Changes in muscle tension of body segments in children with cerebral palsy

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PhD, Associate Professor **N.A. Gross**[1]
PhD **T.L. Sharova**[1]
[1]Federal Science Center of Physical Culture and Sport (VNIIFK), Moscow

Corresponding author: volodchenkova.e.n@vniifk.ru

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Abstract

Objective of the study was to identify changes in muscle tension in body segments in children with cerebral palsy for an objective analysis of the state of their motor system and the search for effective methods of pedagogical influence on the muscular system in the process of rehabilitation measures.

Methods and structure of the study. Children from 6 to 14 years old with a diagnosis of cerebral palsy of varying severity took part in the scientific work. Children were distributed according to the levels of development of gross motor functions on the GMFCS scale. Muscle imbalance, their symmetry, as well as the degree of tension in the muscles of the face, back, back and front of the legs were measured. The studies were carried out using the MES 9000 EMG computer diagnostic system.

Results and conclusions. An uneven distribution of muscle tension in the muscle segments of the face and body was revealed, predominantly on the left side (from 34 to 160 mV) in both boys and girls diagnosed with cerebral palsy. Tension of the tibialis muscle of the left leg was noted, which was 135,2 mV and strong tension of the calf muscles of both the left (158,4 mV) and right legs (143,4 mV) with support compensation on the toe of the left leg (60%). Diagnosis of muscle tension and identification of the developmental features of skeletal muscles in children with cerebral palsy is a necessary condition for an objective analysis of the state of their motor system and the search for effective methods of pedagogical influence on the muscular system in the process of rehabilitation measures.

Keywords: *cerebral palsy (CP), muscle tension, asymmetry, body segments, postures.*

Introduction. When forming a particular active posture and stability in space, the necessary tension of the skeletal muscles that carry out the anti-gravity function of the body is of great importance. Maintaining the balance of the body and its individual parts is one of the criteria for the physical condition of the body, since a certain stability requires the development of the musculoskeletal system necessary to perform appropriate efforts and timely redistribution of the tone of body segments [1-3].

In children with cerebral palsy at the early stage of the disease, disturbances in muscle tone are observed, which lead to limitation of the child's functional capabilities, ultimately creating a motor deficit. Uneven muscle tension leads to disturbances in the shape of the body, the proportions of its elements and asymmetry, which is one of the main causes of motor disorders in children with cerebral palsy. If children have spastic tensions of variable tone due to athetosis or cerebellar disorders, not only the structure of movement in space changes, but also the shape, direction, amplitude, which distorts the spatial structure of the child's movement and interferes with its further development [4, 5]. Shortening or lengthening a muscle reduces the force of contraction, leading to mechanical failure. Over time, pathological attitudes are formed, leading to the formation of contractures, subluxations and dislocations of the joints [6, 7]. Children with cerebral palsy can remain in a certain position for a long time, so it is necessary to know the state of their muscle tone in order to understand the process of formation of the musculoskeletal system during the period of growth and development of the child.

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Methods and structure of the study. Children from 6 to 14 years old with a diagnosis of cerebral palsy of varying severity took part in the scientific work. Children were distributed according to the levels of development of gross motor functions on the GMFCS scale. Muscle imbalance, their symmetry, as well as the degree of tension in the muscles of the face, back, back and front of the legs were measured. The studies were carried out using the MES 9000 EMG computer diagnostic system, which monitors and processes indicators of muscle tension from superficial muscles and measures the activity of each muscle 240 times per second. The static test asymmetry indication indicates the percentage of imbalance between the left and right sides of the body, how their values differ, and which side has higher activity.

Results of the study and discussion. It has been shown that in children with cerebral palsy, with various changes in body position, the facial muscles of the face of varying degrees of severity are strongly tensed. This is due to the lack of coordination of various receptors that communicate between the vestibular, visual analyzers and analyzers of musculoskeletal sensitivity. It was revealed that different degrees of muscle tension of the masticatory and cleidomastoid muscles (44,6-147 mv) lead to left-sided asymmetry of the face and tilt of the head to the left, resulting in instability of the spine and limbs in static conditions. Severe tension in the temporal and masticatory muscles does not allow the mouth to be completely closed and chewing fully, which usually occurs in children at level 5 on the GMFCS scale. In addition, severe tension in the temporal and masticatory muscles can lead to facial numbness and even mild deafness. In table Figure 1 shows the values of facial muscle tone in children diagnosed with cerebral palsy.

Studies have shown that maintaining a vertical posture when standing in children with cerebral palsy is achieved at the cost of muscle efforts that exceed the norm by an average of 30% of the maximum. Asymmetrical tension of body segments relative to their axis leads to muscle imbalance, poor posture (either hyperlordosis, or kyphosis, or displacement to the side, i.e. scoliosis).

In all groups of children diagnosed with cerebral palsy, left-sided body tension was detected, especially in the upper part of the trapezius muscle: in boys 46,4-136,5 mv, in girls 84-160 mv, with backward rotation of the shoulder girdle, with left-sided tension in the middle bundles of the trapezius muscle and asymmetry from 51 to 87% of cases. Strong tension is observed in girls of GMFCS level 5 in the area of the lower fascicle of the trapezius muscle with the greatest tone of 159 mV. Excessive tension of the latissimus dorsi muscle (184,2 mV) on the left, with minimal right-sided asymmetry (21% of cases) and a tension of 130 mV, causes

Table 1. Muscle tone (mv) of the face in children diagnosed with cerebral palsy

Level GMFCS	Indicators	Frontalis muscles (frontalis)		Temporalis muscles (Anterior temporalis)		Chewing muscles(Masseter)		Cleidomastoid muscles (Sternocleidomastoid)	
		Left	Right	Left	Right	Left	Right	Left	Right
Boys									
I	$\bar{X} \pm \sigma$	61,0±43	31,0±3,9	52±54,7	41±57,4	44,6±43,7	21,8±30,5	32,4±47,6	19,0±19
II	$\bar{X} \pm \sigma$	90,2±86	80,9±84	110,6±106	125±99,7	119,0±109	82,0±93,5	116,1±111	53,4±68
III	$\bar{X} \pm \sigma$	67,5±65	75,1±57	81,1±99	150±91	114,6±93	61,6±63,2	94,4±86,1	44,8±46,5
IV	$\bar{X} \pm \sigma$	70,6±52	77,6±58	114,5±83	112,1±94	147,2±94	83,3±67	129,1±92,6	54,1±65
V	$\bar{X} \pm \sigma$	55,41±66	58,4±59	98,90±12	165±123	120,3±110	50,9±78,3	78±72,45	27,7±33
Girls									
I	$\bar{X} \pm \sigma$	75,8±88	37,2±33	66,9±91	59,0±81	47,7±79,7	44,9±69,6	50,3±82	29,7±32,0
II	$\bar{X} \pm \sigma$	96,6±90	82,1±86	119,5±79	127,8±96	112,8±81	57,7±69,6	106±81	48,3±59,7
III	$\bar{X} \pm \sigma$	72 ±86	81,5±86	138±121	210±103	134±98,5	90,6±84,1	99±86	51,9±64,3
IV	$\bar{X} \pm \sigma$	32 ± 46	78,3±77	112,5±119	122,4±114	116,3±109	76,6±75,8	76,4±78	34,2±44,1
V	$\bar{X} \pm \sigma$	96±110	139±105	137±133	170,9±121	161±101	117,1±98,8	123±89	29,8±8,6

Table 2. Muscle tone (mv) of the body in children diagnosed with cerebral palsy

Level GMFCS	Indicators	Upper trapezoidal beam (Splenius Capitus)		Scapular bundle of trapezoid (Upper Trapezius)		Middle beam trapezoidal (Middle Trapezius)		Lower trapezoidal beam (Lower Trapezius)		Latissimus muscle (Latissimus Dorsi)	
		Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Boys											
I	$\bar{X} \pm \sigma$	46 ±44	34±19	47,7±38	40,7±32	59±43	55,2±49	58±46	46,7±40	55,9±61	49,6±71
II	$\bar{X} \pm \sigma$	137±100	106±91	120,7±92	69,8±64	99,0±83	83,0±67	128±102	90,6±75	113±99	76,1±75
III	$\bar{X} \pm \sigma$	107±104	64,5±60	95,1±82	70,8±68	116±96	76 ±85	106±94,3	84±79,8	109±86	89,1±72
IV	$\bar{X} \pm \sigma$	120±95	101±87	114±77	69,9±76	115±86	59 ±62	117,2±72	59,7±45	119±104	68,0±69
V	$\bar{X} \pm \sigma$	102±84	76±77	94±84	58±64	139±92	95±72	106±102	79,5±79	109±91	66±66
Girls											
I	$\bar{X} \pm \sigma$	84±92	79,6±85	70,3±76	51,1±71	56,0±71,2	38,9±41,3	54,9±69	41,0±43	60,6±73	44,2±50,3
II	$\bar{X} \pm \sigma$	129±102	91±88	89±80	65±54	89±64	45,6±51	102±69	56±54	102±84	77,4±79
III	$\bar{X} \pm \sigma$	154±93	100±78	119±103	87±66	89±69	73,5±55	132±79,5	89±53	127±74	119±64
IV	$\bar{X} \pm \sigma$	90±79,5	63±77	68,2±76	72,7	78,7±66	62,9±59	104,8±59	44,9±54	76,7±74,	40±49
V	м	160±119	130±124	167±113	112±97	173±121	105± 93	159±135	136±117	184±122	129,5±97

its shortening. In this case, the spine begins to deviate from its axis and bend forward, which leads to a displacement of the pelvis. As a result, not only the back suffers, but also the internal organs.

Increased muscle tone and asymmetry (from 50 to 70%) in the upper bundles of the trapezius and latissimus dorsi muscles is observed in all children with cerebral palsy, more predominantly on the left than on the right, both in boys and girls, which is reflected in table 2.

In all children with cerebral palsy, tension in the left calf muscle was also detected, especially in children of GMFCS levels 2-5 (123-159 mV), the cause of which is shortening of the iliopsoas muscle. In level 4 boys, the greatest tension in the calf muscle of the left leg is 162 mV, and in level 5 girls it is 145,2 mV. The highest level of tension in the gastrocnemius muscle of the right leg was observed in boys at GMFCS level 2 and was 120 mV, and in girls at level 5 – 199,2 mV. The tension of the tibialis muscle with an asymmetry of 63% and the tension of the calf muscles (mainly the left leg) is 159 mV for boys, 199,2 mV for girls), table 3.

Body imbalance in children with cerebral palsy leads to increased tone and asymmetry, as a result of which vicious positions of the body and limbs persist for a long time, forming secondary changes in muscles, bones and joints and the occurrence of contractures and deformities, which further complicates the development of motor skills and stability in life. space. It is believed that with an increase in muscle tone in the lower extremities, a pathological equinus position (equinus deformity) of the feet is formed, which is caused by an increase in flexor tone and immature support [1, 2].

Conclusions. Specific approaches to the formation of motor skills in children with cerebral palsy depend on which muscle groups or body segments are affected by spastic manifestations and the degree of their severity.

Table 3. Muscle tone (mv) of the anterior and posterior surfaces of the legs in children with cerebral palsy

Level GMFCS	Indicators	Boys				Girls			
		Tibial (Tibialis Anterior)		Calf muscle (Gastrocnemius)		Tibial (Tibialis Anterior)		Talf muscle (Gastrocnemius)	
		Left	Right	Left	Right	Left	Right	Left	Right
I	$\bar{X} \pm \sigma$	53,7±68	49,7±63	60,9±68,5	42,8±50,3	62±87,4	51,5±70,3	46,2±55	48,6±76
II	$\bar{X} \pm \sigma$	123±106	77,9±90	113,7±115	120,3±95	108±75,8	76,4±73,7	93,7±76,3	134,1±98
III	$\bar{X} \pm \sigma$	159±93	100,3±87	141±91,4	76,6±70,8	159±92,5	100,3±87,3	76,6±71	141±91,4
IV	$\bar{X} \pm \sigma$	141±113	101±90,5	162±62,5	64,9±61,0	213±86	183±130	101,9±133	185,9±31,1
V	$\bar{X} \pm \sigma$	159±93	100,3±87	141±91,4	76,6±70,8	185±129	115,4±114	145,3±82	199,2±168

Body imbalance is caused by dysregulation of muscles due to changes in the functioning of body segments. The muscle segments of the face, back and legs have different tensions depending on the level of development of motor skills on the GMFCS scale and the reflex adoption of various body positions.

Diagnosis of the stability of muscle tension and identification of its characteristics in children with cerebral palsy is a necessary condition for an objective analysis of the state of their motor system and the search for effective methods of pedagogical influence on the muscular system in the process of rehabilitation measures.

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