

Application and influence of the complex program of physical therapy on the state of the cardiovascular and autonomic nervous system of young women, patients with alimentary obesity

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Purpose: to investigate the dynamics of the types of reaction of the cardiovascular system to the dosed physical load using the Martine-Kushelevsky test and determine the functional state of the autonomic nervous system (ANS) using the Kerdo index of young women suffering from alimentary obesity under the influence of the developed comprehensive physical therapy program.

Material & Methods: study was based on the clinical and functional examination of 50 women aged from 18 to 30 years old, patients with alimentary obesity I–II degree.

Results: conducted and analyzed the state of the cardiovascular system on the dosed exercise with the help of the Martine-Kushelevsky and vegetative nervous system tests according to the Kerdo index.

Conclusion: use of a physical therapy program, which includes a low-calorie diet, massage, therapeutic gymnastics with elements of sports-oriented aerobics, dosed walking in combination with breathing exercises taking into account the activity of the ANS, helps to normalize the functional state of the cardiovascular and autonomic nervous system.

Keywords: obesity, physical therapy program, cardiovascular system, autonomic nervous system, examination of patients.

Introduction

Obesity is an important risk factor for many serious medical problems leading to a decrease in the quality of life, a significant increase in morbidity and premature death. Due to increased food consumption, on the one hand, hypokinesia and reduced energy costs during work (mechanization and automation of heavy physical labor), on the other, obesity has become one of the social problems in industrialized countries, where people suffering from various forms of obesity make up 20–30% of the total population. Studies conducted in Ukraine have shown that the prevalence of obesity among people over 45 can be 52,6%, and overweight – 33,4%. Normal body weight is manifested only in 13,2% of the adult population of Ukraine. A large-scale study conducted simultaneously in 15 countries of the European Union, which was attended by 15,239 people over the age of 15, showed that obesity and weight gain are closely linked to a slow-moving lifestyle [9; 30].

Recently, the World Health Organization, the US National Institutes of Health, Organization of Healthy People 2010 offered recommendations for the classification of weight status by determining body mass index. The main reason for the increase in the prevalence of obesity and its complications is the energy imbalance between the excess energy in the body in the form of food and its expenditure due to a decrease in the physical activity of a modern person [26; 38]. This disease is an important risk factor for many serious medical problems, disrupts the activity of the cardiovascular system, and this is one of the main 3; [manifestations of obesity [17; 20; 28]. It is

obesity that leads to the development of myocardial dystrophy, atherosclerotic vascular lesion, coronary heart disease, hypertension [19; 25; 27]. Disruption of the cardiovascular system may be complicated by the development of myocardial infarction, stroke, cardiovascular failure. With the progression of obesity with increasing body weight, fat is deposited in the connective tissue layers of the myocardium, making it difficult to contractile function. These changes in the myocardium lead to a marked decrease in the contractility of the heart muscle [36; 40; 41].

Obesity is often combined with such severe comorbidities, such as type 2 diabetes. This disease is one of the most important problems of modern medicine, which is associated with both the steadily growing prevalence and the high frequency and severity of complications of this disease [12; 39; 44]. Obesity is visceral, plays an important role in the development of insulin resistance (insufficient response of the body's cells to insulin with its sufficient content in the blood). Due to the insufficient effect of insulin, the percentage of glucose in the blood increases. This in turn affects the secretion (secretion) of insulin and the sensitivity of tissues to it, and this closes the vicious circle in the development of type 2 diabetes [16; 33; 47].

The negative effect of obesity on the respiratory system largely consists in the formation of respiratory and then heart failure in persons suffering from this pathology [13; 14]. In obesity, the function and function of the respiratory system is impaired, resulting from compression of the lungs, changes in blood circulation in the lung tissue [34; 35]. An increase in

body weight leads to the development of a high standing of the diaphragm, deformation of the chest, a decrease in its elasticity. In patients with obesity often develop acute and chronic bronchitis, pneumonia, pneumosclerosis. These patients are prone to frequent acute respiratory infections, influenza. Subsequently, they develop chronic pulmonary insufficiency. Violation of pulmonary ventilation against the background of a decrease in non-specific resistance is often accompanied by the development of long-lasting inflammatory processes, such as bronchitis, pneumonia [14; 21].

There are problems with the gastrointestinal tract [15; 18; 23]. Abundant nutrition leads to an overload of the gastrointestinal tract and its anatomical changes: an increase in the size of the small intestine, the absolute weight of which increases by 20–40%. The function of the gastrointestinal tract is changed in more than 55% of obese patients. It has been established that in 64% of patients an increase in gastric secretory function and the development of chronic gastritis is observed [22; 43; 45]. Obesity leads to the development of concomitant diseases of the nervous, reproductive, urinary, musculoskeletal system. These data suggest that in fact there is not a single organ, no system that would not suffer from obesity [2; 7]. Therefore, the treatment of obesity should be comprehensive, include physical therapy [1; 5, 34; 35], herbal medicine [11], massage [1; 6; 10], physiotherapy, diet therapy [5; 29], drug therapy and many other means of physical therapy [8].

Purpose of the study: analysis of the reaction of the cardiovascular system to the metered physical load and the state of the autonomic nervous systems of patients alimentary obesity under the influence of the developed comprehensive program of physical therapy during the rehabilitation process.

Material and Methods of the research

Examination of patients with alimentary obesity was carried out on the basis of the Kharkiv City Student Hospital. Under our supervision there were 50 women of the first mature age, patients with alimentary obesity of the I–II degree. They were arbitrarily divided into two groups: the main and control groups – 25 patients each. The average age of patients with MG was 24,49±0,71 years, CG – 24,06±0,57 years.

In the course of the study, the international instruments for the regulation of biomedical research were adopted: "Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects", adopted by the General Assembly of the World Medical Association (VMA, 1964, 1975, 1983, 1989, 1996, 2000, 2002, 2004, 2008, 2013) [51]; "Universal Declaration on Bioethics and Human Rights" (UNESCO, 2005) [49]; "Convention on the Protection of Human Rights and Dignity in Connection with the Application of the Achievements of Biology and Medicine", adopted by the Council of Europe (1997) [50].

For the purpose of determining and assessing the type of reaction of the cardiovascular system to the dosed physical load of the examined women, a Martine-Kushelevsky test was used – 20 squats for 30 s [24]. The results of functional tests were assessed by the following indicators: the degree of increased heart rate (%), changes in systolic and diastolic pressure, recovery time values of pulse and blood pressure after exercise, was determined by the indicator of quality reaction (IQR), which was calculated by the formula (1):

$$IQR (c.u.) = PP_2 - PP_1 / PS_2 - PS_1, \quad (1)$$

where PP_2 – pulse pressure on the 1st minute of the recovery period; PP_1 – pulse pressure before load; PS_2 – pulse in the 1st minute of the recovery period; PS_1 – pulse before a load.

In norm IQR = 0,5–1,0 c. u. [24].

With the help of the Martine-Kushelevsky test, the type of reaction to the measured physical load is determined:

– *Normotonic* – the pulse increases by 60%, systolic blood pressure increases by 20–40 mm Hg., diastolic blood pressure decreases by 5–15 mm Hg. or does not change, the pulse pressure increases, the recovery time of the pulse rate and blood pressure 2–3–4 minutes.

– *Hypotonic* – pulse increases by more than 120%, systolic blood pressure does not practically change, diastolic blood pressure decreases slightly or does not change, and pulse pressure does not change, recovery time of pulse frequency and blood pressure – 3–4–5 minutes, sometimes longer.

– *Hypertonic* – the pulse responds as in the normotonic type, the systolic blood pressure rises to 180–200 mm Hg., diastolic blood pressure rises to 90 mm Hg. and higher, the pulse pressure increases, the restoration of the pulse rate and blood pressure for 3–4–5 minutes may not take place.

– *Dystonic* – pulse reacted as in normotensive type, systolic blood pressure – as in normotensive type, diastolic blood pressure falls to 0 (the phenomenon of an infinite or zero pitch), the pulse pressure increases, the recovery heart rate and blood pressure – 3–4–5 minutes can and not take place.

– *Step increase in maximal arterial pressure* – the pulse responds as in the normotonic type of reaction, systolic blood pressure is 2–3 times longer than the first, the diastolic arterial pressure is as in the normotonic type of reaction, the recovery time is 3–4–5 minutes or recovery is delayed.

Dissociated reactions – proceed according to the type of so-called "scissors", when there is a negative phase on the part of one of the indicators (pulse or systolic blood pressure). When the pulse rate decreases with an increase in systolic blood pressure, a reaction like cardiovascular dystonia occurs, and, conversely, in the presence of a negative phase from the systolic pressure, a reaction of the type of cardiovascular dissociation.

To study the status of ANS, which would allow to register relatively small changes in vegetative activity using a simple tool, while having any effect on the activity of the organism, we used the definition of the *vegetative Cerdo index* (V.I.) [46] and methods of mathematical statistics. V.I. calculated by the formula (2):

$$V.I. = (1 - d/p) \cdot 100, \quad (2)$$

where V.I. – vegetative index Cerdo, d/p – the ratio of diastolic pressure / pulse rate.

Estimation of the calculation of the Cerdo index are presented in Table 1.

Results of the research

According to the literature [4; 7, 9] it is known that the course of alimentary obesity, depending on the severity, is compli-

Table 1
Assessment of the vegetative index Cerdo

Indicators	Areas of ANS
from +16 to +30	sympathicotonia
≥ +31	expressed sympathicotonia
from -16 to -30	parasympathicotonia
≤ -30	expressed parasympathicotonia
from -15 to +15	balance of sympathetic and parasympathetic influences

Remark. Norm: from -10 to +10%. A positive index value reflects the predominance of sympathetic regulation. Negative – predominance of parasympathetic regulation.

cated by coronary artery disease, hypertension, vegetative dysfunction. The data obtained during the initial examination showed the absence of economization of the cardiovascular system, the presence of dysfunction of the autonomic nervous system, which was determined using the Kerdo vegetative index, in the direction of the predominance of the sympathetic section, confirming the data from literary sources [46; 49]. The Kerdo vegetative index was determined in patients with alimentary obesity at the beginning and at the end of the study, as well as before exercise therapy sessions for timely correction, regulated breathing exercises, taking into account sympathetic, parasympathicotonia or eutonia. Using the repeat definitions of the index, one can determine which shifts in the autonomic tone of the examined patients occurred during the time between individual studies [46; 48].

In determining the vegetative index of Cerdo, we found in the main group 23 people with sympathicotonia and 2 people with parasympathicotonia. In the control group of 22 people sympathicotonia was observed and 2 people had parasympathicotonia. Eutonia was not observed during the initial examination in the ExAg, in the control group we found 1 patient with the balance of the sympathetic and parasympathetic divisions of the ANS (Fig. 1).

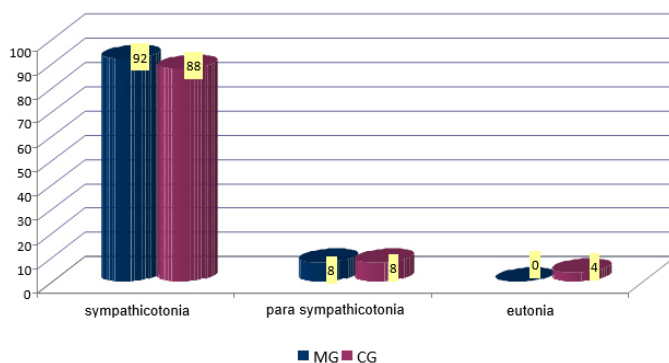


Figure 1. Predominance of ANS activity in patients of the main and control groups during the primary study (%)

The obtained data indicate a shift in Vagal-sympathetic balance towards weakening of vagal and sympathetic domination in patients of both groups, which is also confirmed by the Kerdo vegetative index ($-7,00 \pm 1,23$ – in patients with MG and $-4,4 \pm 1,47$ patients with CG) ($p > 0,05$) [46] (Table 2).

When determining the type of reaction to the dosed physical load during the initial examination in both groups of people

Table 2
Hemodynamic parameters and the Kerdo index of women in the examined groups during the initial study (M±m)

Indicators	Norm	Survied groups		t	p
		MG, n=25	CG, n=25		
Kerdo index, c. u.	0±0,15	-7,00±1,23	-4,4±1,47	1.35	>0,05

with the normotonic type of reaction was not found. In both groups, the hypertonic type of reaction prevailed. So, in the main group 88,0% were detected with the hypertonic reaction type, with the dystonic type – 8,0%, with the hypotonic reaction – 4,0%; 84,0% were detected in the control group with the hypertonic type of reaction; with dystonic type – 8,0%, with hypotonic – 8,0% (Fig. 2).

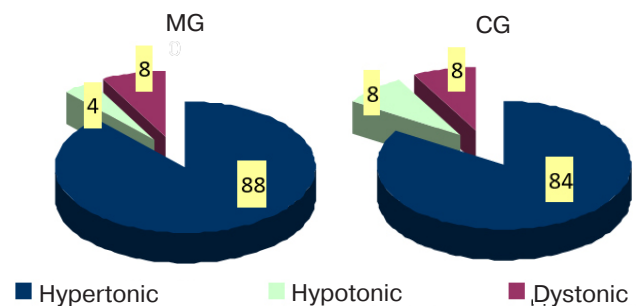


Figure 2. Types of reaction to the dosed physical load of women in the MG and CG during the initial study (%)

According to the data of the primary examination in the main and control groups the IQR in the Martin-Kushelevsky sample was less than the norm, which indicates an unsatisfactory reaction of the cardiovascular system of patients with physical exercise (Table 3).

Table 3
Indicators of the quality of the reaction in the sample Martin-Kushelevsky surveyed groups during the initial study (M±m)

Indicators	Norm	Survied groups		t	p
		MG, n=25	CG, n=25		
IQR, c. u.	0,5–1,0	0,44±0,01	0,45±0,01	0,57	>0,05

Thus, the initial examination of patients for alimentary obesity I-II degree showed that the indicators of the general condition of women in the main and control groups did not differ significantly, which indicated the homogeneity of the studied groups.

The program of physical rehabilitation for the patients of the main group consisted of: low-calorie diet number 8 [5; 29]; massage according to the method of P. B. Efimenko (2013) [10]; therapeutic gymnastics with elements of sports-oriented aerobics [8; 37], in which simple series of movements are used, as well as jumps, running in place; morning hygienic gymnastics; dosed walking in combination with breathing exercises, taking into account the activity of the ANS. In the control group of patients, a program of physical therapy was applied, which included physiotherapy exercises according to the method of S. N. Popov (2005, 2008) [34; 35], diet therapy

using a low-calorie diet was used [5; 29] and therapeutic massage according to the method of A. F. Verbova (2006) [6].

When analyzing the status of the ANS, a statistically significant improvement in indicators characterizing the imbalance of the sympathetic and parasympathetic parts of the ANS was observed. Thus, during repeated examinations in patients of the main group, eutonia was observed in 10 (40,0%), sympathicotonia – in 5 (20,0%), parasympathicotonia – in 10 patients (40,0%). In patients of the control group, eutonia was observed in 3 patients (12,0%), sympathicotonia – in 2 patients (8,0%), parasympathicotonia – in 20 (80,0%) (Fig. 3).

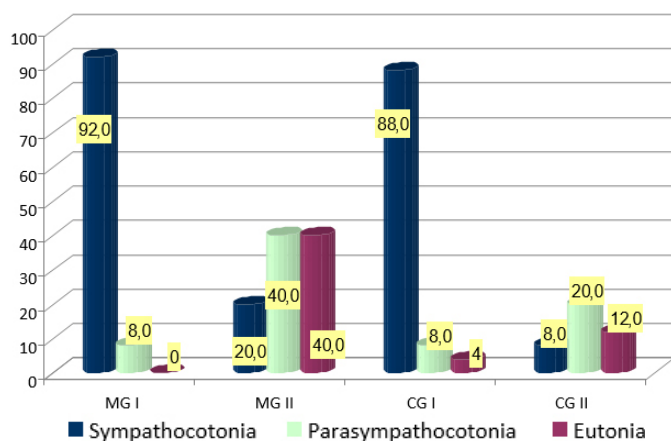


Figure 3. Dynamics of indicators of the state of the autonomic nervous system in patients of the main and control groups during the primary and repeated research (%)

When comparing the Kerdo index in a repeated study in both groups, we found a statistically significant difference in the main and control groups, indicating a greater positive effect of the author's program of physical therapy on the ANS tone (Table 4).

Table 4

Kerdo index in patients of both groups after repeated research (M±m)

Indicators	Norm	Survived groups		t	p
		MG, n=25	CG, n=25		
Kerdo index, c. u.	0±0,15	1,87±0,76	-0,2±1,26	1,81	<0,05

The introduction of complex physical rehabilitation has had a positive effect on the indicators of the quality of the reaction of the cardiovascular system on the metered physical load of patients with alimentary obesity I–II degree, as evidenced by the indicators of the functional test of Martine-Kushelevsky.

When determining the type of reaction to the dosed physical load during the re-examination in the MG, 9 (36,0%) were de-

tected with the normotonic type of reaction, 14 (56,0%) with the hypertonic type of reaction (22% (88,0%) in the primary), with dystonic type – 2 (8,0%) (in the primary – 2 (8,0%) people), with the hypotonic type was not detected (in the initial study – 1 (4,0%). In the control group, with the repeated examination, 4 (16,0%) people were found with the normotonic type of reaction, 17 (68,0%) with the hypertonic type (with the primary group – 21 (84,0%) people); the number of patients with dystonic and hypotonic type remained at the same level – 2 people each (8,0%) (Figure 4).

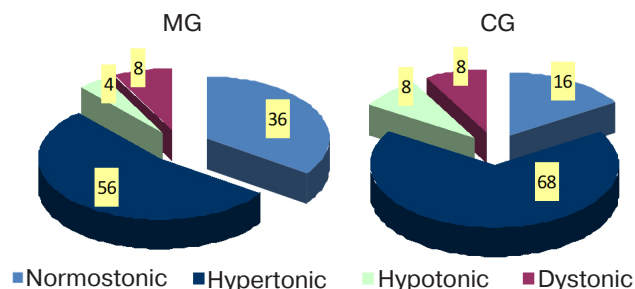


Figure 4. Types of reaction to the dosed physical load of women in the OG and KG during repeated research (%)

As a result of the application of a comprehensive program of physical therapy at the outpatient stage for 4 months in patients of the main and control groups, the quality indicators of the reaction according to the Martin-Kushelevsky sample significantly changed. Thus, in the main group of IQR increased by 47,7%, in the control group – by 24,4% (Table 5).

Conclusions / Discussion

Among the large number of works on the problem of rehabilitation / therapy for obesity, there are no generally accepted methods of physical exercise, there is no classification of the most physical exercises, and there are conflicting data about the exact methods of monitoring and regulating physical activity according to the condition of patients, that is, the optimal pedagogical control during group exercises in gymnastics with people who are overweight. In addition, recommendations for the use of diet therapy, massage and physiotherapy are rather contradictory and not individualized..

To increase the effectiveness of rehabilitation treatment of patients with alimentary obesity of grades I–II, we first developed, substantiated and applied in the main group of patients a differentiated program of physical rehabilitation. In developing a comprehensive physical rehabilitation program, we were guided by the tasks that should be solved when it is introduced in patients with alimentary obesity: stimulation of the metabolism due to the effect of exercise on the endocrine system; increase in energy consumption and weight loss through improved redox processes; improving the functional state of the cardiovascular and autonomic nervous systems and improv-

Table 5
Dynamics of indicators of the quality of the reaction in the Martin-Kushelevsky test in patients of both groups during the primary and repeated studies (M±m)

Indicators	Groups	Norm	Study periods		t	p
			Primary study	Repeated study		
IQR, c. u.	Main group	0,5–1,0	0,44±0,01	0,65±0,01	5,35	<0,05
	Control group		0,45±0,01	0,56±0,12		

ing the physical performance of patients [30; 31; 32; 42].

Thus, our studies have confirmed the need to correct the functional state of the autonomic nervous system and the type of cardiovascular system response to measured physical activity in patients with alimentary obesity I-II degree in order

to reduce the severity of the disease, prevent the occurrence of complications and reduce the severity of concomitant pathology.

The prospect of further research is to study the peculiarities of the psychological status of young women with obesity.

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