



Adaptation of voltage degree of regulatory systems to active physical activity in children with cerebral palsy

UDC 796.07;796.034.2



PhD, Associate Professor **N.A. Gross**¹

Postgraduate student **D.O. Khrekin**¹

PhD **T.L. Sharova**¹

PhD **V.A. Klendar**¹

¹Federal Science Center of Physical Culture and Sport (VNIIFK), Moscow

Corresponding author: niinagross@yandex.ru

Received by the editorial office on 25.05.2023

Abstract

Objective of the study was to study the level of adaptive capabilities of the body of children with cerebral palsy based on the analysis of heart rate variability (HRV), determined before and after performing active physical exercises in a rehabilitation session.

Methods and structure of the study. The scientific work involved 303 children aged 5 to 14 years with a diagnosis of cerebral palsy and different levels of development of gross motor functions according to the international GMFCS scale. The frequency of occurrence (in %) of indicators of activity of regulatory systems (IARS) and indicators of functional resources in children before and after performing active physical activity was analyzed.

Results and conclusions. A low level of initial functional reserve and insufficient activity of the cardiovascular system were revealed, which should be taken into account when conducting classes. Adaptive reactions in children with varying degrees of disease severity are individual and are implemented in different ways. It was revealed that individually selected physical activity increases the activation of regulatory systems and functional resources in children with cerebral palsy, especially with severe motor impairments (level 4-5 of the GMFCS scale). To develop functional and physical abilities in children with cerebral palsy, continuous physical rehabilitation is necessary, as a result of which the body's capabilities gradually increase and long-term adaptation is formed, associated with the activation and mobilization of functional resources.

Keywords: *adaptation of the body of children with cerebral palsy, heart rate variability, active physical exercise.*

Introduction. Limited motor activity in children with cerebral palsy reduces their adaptive capabilities and leads to a decrease in the ability to adequately respond not only to active physical activity in classes, but also to everyday ones [2]. The ability to ensure adaptation to physical stress is determined not only by motor, but also by the functional capabilities of the body, which depend on the interaction of control regulatory systems (control, regulation and management) over the state of the whole organism [2, 5]. Assessment of the functional reserves of the mechanisms of autonomic regulation and various parts of the control system of physiological functions can serve as diag-

nostic and prognostic criteria in dynamic observations of the body's response to physical activity [1, 6, 7]. In children with cerebral palsy, the body's adaptation to physical activity occurs differently depending on the mental state, intensity and volume of the load, as well as the presence of functional reserves. If the physical activity used is inadequate, children with cerebral palsy may experience ambiguous reactions of the body from the cardiovascular system, which lead to failure of adaptation [4, 7]. Therefore, determining the level of adaptive capabilities of the body of children with cerebral palsy when performing physical activity is one of the most important tasks of physical rehabilitation.



Objective of the study was to assess the level of adaptive capabilities of the body of children with cerebral palsy based on HRV indicators obtained before and after performing active physical exercises in a rehabilitation session.

Methods and structure of the study. The work used the method of cardiointervalometry - HRV using the Varicard apparatus, which determines the degree of activity of regulatory systems according to the indicator of activity of regulatory systems with a differentiated assessment according to ranges and indicators of functional resources. The study involved 303 children diagnosed with cerebral palsy aged from 5 to 14 years and with different levels of development of gross motor functions according to the international GMFCS scale. Measurements of functional status were carried out before and after rehabilitation sessions with active physical exercises. The physical activity of children of all levels consisted of general developmental gymnastics, walking on a treadmill, working on a MOTomed, a bicycle ergometer and other exercise equipment, and was selected individually taking into account the GMFCS levels and the functional state of their body. Children of levels III-IV GMFCS trained in the "Gross Trainer" to maintain a vertical position and provide a dosed load on the musculoskeletal system.

The research consisted of a comparative analysis of the frequency distribution (in %) of the degree of tension of regulatory systems and functional state according to IARS indicators in children with cerebral palsy before and after performing physical activity at each level of development of gross motor functions on the GMFCS scale.

A physiological assessment of the state of regulatory systems was expressed in points: 0 points - normal, +1 or -1 indicated a moderate deviation from the norm, with a score of +2 or -2 - a significant deviation from the norm. IARS values, consisting of five ranges, were assessed in points from 1 to 10, where: the physiological norm was from 1-2 points (the optimal level of tension of regulatory systems), moderate functional tension - 3-4 points, pronounced functional tension - from 5-6 points, overexertion - 7-8 points, the assessment of failure of the body's adaptation was 9-10 points.

Results of the study and discussion. The degree of tension in regulatory systems in children with cerebral palsy is realized in different ways, changes and has a variable multidirectional func-

tional organization with the inclusion of different levels of compensatory functions [2, 7]. The state of regulatory systems before physical activity in the majority of children (from 49 to 70%) of all five GMFCS levels was relatively balanced. Normal functioning of the cardiovascular system (CVS) was observed in 61% of children at GMFCS level I and 48% of children at level III. In 55% of children of levels IV-V, severe tachycardia was observed, which is characterized as an increased neuro-emotional state or lack of sufficient functional reserves. The majority (42-57%) of children experienced significant tension in autonomic homeostasis. A common characteristic of autonomic regulation of the initial state was increased tone of the sympathetic part of the autonomic nervous system in all groups. The activity of the sympathetic vascular center was normally observed in 50-70% of children of all levels, pronounced sympathetic activity was observed in 17-35% of children. The results of assessing the state of regulatory systems before and after physical activity are shown in the table.

After physical exercise, the state of the regulatory systems in all children, regardless of the level of GMFCS, was characterized by a decrease in the degree of central control and autonomic homeostasis due to increased autonomous regulation, that is, due to increased breathing and the removal of stress during physical exercise, which increases the activation of regulatory systems and balancing various body systems with each other. The greatest improvement in indicators was observed in children of levels IV-V of the GMFCS scale, i.e. with severe motor impairments. This confirms the fact of the positive effect of active physical exercise on the functional state of children with cerebral palsy.

According to the IARS indicators, it was revealed that the initial state of a large number of children was in the range of 4-6 points, which characterizes the state of functional reserve. 5% of children belonging to levels IV-V of the GMFCS scale were in the range with high tension of regulatory systems - 8-9 points, which was characterized by an increased risk of adaptation failure.

After the load, all children showed a transition of the body state into the normal range or close to normal; this was more evident in children of levels IV-V GMFCS.

Thus, indicators of heart rate variability are informative for assessing the adaptation of children's bod-



Frequency distribution (in %) of the degree of tension of regulatory systems (in %) in children with cerebral palsy before and after physical activity

Frequency of occurrence of the degree of tension of regulatory systems, % in children with cerebral palsy											
GMFCS	ASRS *	Functioning level		Stability of regulation		Vegetative homeostasis		Activity of the sympathetic vascular center		Degree centralization of management	
		before	after	before	after	before	after	before	after	before	after
Level 1	0	61	39	43	39	17	26	57	78	13	22
	1	22	39	0	0	9	0	17	17	0	0
	-1	0	17	17	39	4	9	13	4	17	30
	2	13	4	0	0	13	17	9	0	0	0
	-2	4	0	39	22	57	48	4	0	70	48
Level 2	0	33	31	24	31	16	18	62	58	18	22
	1	24	13	16	7	9	13	27	31	9	4
	-1	4	2	31	33	11	13	7	9	24	27
	2	38	53	2	4	22	22	4	2	0	7
	-2	0	0	27	24	42	33	0	0	49	40
Level 3	0	48	43	38	32	15	20	50	53	27	17
	1	22	17	3	3	15	13	35	30	3	5
	-1	3	10	22	33	15	12	8	8	23	33
	2	27	30	0	0	5	8	7	8	0	0
	-2	0	0	37	32	50	47	0	0	47	45
Level 4	0	24	27	21	27	12	16	70	66	15	24
	1	15	15	3	5	14	11	18	23	7	5
	-1	6	5	36	31	13	15	7	8	23	24
	2	55	53	0	1	16	17	5	3	2	2
	-2	1	0	40	35	45	41	1	0	53	45
Level 5	0	17	17	2	7	7	12	68	78	17	32
	1	29	27	0	7	10	7	20	20	2	12
	-1	0	5	34	24	10	7	10	2%	15%	10
	2	54	51	0	0	7	15	2	0%	2%	0
	-2	0	0	63	61	66	59	0	0%	63%	46

Note: ASRS* – Assessment of the state of regulatory systems.

ies to physical activity and can be used for dynamic observations. With the help of individually selected active physical exercises, real opportunities are opened for increasing the functional reserve of the body and physical abilities of children with cerebral palsy.

Conclusions. The initial functional state in children with cerebral palsy is characterized by a low level of functional reserve and insufficient activity of the cardiovascular system, which should be taken into account when developing programs using active physical exercises. For the development of functional and physical capabilities, children with cerebral palsy require continuous physical rehabilitation, as a result of which a gradual functional restructuring of the body

occurs: physiological capabilities increase, long-term adaptation is formed, associated with the activation and mobilization of the body's functional resources. Indicators of activity of regulatory systems and the degree of tension of regulatory systems make it possible to assess the adaptive capabilities of the body of children with cerebral palsy when performing active physical exercises; they are informative indicators and can be used in dynamic observations.

The work was carried out within the framework of the state assignment of the Federal Scientific Center VNIIFK No. 777-00036-23-01, subject code No. 001-21/3.



References

1. Abolenskaya A.V., Samokhvalova V.P. Sposob otsenki adaptatsionnykh vozmozhnostey detskogo organizma. Voprosy okhrany materinstva i detstva. 2009. No. 3. pp. 50-54.
2. Baevsky R.M. Variabelnost serdechnogo ritma: teoreticheskiye aspekty i vozmozhnosti klinicheskogo primeneniya. Moscow: Meditsina publ., 2000. 295 p.
3. Dubovskaya T.A., Vorontsova M.V., Kukushkin V.S. Adaptatsiya i rehabilitatsiya detey s ogranichennymi vozmozhnostyami zdorovya. Moscow: Rossiyskiy gosudarstvennyy sotsialnyy universitet publ., 2012. 362 p.
4. Enikeev D.A., Khisamov E.N. Mekhanizmy adaptatsii organizma k fizicheskim nagruzkam. Mezh-dunarodnyy zhurnal eksperimentalnogo obrazovaniya. 2016. No. 6-1. pp. 99-100.
5. Klendar V.A., Gross N.A., Korzhenevsky A.N. Izmeneniya funktsionalnogo sostoyaniya u detey s detskim tserebralnym paralichom pri vypolnenii dvizheniy tsiklicheskogo kharaktera. Chelovek, Sport, Meditsina. Izdatelskiy tsentr YUUrGU publ., 2019. pp. 112-119.
6. Klendar V.A., Gross N.A., Korzhenevsky A.N. Izmeneniye funktsionalnogo sostoyaniya detey s DTSP pri vypolnenii dvizheniy tsiklicheskogo kharaktera. Chelovek, sport, meditsina. 2019. No. 3. pp. 112-118.
7. Shlyk N.I. Serdechnyy ritm i tip regulyatsii u detey, podrostkov i sportsmenov. Izhevsk: Udmurtskiy universitet publ., 2009. 259 p.