Ways to control and improve physical performance

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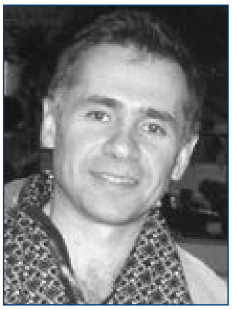

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Abstract

Objective of the study was to reveal the relationship between the mobility of the cervical spine and the blood circulation of the vertebral arteries, neurohumoral regulation and the physical performance of the body.

Methods and structure of the study. A group of active athletes, polyathletes, track and field athletes (23 people, 17-22 years old), qualification Master of Sports, Candidate for Master of Sports, 1 sports category, was examined. The mobility of the cervical spine (CS) was assessed, an ultrasound scan of the brachiocephalic vessels (USV) was performed; if mobility disorders of the cervical spine were detected, each athlete underwent up to three sessions of individual myocorrection: acupressure, reflex, vacuum massage of the cervical spine. Heart rate (HR) indicators during the active orthostatic test and maximum exercise testing were assessed twice before and after myocorrection.

Results and conclusions. In all cases of changes in the mobility of the cervical spine, USV confirmed various degrees of disturbance and asymmetry of blood circulation in the basin of the vertebral artery (VA). A decrease in the diameter of the vertebral artery corresponded to a decrease in the linear, volumetric blood flow velocity and was manifested by a low level of the total spectral power of HR, with the actual absence of fast regulatory elements. After myocorrection, the degree of restoration of blood circulation was confirmed by USV. The HR analysis revealed an increase in the total power of the spectrum and its redistribution to the high-frequency region. The results of load testing before and after myocorrection revealed significant differences in the efficiency of overcoming the load maximum and recovery. Violation of the mobility of the cervical spine, leading to a decrease and asymmetry of the blood circulation of the vertebral arteries, is manifested by depression of neurohumoral regulation and physical performance. Restoration of blood circulation after myocorrection improves the functional state and exercise tolerance.

Keywords: *mobility of the cervical spine, blood circulation, vertebral arteries, neurohumoral regulation.*

Introduction. The physical performance (PP) of an athlete is largely determined by the functional state (FS) of the body, in other words, by its neurohumoral regulation [1, 7, 8]. The latter is mainly determined by the viability of the blood supply to the brain stem. At the same time, the brain stem, which is responsible for maintaining life support functions and, accordingly, their neurohumoral regulation, is supplied exclusively from the vertebrobasilar basin. Its insufficiency is associated with a change in the cross section, volumetric and linear blood flow velocity of the vertebral arteries. Since these arteries pass through the transverse processes of the cervical vertebrae, the orientation and position of the latter will have a direct effect on the hemodynamics of these vessels. In turn, an increase, asymmetry of the tension of the muscles of the neck and the corresponding section of the spine can cause impaired mobility of the vertebrae and, accordingly, changes in the hemodynamics of the vertebral arteries. At the same time, an increase, asymmetry of muscle tone may be the result of a constant readiness to perform physical activity due to insufficient recovery, overload, overtraining or the formation of a forced (habitual) posture due to special physical activity (cyclists, rowers, athletes, weightlifters and others), as well as due to an untreated injury.

A change in the mobility of the cervical spine, expressed in a decrease and asymmetry of the angles of inclination and rotation of the head relative to the physiological axes, is an external manifestation of a probable circulatory disorder of the vertebral arteries. The latter circumstance will probably be manifested by a violation of neurohumoral regulation and a decrease in the physical performance of the body. In turn, the restoration of blood supply in the basin of the vertebral artery is likely to lead to an improvement in neurohumoral regulation and physical performance of the athlete's body.

Objective of the study was to reveal the relationship between the mobility of the cervical spine and the blood circulation of the vertebral arteries, neurohumoral regulation and the physical performance of the body.

Methods and structure of the study. A group of active athletes, polyathletes, track and field athletes (23 people, 17-22 years old), qualification Master of Sports, Candidate for Master of Sports, 1 sports category was examined. The study included: ***firstly***, an assessment of the mobility of the cervical spine in the sagittal, frontal and vertical axes.

Secondly, in case of identified mobility disorders, an ultrasound scan of the brachiocephalic vessels (USV) was performed, the diameter and linear velocity of the blood flow of the vertebral arteries were assessed in areas V1 (from the beginning to the transverse process of the 6th cervical vertebra (C-6)), 2 (from C-6 to C-2), 3 (from C2 to the entrance to the spinal canal C1) on the left and right.

Thirdly, after identifying mobility disorders and their objective confirmation by ultrasound, each athlete underwent up to three sessions of individual myocorrection, including acupressure, reflex, and vacuum massage of the cervical region.

Fourth, an active orthostatic test (AOT) was performed, during which the electrocardiogram was recorded for 5 min in the supine position (clinostasis), and then in the standing position (orthostasis), including an active transition from the clinostasis position to orthostasis. The current functional state was assessed by the TP indicator (total power of the spectrum), taking into account the contribution of fast oscillations (HF-component), reflecting the activity of the parasympathetic division of the autonomic nervous system, slow oscillations (LF-component) - a marker of the activity of sympathetic influences and very slow oscillations (VLF -component) - reflective, humoral-metabolic and cerebral ergotropic effects on the heart rhythm. The LF/HF ratio was regarded as sympathetic reactivity. The reactivity of the parasympathetic division was assessed by a ratio of 30:15 [1, 2, 7, 8].

Fifth, the maximum bicycle ergometric testing was carried out according to an individual protocol. The power W1(Watt) of the 1st stage (3 min) was calculated from the value of the proper basal metabolic rate (BMR): W1(W)=BMR × 0.1. Next - ramp-protocol, increment 30W per minute, until failure - an individual maximum (Wmx), causing the end of the load and the beginning of the recovery period - 7 minutes [3-6].

Exercise tests were carried out in the first half of the day on a Lode Corival bicycle ergometer (7-1000 W). During the entire testing, the digitized ECG (Poly-Spectr-12, Neurosoft) was converted into a sequential time series of RR-intervals (CI) - a cardiorhythmogram (CRG). Physical exercise tolerance (Watts) was determined by the difference between the achieved

Table 1. *Results of USV of the vertebral artery before correction*

Results		Smaller diameter			Larger diameter		
	Pz	C1	C2	C3	C1	C2	C3
Diameter, mm	25	2,9	2,0	2,7	3,3	3,3	3,1
	50	3	2,7	2,8	3,6	3,6	3,2
	75	3,1	2,8	2,9	3,7	3,7	3,3
Vs sm/s	25	40	23	37	45	33	47
	50	44	27	40	53	41	48
	75	48	36	43	55	45	49

Table 2. *Results of USV of the vertebral artery before correction*

Results		Smaller diameter			Larger diameter		
	Pz	C1	C2	C3	C1	C2	C3
Diameter, mm	25	2,8	2,8	2,8	3,2	3,2	3,45
	50	3,1	3	2,9	3,4	3,3	3,5
	75	3,6	3,4	2,97	3,5	3,6	3,55
Vs sm/s	25	42	36	34,5	41	30	34,3
	50	46	38	35,5	44	38	39,5
	75	49	45	37,7	46	51	44,3

Table 3. *HRV spectrum in the clino- (C) orthostasis (O) position before correction*

HRV	Pz	30/15	Ps	TPмс²	VLFмс²	LFмс²	HFмс²	LF/HF	%VLF	%LF	%HF
C	25		68,7	517,2	260,9	104,7	80,78	1,2	34,58	20,66	10,8
	50		75,5	798,4	318,5	273,2	110,6	1,99	44,88	31,76	14,1
	75		88,2	1054,7	370,5	471,9	180,0	3,46	64,33	40,64	20,1
O	25	1,05	88	725,73	263,6	234,3	54,78	4,26	29,05	28,42	4,02
	50	1,15	100	1231,9	619,0	404,8	72,59	5,04	61,53	32,62	7,08
	75	1,22	111	1762,9	1230	515,2	113,0	7,39	66,73	61,68	8,7

Table 4. HRV spectrum of clino- (C) orthostasis (O) after correction

HRV	Pz	30/15	Ps	TPмс²	VLFмс²	LFмс²	HFмс²	LF/HF	%VLF	%LF	%HF
C	25		64	1212,5	355,1	287,4	501,3	0,5	22,34	22,32	31,1
	50		69	2168,3	587,8	601,5	727,6	0,65	31,01	30,08	37,8
	75		74	2518,7	732,3	818,0	945,4	1,11	37,4	36,37	52,2
O	25	1,28	78	1491,9	754,1	445,0	160,6	1,58	41,24	22,74	8,43
	50	1,35	88	2232,8	1121,5	619,3	286,1	2,74	52,64	32,09	12,3
	75	1,46	92	2783,6	1474,2	1098	466,3	4,85	64,22	45,05	19,2

maximum physical activity (Wmx) and power W1. The indicator W/Ps - according to the formula: W/HRpm, where HRpm is the sum of CI of the last minute of the load. The duration of recovery was determined by the integral indicator (II), as the sum of CI for 7 minutes of the recovery period.

Sixth, after myocorrection, repeated ultrasound scanning of brachiocephalic vessels was performed, the functional state was assessed by the frequency spectrum of HR during an AOT, and stress testing. The results of the study were processed using the statistical package Statistica 10.0.

Results of the study and their discussion. In all cases (12 people) of changes in the mobility of the cervical spine, ultrasound scanning confirmed various degrees of disturbance and asymmetry of blood circulation in the basin of the vertebral artery.

For the correctness of the analysis and simplification of perception, the results are grouped according to the size (larger/smaller) of the cross section of the vessels detected by ultrasound scanning of the vessels. The classical representation (right/left vertebral arteries) would complicate perception and analysis, since circulatory disorders in athletes were detected with equal frequency from different sides. In turn, we did not establish differences in neurohumoral regulation in the presence of predominant circulatory disorders in the left or right vertebral arteries in this work (Table 1).

At the same time, a decrease in the diameter of the vertebral artery, detected in V1, 2, 3 areas, corresponded to a decrease in the linear and volumetric blood flow velocity in them. The asymmetry of the blood supply during the initial examination is manifested by a low level of the total power of the spectrum, which actually lacks fast regulatory elements, and is based on humoral-metabolic waves in both ortho- and clinostasis (Table 2).

After individual myocorrection, partial restoration of blood circulation was confirmed by repeated ultrasound scanning. The frequency analysis revealed an increase in the total power of the spectrum and its redistribution to the high-frequency region.

In clinostasis, the role of rapid regulation increases, which already makes up 2/3 of the entire spectrum. In orthostasis, despite the predominance of humoral-metabolic activity, the sympathetic component occupies a third of the total power, and together with parasympathetic activity makes up 44.4%. The Ewing index increases significantly (from 1.15 to 1.35), which indicates an increase in parasympathetic reactivity (Tables 3, 4).

When comparing the results of stress testing before and after myocorrection, no significant differences in achieving the maximum physical performance were found, however, statistical significance was confirmed by the effectiveness of exercise tolerance (W/HR in the last minute of exercise: 159.1 vs. 146.9) and recovery (II - 819 .8 vs. 759.5).

Conclusions. Thus, impaired mobility of the cervical spine, leading to a decrease and asymmetry of the blood circulation of the vertebral arteries, is manifested by depression of neurohumoral regulation and physical performance. Restoration of blood circulation after myocorrection improves the functional state and exercise tolerance.

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