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Functional activity of the vascular endothelium in patients with initial signs of atherosclerosis against the background of regularly dose-related exercise stress.

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ABSTRACT

Very promising and no side effects approach to enhancing the functional activity of the vascular wall are metered-dose regular aerobic exercise. Earlier, they showed their restorative, hypotensive and cardioprotective effect. At the same time, an important mechanism for the action of physical exertion is their positive effect on the function of the vascular endothelium, many aspects of which have not yet been studied in the initial phenomena of atherosclerosis. The goal is to assess the effect of metered athletic loads on vascular endothelial function in patients with newly developed stable angina of stress 1 functional class. In patients with stable angina of stress 1 functional class, signs of vascular endothelial dysfunction were revealed: a decrease in the amount of nitric oxide in the plasma and an increase in its metabolite in erythrocytes, a weakening of the vasodilation and the development of the inclination of the vessels to spasm. The effectiveness of standard treatment for patients with stable angina pectoris of stress 1 of the functional class is significantly increased by the addition of regular physical exertion to it. This significantly activates the NO system, thereby restoring vasodilating function of the endothelial vessels. Considering the expressed stimulating effect of regular physical exertion on vascular endothelial function on the background of standard therapy, the authors consider it necessary to recommend wider use of them in the treatment of the onset manifestations of coronary artery atherosclerosis.

Keywords: endothelial dysfunction, atherosclerosis, stenocardia, exercise, athletics.

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INTRODUCTION

In a modern society, various non-infectious pathologies remain very common [1,2]. Despite the serious success of world medicine, atherosclerosis does not decrease its prevalence among people of mature age. At the same time he has a tendency to manifest everything at a younger age, which makes him consider it one of the actual medical and social problems of our time [3]. Apparently, this is due to the widespread prevalence of arterial hypertension, chronic psychoemotional stresses, high cholesterol and triglyceride diets that accelerate the course of atherosclerosis in modern society [4,5].

According to modern concepts, the development of atherosclerosis is always accompanied by impairment of endothelial function, which in itself aggravates the condition of patients [6]. In this connection, at all stages of development of atherosclerosis, the endothelium is considered as an important target for therapeutic effects [7]. At present, the influence of medications on the functional state of the endothelium in vascular pathology is actively studied [3,8]. A number of studies have focused on the possibilities of combining them with non-medicamentous effects. It becomes clear that a very promising and no side effects approach to enhancing the functional activity of the vascular wall are metered-dose regular aerobic exercise. Earlier, they showed their restorative, hypotensive and cardioprotective effect [2,9,10]. At the same time, their positive effect on the function of the vascular endothelium is considered to be an important mechanism of action of physical exertion [11], many aspects of which have not yet been studied in the initial phenomena of atherosclerosis.

The aim of the study was to evaluate the effect of metered athletic loads on vascular endothelial function in patients with newly developed stable angina of stress 1 functional class.

MATERIALS AND METHODS

The study was approved by the local ethical committee of the Kursk State University on September 15, 2016 (protocol №9), the local ethical committee of the Kursk State Medical University on September 12, 2016 (protocol №12) and local ethical committee of the Samara National Research University on October 04, 2016 (protocol №10).

A total of 59 patients were examined, including 27 men and 32 women with stable angina of stress of 1 functional class of the second adult age (mean age 55.8 ± 2.4 years). They did not have endocrine, oncological and autoimmune diseases. Patients had previously not had heart attacks and strokes. The diagnosis of stable angina was verified by clinical examination and veloergometry according to generally accepted examination rules no more than 1 year ago. The patients were divided into two groups. The 1st group included 27 patients who received basic therapy. In the 2nd there were 32 patients who additionally experienced daily athletic loads not less than 30 minutes a day. The period of observation of patients of both groups was 3 months. The patients were examined twice: when they were taken to the study and at the end. The control group consisted of 22 clinically healthy persons, comparable in sex and age with the patients under observation. The control group was inspected once.

All examined had an echodopler cardiography and dopplerography of the brachial artery under conditions of a test with reactive hyperemia. With the help of these methods of research, the vasoretagating abilities of the vascular endothelium and cardiogeodynamics were evaluated [12]. The magnitude of the shear stress on the endothelium was calculated in a conventional way [13]. The state of the NO synthesis system was assessed by the level of its stable metabolite NO^2 in plasma and erythrocytes [14].

The results obtained in the study were processed statistically with an assessment of the reliability of differences in the t-test of the Student's.

RESULTS AND DISCUSSION

The patients examined had atherosclerosis of the coronary vessels, which manifested itself as clinical signs of the angina of tension of the 1 functional class. As a result of observation in patients of the 1 st group, the clinical picture remained unchanged, and in the second group at the end of the observation, angina attacks were practically not registered.

In the outcome, all patients had dysfunction of the vascular endothelium: a decrease in the content of nitric oxide in their plasma and excess NO metabolite in their erythrocytes in comparison with the level of control. The patients examined also showed a decrease in the blood flow velocity and shear stress on the endothelium. This was accompanied by a low increase in blood flow velocity during reactive hyperemia (Table 1).

Regular athletic loads, included in the scheme of treatment of patients, had a positive effect on the functional state of the endothelium.

In the 1st group of patients, against the background of standard treatment, an increase in the shear stress on the endothelium was noted - by 25.1% at rest and by 26.0% with reactive hyperemia, in the 2nd group, when included in the scheme of treatment of athletic loads, this indicator increased from 25.7% at rest to 35.1% in conditions of reactive hyperemia (Table 1). This indicator is very important in connection with the fact that the shear stress on the endothelium regulates the synthesis of the NO synthetase enzyme and, thereby, the production of NO [15, 16]. The content of NO² in the blood plasma of patients of the 1st group increased less during the observation than in patients of the 2nd group. The concentration of NO² in the erythrocytes of Group 1 patients who received standard treatment decreased by 18.6%. In the 2nd group, as a result of additional exercise by the patients of physical exertion, it decreased more pronounced (by 33.5%). This indicated the increased synthesis of NO in the walls of blood vessels and the growth of its functional effects in the body [17,18]. The revealed weak dynamics of NO²-level in plasma and erythrocytes during standard therapy indicated unbalanced activation of the NO-synthesis system while maintaining its obvious dysfunction [19]. At the same time, when regular physical activities were included in the list of medical measures, it was possible to achieve a balanced normalization of NO-synthesis system activity.

Table 1: The parameters characterizing endothelial function during the study (M ± m)

Registered parameters	1 group of patients (n=27)		2groupofpatients (n=32)		Control (n=22)
	Start of observation	End of observation	Start of observation	End of observation	
Blood flow velocity in the brachial artery at rest, m/s	0.52±0.022**	0.62±0.019*	0.50±0.013**	0.79±0.009	0.82±0.012
Diameter of brachial artery at rest, × 10 ⁻² , m	0.43±0.009**	0.46±0.007*	0.44±0.011**	0.49±0.010	0.50±0.008
The shear stress on the endothelium at rest, ×10 ⁻⁶ din×m ²	409.7±3.92**	429.5±2.15*	410.8±3.30**	440.6±2.29	441.8±4.27
Blood flow velocity in the brachial artery with reactive hyperemia, m/s	0.63±0.009**	0.68±0.012*	0.61±0.010**	0.73±0.016	0.75±0.017
Diameter of the brachial artery in reactive hyperemia, × 10 ⁻² , m	0.49±0.019**	0.55±0.017*	0.48±0.021**	0.61±0.029	0.62±0.021
Shear stress on the endothelium during reactive hyperemia, ×10 ⁻⁶ din × m ²	512.5±3.72**	541.3±4.61*	516.6±4.25**	595.4±2.15	605.3±3.21
NO ² in plasma, nmol/ml	102.3±0.75**	110.8±0.48*	103.0±0.96**	122.1±0.53	124.6±0.91
NO ² in erythrocytes, nmol/ml	97.7±0.42**	82.4±0.39*	98.5±0.59**	73.8±0.52	74.2±0.65

Note: the reliability of the differences with the control: * - p <0,05, ** - p <0,01.

At the end of the observation, the remaining tendency of the vessels to spasm was noted in the 1 group of patients, as indicated by a slight increase in the blood flow velocity and a small increase in the diameter of the brachial artery by 6.9% at rest and by 12.2% in reactive hyperemia. This reflects the presence of

hyperstimulation of the endothelium, while maintaining its dysfunction as a result of the standard treatment. In the second group of patients, as a result of treatment, an increase in blood flow velocity was achieved against a background of normalization of the diameter of the brachial artery at rest and in reactive hyperemia. This indicated a more pronounced recovery of vascular endothelial function in conditions of increased physical activity of patients.

The positive effect of regular physical exertion on the endothelium of blood vessels is probably due to the activation of metabolic processes in it and the strengthening of the synthesis of gamma-butyrobetaine in this background. This substance is close in its chemical structure to acetylcholine and stimulates acetylcholine receptors, activating the biosynthesis of NO [20-22]. This effect, apparently, leads to a positive dynamics of the indicators considered [23,24]. It becomes clear that an important aspect of the impact of regular athletic loads on the body with atherosclerosis beginning is their stimulation of NO synthesis in a physiologically necessary amount for the systemic normalization of vascular tone [25]. The observed corrective effect of regular physical exertion on the functional state of the vascular endothelium, apparently, is accompanied by an increase in other vascular systems affecting hemostasis [26,27]. The results confirm the need for further active use of regular physical exertion in the onset of atherosclerosis.

CONCLUSION

In patients with stable angina of stress 1 functional class, signs of vascular endothelial dysfunction were revealed: a decrease in the amount of nitric oxide in the plasma and an increase in its metabolite in erythrocytes, a weakening of the vasodilation and the development of the inclination of the vessels to spasm. The effectiveness of standard treatment for patients with stable angina pectoris of stress 1 of the functional class is significantly increased by the addition of regular physical exertion to it. This significantly activates the NO system, thereby restoring the vasoregulatory function of the vascular endothelium. Considering the expressed stimulating effect of regular physical exertion on vascular endothelial function on the background of standard therapy, the authors consider it necessary to recommend wider use of them in the treatment of the onset manifestations of coronary artery atherosclerosis.

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