitus is a very difficult disease to treat and rehabilitate. It not only changes the lives of patients, but also the lives of their families. Modern medicine can only partially help a patient to alleviate his or her condition, because, on the one hand, all the causes of the disease have not been fully understood yet, and on the other hand, and no less importantly, the psychological and personal aspects of the problem remain unresolved in the vast majority of patients [4,5]. Therefore, patients with diabetes are at increased risk for decline in psychological well-being, which is observed in about half of patients at the time of diagnosis; anxiety and/or depression may develop [3] .

When choosing revascularization methods, CABG is considered to be preferable to PCI for patients with progressive coronary artery disease and diabetes mellitus. However, if urgent revascularization is required in acute coronary syndrome (ACS), PCI is performed according to generally accepted indications.

CABG surgery is the most common type of cardiac surgery. More than 1.5 million such operations are performed worldwide every year. According to the Association of Cardiovascular Surgeons, more than 24,000 cardiac surgeries are performed in Ukraine every year. Given this volume of surgical interventions for CVD, there is the question of the need to to study the features of cardiac rehabilitation after revascularization in patients with diabetes [4].

CONCLUSIONS

The majority of patients with concomitant diabetes mellitus in ACS and CHD who required myocardial revascularization were women.

Comprehensive cardiac rehabilitation is effective in patients with and without concomitant diabetes mellitus.

The effectiveness of CR measures was confirmed by the improvement of LV systolic function with an increase in EF, a decrease in HF and an increase in LVEF, an increase in VO_2 max and an increase in adherence to treatment.

Lower rates of CR effectiveness in patients with concomitant diabetes mellitus compared with patients without diabetes mellitus, regardless of the method of revascularization, combined with a higher rate of anxiety and depressive disorders among patients with diabetes mellitus may be indicative of an additional impact of psychological state on the effectiveness of CR.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest.

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* Contribution: 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.