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FEATURES OF MICROCIRCULATORY PROCESSES IN GIRLS WITH DIFFERENT TYPES OF HAND MOTOR ASYMMETRY

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Abstract:
In a comparative aspect, the dynamics of microcirculation in the skin of the ring finger was studied according to the parameters of LDF-grams (Laser Doppler Flowmetry) (microcirculation in 17-19-year-old girls, taking into account the functional asymmetry of their hands under physiological conditions and under the influence of a thermal sample).
The recording of the LDF-gram wave process, as a result of the superposition of microcirculation waves associated with their "active" and "passive" mechanisms in the frequency band from 0.0095 Hz to 1.6 Hz, has practical and diagnostic significance, both for scientific purposes aimed at evaluating various aspects of its reactivity and manifestation at different stages of human development. They are represented by non–overlapping frequency ranges (active – neurogenic, endothelial, myogenic) and two rhythms (passive - respiratory and

cardiac) [2, 5]. Functionally, microcirculation processes determine the process of adequate response to shifts in the parameters of the external or internal environment.

Our study was aimed at analyzing the nature of the relationship between the functional parameters of the cardiovascular system and the typological features of their nervous system of girls.

Keywords: microcirculation, LDF-gram frequency ranges.

Introduction

The age-related features of microcirculation were studied in 33 girls aged 19-20 years, in whom the dominant type of motor asymmetry of the hands was determined [1, 6], two groups were formed – 25 right-handed and 8 left-handed. The girls were informed about the purpose, objectives and methods of the research. The participants of the study agreed to participate in it. They had no chronic diseases or unhealthy habits at the time of the study.

In the study, a functional test unit "LAKK-test" with a controlled thermoelement (Scientific and Industrial Enterprise "Lazma", Russia) was used to record the initial LDF-grams and conduct samples with local heating. The flowmeter probe was fixed on the ventral surface of the index finger of the leading hand; LDF-grams were recorded in a sitting position at 18-20 ° C in a room in the absence of extraneous stimuli before and for 4 minutes of a thermal sample using the red channel of the 2-channel laser Doppler flowmeter LAKK-02 [2, 3].

In the tested area of the skin of the ring finger of the leading hand, statistical amplitude-frequency parameters of basal blood flow were recorded before and during the thermal test, microcirculation parameters were recorded in perfusion units (pf. units). The reactivity of microvessels and perfusion intensity were evaluated based on the use of a functional test with local heating (at a rate of 4 ° C/min in the temperature range 32-38 ° C) against the background of maintaining the final temperature value.

LDH-gram indicators were analyzed taking into account the diagnostic values of microcirculation indicators and their characteristics. The indicators of the average blood flow at rest, at the end of the second and fourth minutes of the thermal test, were evaluated according to microcirculation parameters – MP (pf. units); temporal variability of perfusion – SD (Standard deviation) (pf.units), which reflects the average modulation of blood flow in all frequency ranges; coefficient of variation (CV = SD / M • 100%); normalized fluctuations in blood flow according to the values of SD, values of amplitudes (pf. units) and frequencies (Hz) in each studied range. The normalized values of each rhythm were estimated by the average level of microcirculation (in %). The analysis of the LDF gram was performed on the basis of a wavelet analysis algorithm with a low frequency removal function [2, 4]. The amplitude-frequency characteristics of the signals were evaluated in 5 frequency ranges associated with physiological processes; the muscle tone of micro vessels was evaluated by the amplitudes of fluctuations in microcirculation; the shunting index (SI) was calculated using the formula: SI =

MT (muscle tone)/NT (neurogenic tone) [2, 5]. The data obtained in the work were processed using the Statistica 11 program.

The results of the study and their discussion

The right-handed type of motor asymmetry of the brain was detected in 76.6%, the left–handed type in 23.3%. The dynamics of microcirculation in the skin of the 2nd finger of the right or left hand caused by local heating in female students are presented in Table 1.

Table 1 Microcirculation parameters and standard deviation of blood flow in the skin of the 2nd finger of the hand in students with different types of motor asymmetry

Parameters	Right-handed	Left-handed	Right-handed	Left-handed	Right-handed	Left-handed
	MP, pf.units		SD, pf.units		CV, %.	
Before the thermal test						
M± m	12,1±0,9	15,5±1,1	0,6±0,03	0,6±0,08	5,8±0,50	4,1±0,50
σ	4,5	2,8	4,45	0,22	2,43	1,5
Min-max	6,3-21,96	12,24-19,39	6,3-21,96	0,29-0,99	2,47-11,48	2,38-7,00
120 sec of the thermal test						
M± m	13,9±0,86	16,4±1,03	0,8±0,05*	0,8±0,14	6,5±0,50	4,9±0,90
σ	4,1	2,7	0,28	0,37	2,8	2,37
Min-max	4,72-19,89	12,86-19,88	0,43-1,46	0,51-1,49	2,24-14,36	3,07-9,17
240 sec of the thermal test						
M± m	16,9±0,71*	17,5±0,75*	0,7±0,04	0,6±0,06	4,8±0,47	3,4±0,27
σ	3,44	1,90	0,22	0,16	2,30	0,72
Min-max	8,47-22,87	15,47-20,33	0,45-1,23	0,42-0,93	2,26-12,93	2,70-4,76

* The reliability of the differences in the values in the group of right-handed compared with the values of left-handed according to the Student's criterion ($p<0.05$)

In a state of relative rest, the average value of MP in the group of left-handers versus right-handers was 3.4 pf higher. But during the first 2 minutes of heating the finger, it increased 1.5 times more than the normal MP in right-handed people and at the end of the 4th minute exceeded the normal MP by 4.8 pf. units ($p<0.05$). The increase in the MP value at the end of the 2nd minute was less significant in left-handers, but at the end of the 4th minute it was more variable, exceeding the normal parameters ($p<0.05$) by 2.0 pf. units (Tab. 2).

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Table 2 Microcirculation parameters, standard deviation and coefficient of variation of blood flow in the skin of the 2nd finger of the hand in students with different types of motor asymmetry

Parameters	Right-handed	Left-handed	Right-handed	Left-handed	Right-handed	Left-handed
	MP, pf.units		SD, pf.units		CV, %.	
Before the thermal test						
M± m	12,1±0,90	15,5±1,10	0,6±0,03	0,6±0,08	5,8±0,50	4,1±0,50
σ	4,5	2,8	4,45	0,22	2,43	1,5
Min-max	6,3-21,96	12,24-19,39	6,3-21,96	0,29-0,99	2,47-11,48	2,38-7,00
120 sec of the thermal test						
M± m	13,9±0,86	16,4±1,03	0,8±0,05*	0,8±0,14	6,5±0,50	4,9±0,90
σ	4,1	2,7	0,28	0,37	2,8	2,37
Min-max	4,72-19,89	12,86-19,88	0,43-1,46	0,51-1,49	2,24-14,36	3,07-9,17
240 sec of the thermal test						
M± m	16,9±0,71*	17,5±0,75*	0,7±0,04	0,6±0,06	4,8±0,47	3,4±0,27
σ	3,44	1,90	0,22	0,16	2,30	0,72
Min-max	8,47-22,87	15,47-20,33	0,45-1,23	0,42-0,93	2,26-12,93	2,70-4,76

* The reliability of the differences in the values in the group of right-handed people compared with the values of left-handed people according to the Student's criterion ($p<0.05$).

In girls of both groups, the initially equal values of SD perfusion efficiency increased by 25% at the first 120 seconds of local heating (see Tab. 2). The values decreased by 120 seconds of heating, and after its completion, the individual values of SD became more variable in right-handers, exceeding the initial normal parameters by 17%; in left-handers they became less variable and decreased to the initial normal parameters.

The increase in SD values in girls of both groups was due to increased micro-blood flow due to increased heart rate and respiratory rate; but a decrease in the values of SD to the normal parameters reduced their spread and caused an increase in blood flow in them.

The CV values before and after the application of the thermal sample were higher in right-handers (see Tab. 2). Initially decreased by 29% CV values in left-handers in the first 120 minutes of local heating of the finger skin on the background of an increase in Kv values indicated an increase in microcirculation in the finger skin, which was less pronounced in right-handers. However, during the heating period from 120 seconds to 240 seconds, the average CV values decreased compared to the initial ones and this process was more expressed in left-handers.

In a state of relative physiological rest, the indicators of neurogenic tone in students of both groups corresponded to the norm (see Tab. 3).

Local heating of the skin of the 2nd finger in the first 120 seconds caused a decrease in neurogenic tone by 5.6% in right-handers, and by 6.2% in left-handers. At this level, it was marked at the end of the 4th minute of local heating. This result indicated activation of

sympatho-adrenergic vasoconstrictor nerve fibers, which regulated the mechanism of the microcirculatory channel by maintaining capillary tone.

By the end of the 4th minute of local heating, the neurogenic tone in both groups of students stabilized to the initial one.

Table 3 Dynamics of neurogenic (NT) and myogenic tones (MT), shunting (SI) of blood flow in the skin of the 2nd finger of the hand in students with different types of motor asymmetry (M± m; σ; Min-max)

Parameters	Right-handed	Left-handed	Right-handed	Left-handed	Right-handed	Left-handed
	NT, cu		**MT, cu**		**SI, cu**	
	Before the thermal test					
M± m	1,8±0,07	1,9±0,20	0,6±0,03	0,6±0,08	5,8±0,50	4,1±0,50
σ	0,37	0,58	4,45	0,22	2,43	1,5
Min-max	1,18-2,44	1,52-3,23	6,3-21,96	0,29-0,99	2,47-11,48	2,38-7,00
	120 sec of the thermal test					
M± m	1,7±0,09	16,4±1,03	0,8±0,05*	0,8±0,14	6,5±0,50	4,9±0,90
σ	4,4	2,7	0,28	0,37	2,8	2,37
Min-max	1,18-3,28	12,86-19,88	0,43-1,46	0,51-1,49	2,24-14,36	3,07-9,17
	240 sec of the thermal test					
M± m	1,8±0,07	1,5±0,75*	0,7±0,04	0,6±0,06	4,8±0,47	3,4±0,27
σ	0,37	1,90	0,22	0,16	2,30	0,72
Min-max	1,18-2,44	15,47-20,33	0,45-1,23	0,42-0,93	2,26-12,93	2,70-4,76

* The reliability of the differences in the values in the group of right-handed people compared with the values of left-handed people according to the Student's criterion ($p<0.05$).

In right-handers, the thermal test caused a two-phase effect: during the first 120 seconds of heating, a slight decrease in myogenic tone, and in the next two minutes of heating its increase by 7.2% was caused.

Local heating of the finger skin in left-handers increased myogenic tone by 2.9% during the first 120 seconds and it was maintained at this level during the next 120 seconds of heat exposure (see Table 3).

A 4-minute thermal test did not change the SI value in right-handed students and their ratio of the severity of neurogenic and myogenic tones remained at a constant level. Thermal exposure caused an unreliable increase in SI in left-handers by 14.2% by the end of the 2nd minute and by 28.5% by the end of the 4th (see Table 3).

An increase in SI indicated that in left-handers the myogenic mechanism is the leading one, determines the adaptation of microvessels to an increase of temperature.

Conclusion

1. The dynamics in the microcirculatory channel of blood flow oscillations caused by local heating of the skin of the finger of the hand is mainly carried out due to local vasodilation

mechanisms, determines the two-phase response character of changes in blood flow in capillaries in students with different types of motor asymmetry. The mechanisms of maintaining capillary tone in the group of right-handed girls are realized by activating sympathetic adrenergic vasoconstrictor nerve fibers; in the group of left-handers, the myogenic mechanism is the leading component of adaptation to an ambient temperature increase.

2. Dynamics of blood flow oscillations in the microcirculatory channel with local heating of the skin of the leading hand index finger activate a two-phase response character of changes in the intensity of blood flow in capillaries in girls with different types of motor asymmetry of the hands. Changes in the microcirculatory channel caused by thermal heating are mainly realized due to the action of local vasodilation mechanisms. Fluctuations in the neurogenic rhythm in right–handers activate the tone of the sympathetic vasoconstrictor nerve; in left-handers, myogenic tone is determined by the activity of smooth muscle cells of the vascular walls.

3. The mechanism of maintaining capillary tone in the right–handed group implements the activation of sympathetic adrenergic vasoconstrictor nerve fibers; in the left-handed group, the myogenic mechanism as the leading process of adaptation to temperature rise. Changes in venous tone in a group of left-handed girls determine the processes of redistribution of blood flow in the vascular channel. In response to thermal stimulation in right-handed people, the vascular endothelium secretes periodically changing concentrations of vasoactive substances into the blood, which activate the modulation of vascular muscle tone. Fluctuations in the neurogenic rhythm in right–handers are associated with the activity of the sympathetic vasoconstrictor nerve, and in left-handers they are associated with the myogenic tone of smooth muscle cells of the vascular walls.

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