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# FEATURES OF THE RESPONSE OF ARTERIAL BLOOD FLOW TO THE ORTHOSTATIC LOAD IN YOUNG WOMEN WITH IDIOPATHIC ARTERIAL HYPOTENSION

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## SUMMARY

The aim of the study was to evaluate the response of arterial blood flow to the orthostatic load in young women with idiopathic arterial hypotension (IAH).

**Material and methods.** A comparative analysis of systemic hemodynamics and peripheral arterial blood flow parameters was performed for orthostasis between two groups of women aged 18-25: test with IAH (n = 73) and control (n=37). The SBP level in the test group was 90-98 mm Hg, in the control group - 120-129 mm Hg. BP, heart rate and angio-scanning were performed twice: at rest, lying after 15 minutes rest and during the first minute of orthostasis. Blood flow was studied in the right vertebral, radial and posterior tibial arteries. The following parameters were evaluated: diameter during diastole, peak systolic and terminal diastolic blood flow velocity.

**Results.** In young women with IAH, as those with normal arterial pressure, orthostasis was accompanied by an increase in SBP, DBP and an increase in heart rate.

With hypotension, an increase in the diameter of the vertebral artery and a decrease in the diameter of the posterior tibial artery were detected. In both groups, orthostasis was accompanied by a decrease in the rate of blood flow, both during systole and diastole.

**The conclusion.** Orthostasis with IAH is accompanied by an increase in SBP, DBP and heart rate. The response of peripheral arteries to orthostasis is characterized by a change in the diameter of the vessels, which indicates a pronounced adaptive response to the physiological stress load.

**Keywords:** *young women, idiopathic arterial hypotension, arterial blood flow, orthostasis.*

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## INTRODUCTION

Currently, low blood pressure, just like hypertension, is considered a risk factor for cardiovascular complications [1,2]. Along with numerous complaints of young women with low blood pressure, changes in cardiac and vascular hemodynamics have been recorded [3,4]. However, the response of vascular blood flow to physiological loads in arterial hypotension is poorly understood. The aim of the study was to evaluate the response of arterial blood flow to orthostatic load in young women with idiopathic arterial hypotension (IAH).

## MATERIALS AND METHODS

The study subjects were women with IAH aged 18-35 years. The study was on systemic hemodynamics and peripheral arterial blood flow under orthostatic load. Type of research – dynamic. Exclusion criteria: connective tissue dysplasia in the form of Marfan syndrome, Ehlers-Danlo syndrome and imperfect osteogenesis, oncological diseases, diabetes mellitus, hypothyroidism, adrenocortical insufficiency, rheumatic diseases, anemia, congenital heart and vascular diseases, operated heart and blood vessels, drug addiction, acute infectious diseases, obesity, pregnancy. Exceptions were based on the analysis of medical records, interviews and physical examination. The study was carried out as part of a planned medical examination for admission to the studies of students, interns, residents and graduate students. Arterial pressure was measured after a 5-minute rest, twice, on the right shoulder in a sitting position (with the forearm on the table) at an interval of 3 minutes. Based on the results obtained, the average value of the two measurements was calculated. The tonometer A&D UA-777 (AGD Company Ltd., Japan, 2012) was used in the study.

The IAH criterion was a SBP level of 98 mmHg and below [5]. The normal values of SBP were taken to be 120-129 mm Hg, for DBP - 80-84 mm Hg. [1]. According to the specified criterion, two groups were formed - a test group (73 people with IAH) and a control group (37 people with normal blood pressure). The characteristics of patients of both groups are presented in Table 1.

**Table 1. Comparative characteristics of women in the test and control groups**

	Test group (n=73)	Control group (n=37)	p
	<b>M (25%-75%)</b>		
Age, years	19(18-20)	20(19-22)	0,13
Height, cm	163(158-168)	165(157-169)	0,46
Weight, kg	52(48-56)	56(52-62)	0,01
SBP, mmHg	97(92-98)	123(121-125)	0,00
DBP, mmHg	65(60-70)	79(74-82)	0,00
Heart rate, min	70(64-77)	76(71-81)	0,01

Note: p – significance of differences

The dynamics of blood pressure and heart rate was assessed immediately after standing up. Angio-scanning was performed twice: at rest, lying down after a 15-minute rest and immediately after standing up during the first minute of orthostasis [6]. The blood flow of the right vertebral, radial and posterior tibial arteries was studied in standard «ultrasound windows» using a SonoScapeS6 color ultrasound scanner (SONOSCAPE Co., Ltd. China, 2015.) [7].

The following parameters were evaluated: diameter upon diastole (DDiast); peak systolic (Vps) and terminal diastolic (Ved) blood flow velocity.

Statistical analysis was performed using the program «Statistica 6.1» (StatSoft-Russia, 2009). The difference in the variation series of independent groups was estimated using the Mann-Whitney U-test criterion, the difference in variable dynamics of the dependent groups was determined using the Wilcoxon criterion and the fraction dynamics using McNemar's criterion. Significance was accounted for  $p < 0,05$ .

## RESULTS

In the test group, with orthostasis, SBP increased by 9 mmHg (9%) in 43 patients (59%). A decrease in SBP was noted in 23 cases (32%) on average by 6 mmHg (7%). There was no change in SBP in 7 patients (Table 2).

**Table 2. Results of the comparative analysis of systemic hemodynamics in orthostasis in women of the test and control groups**

Parameter	Test group, n=73		p	Control group, n=37		p
	Median, 25%-75%			Median, 25%-75%		
	initial	Upright position (orthostasis)		initial	Upright position (orthostasis)	
SBP, mmHg	97 (92-98)	98 (92-104)	0,004	123 (121-125)	127 (121-135)	0,008
DBP, mmHg	65 (60-70)	78 (69-85)	0,000	79 (74-82)	92 (83-97)	0,000
Heart rate, min	70 (64-77)	86 (73-97)	0,000	76 (71-81)	83 (77-97)	0,002

Note: p – significance of differences

In the control group, SBP increase was recorded in 22 patients (60%) at 13 mmHg. (11%), a decrease was observed in 13 patients (35%) on average by 5 mmHg (4%). No change was observed in SBP in 2 patients.

In the test group, an increase in DBP was recorded in 67 (92%) patients on average by 13 mmHg (20%), a decrease in DBP was observed in 6 patients at 13 mmHg (21%). In the control group, an increase in DBP was recorded in 35 (95%) women at 13 mmHg from the initial level (17%). A decrease in DBP was observed in 2 (5%) patients by 8 mmHg (6%).

In the test group, the increase in heart rate was observed in 55 (75%) women by 25 beats per min. from the initial level (39%). There was no change in heart rate in 2 patients. A decrease in heart rate was noted in 17 patients (23%) by 10 beats per min. (13%). In the control group, 27 patients (73%) had an increase in heart rate of 22 beats per min. (31%), and a decrease in heart rate was observed in 10 patients (27%) on average 10 beats per min. (13%).

The analysis of variability fraction cases and variability fraction values did not reveal differences between the study groups of patients.

Angio-scanning revealed an increase in the diameter of the vertebral artery and a decrease in the diameter of the posterior tibial artery. In the control group, there was no evidence of change in the diameters of the studied arteries (Table 3).

**Table 3. Results of the comparative analysis of blood flow upon orthostasis in women of the test and control groups**

Parameter	Test group, n=73		p	Control group, n=37		p
	Median, 25%-75%			Median, 25%-75%		
	initial	Upright position (orthostasis)		initial	Upright position (orthostasis)	
Vertebral artery						
DDiam., mm	3,0 (2,8-3,2)	3,1 (2,8-3,5)	0,003	3,0 (2,8-3,3)	3,1 (2,9-3,4)	0,72
Vps, cm/s	44,0 (39,0-56,5)	46,6 (38,4-54,8)	0,93	43,1 (36,0-51,5)	48,4 (38,9-56,1)	0,18
Ved, cm/s	25,7 (21,6-32,0)	15,0 (12,9-18,1)	0,000	24,0 (20,4-29,8)	16,2 (14,4-19,2)	0,000
Radial artery						
DDiam., mm	1,4 (1,2-1,6)	1,4 (1,2-1,6)	0,67	1,4 (1,2-1,5)	1,4 (1,2-1,5)	0,61
Vps, cm/s	22,2 (16,9-27,0)	15,8 (12,2-19,3)	0,000	25,1 (18,1-29,9)	18,9 (15,3-21,8)	0,000
Ved, cm/s	6,6 (4,3-9,3)	4,2 (3,0-5,3)	0,000	6,3 (4,5-11,3)	4,5 (3,4-5,8)	0,003
Posterior tibial artery						
DDiam., mm	1,5 (1,4-1,8)	1,3 (1,2-1,5)	0,000	1,5 (1,3-1,8)	1,4 (1,2-1,6)	0,06
Vps, cm/s	20,0 (14,4-27,4)	16,2 (13,1-20,0)	0,010	29,5 (21,4-35,2)	22,0 (14,4-30,3)	0,023
Ved, cm/s	3,8 (2,7-5,3)	4,4 (3,4-5,9)	0,23	6,2 (4,1-8,6)	4,4 (3,3-6,5)	0,06

Note: p – significance of differences

In both groups, orthostasis was accompanied by a decrease in the rate of blood flow, both during systole and diastole.

## EXPLANATION

Previously performed studies in young women with IAH not only revealed signs of remodeling of the cardiovascular system [3,4,5,8], but also a decrease in its adaptive capacity under physiological stress effects [9,10,11]. It is known that IAH develops under the influence of hypoxic and nitrite stress [12,13]. We consider it possible that the metabolic products of hypoxia (lactic acid) and superoxide azotemia recorded with chronic hypotension and known for their toxic effects, form structural and functional changes in blood vessels and the heart, which are accompanied by a decrease in adaptation to physiological stresses [14,15].

Our study showed that along with a similar response to orthostatic systemic hemodynamics in both groups of patients, peripheral arteries respond more quickly to orthostasis in young women with IAH than in women of the control group. The fastest and most pronounced response to verticalization was recorded in the arteries of the lower limbs and arteries that supply blood to the brain and reflects, as we assume, an adaptation mechanism that prevents the aggravation of brain hypoperfusion in the upright position in patients with IAH. The absence of a normal vasotonic reaction of the arteries in the control group is probably associated with a slower change in diameter (1 min after the body shifts to a vertical position), which made it impossible to fix it with the sampling technique used.

## CONCLUSIONS

1. In an upright position, patients with IAH, as well as patients in the group with normal arterial pressure, in 59-69% of cases, SBP increase was recorded, in 92-95% cases an increase in DBP was observed and in 73-75% of cases there was an increase in heart rate.

2. In young women with IAH, the rapid response of peripheral arteries to orthostasis is characterized by a change in

the diameter of the vessels - an increase in the vertebral artery and a decrease in the posterior tibial artery (as compared to patients with normal arterial pressure), indicating a more pronounced adaptive response to the physiological stress load. With IAH, as with normal arterial pressure, the orthostatic test is accompanied by a decrease in the blood flow velocity in the vertebral, radial and posterior tibial arteries.

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