Stato-locomotor resistance in children with cerebral palsy

UDC 796.077-056.266

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Abstract

Objective of the study was to determine the relative position of body segments as a factor in the stato-locomotor stability of children with cerebral palsy.

Methods and structure of the study. In children with cerebral palsy, who had motor disorders of varying degrees of complexity, the statokinetic characteristics of the vertical stance and changes in the configurations of body segments were determined using the Habilect software and hardware complex with biofeedback, the H.VrS virtual stabiloplatform module. The examination was carried out by 134 boys and 129 girls aged 5-14 years, in total - 263 people. The presence of an imbalance in the body segments, the degree of its severity, and the connection of the segments with each other were analyzed.

Results and conclusions. The numerical values of variants of combinations of the location of body segments when taking a vertical stance are revealed. There was a decrease in the effectiveness of the processes of stability and postural regulation, which was expressed in an increase in the amplitude of oscillations along the sagittal, frontal and rotation in various segments of the body, reduced support ability of the lower extremities.

Keywords: *disabled children with cerebral palsy, vertical stability, body segments, posture control.*

Introduction. The physical development of children with cerebral palsy (CP) is usually accompanied by impaired motor functions, which prevents the child from coordinating his movements in space and fully developing. Motor disorders in them are manifested in the instability of maintaining stability when taking a vertical position, the development of pathology of movements, the formation of vicious postures [1].

The problem of optimizing the process of developing the motor abilities of children with disabilities is provided, among other things, by determining the factors that affect the relative position of the body's links and its orientation in space. The control of the posture and movements in space is carried out by the coordinated activity of a number of receptor systems, which are of a continuous dynamic nature, associated with the constant interaction of the body's links, the movement of the common center of pressure and the change in the level of tonic activity of the postural muscles.

If the muscular system and physical capabilities of the child are weak, then with a decrease or absence of loads (for example, a long stay in a horizontal position), antigravity mechanisms may either not develop or be lost with a corresponding loss of motor skills, primarily skills of maintaining an upright position, which can lead to changes in body segments, development of deformities and vicious positions.

In addition, the support load on the feet is reduced, which significantly affects the motion control system in space and is expressed as an imbalance in the distribution of the masses of the musculoskeletal system, tone-power imbalance and leads to a violation in the support contour of the feet [2-6].

Determining the relative position of body segments and the main causes of violations in the formation of vertical stability, as a factor limiting the development of positioning postures and the integrity of the motor action, underlies the study

of the patterns of formation of motor skills and the structure of movements in children with motor disorders, creates the prerequisites for the development of an actual program of rehabilitation and correction [7-9].

Objective of the study was to determine the relative position of body segments as a factor in the stato-locomotor stability of children with cerebral palsy.

Methods and structure of the study. Stato-locomotor stability in space was determined using the Habilect software and hardware complex with biofeedback, the H.VrS virtual stabiloplatform module. An assessment was made of posture and imbalance of the body, pathological changes in the configuration of body segments when taking a vertical position. The static and dynamic balance and the trajectory of the center of mass in the horizontal, frontal and sagittal planes were evaluated. The presence of an imbalance of body segments and their relationship with each other, their type (in what plane, at what level of the musculoskeletal system it manifested itself), as well as the severity of the imbalance were analyzed.

The study involved children with cerebral palsy aged 5-14: 134 boys and 129 girls, a total of 263 people. The position of the body segments (head, shoulders, trunk, pelvis, knees, feet) in the frontal and sagittal planes (cm, degrees), as well as the percentage of deviations (right-left, back and forth) separately in groups of girls and boys. The studies were carried out at the beginning of the rehabilitation session, before physical activity.

Results of the study and their discussion. The average values of deviations of indicators of the spatial position of body parts in the frontal and sagittal planes (cm, degrees), and the frequency of occurrence of deviations (%), are shown in Table 1.

The use of the "Habilect" complex makes it possible to obtain an expanded idea of the stato-locomotor stability of the body of children with disabilities by determining the variants of combined arrangements of body segments and parameters characterizing their angular deviations. Despite the great diversity, in most cases, the frequency of combinations of body segment deviations is noted to the right-back, which is true for boys and girls (Table 1).

In a vertical position, most children with cerebral palsy have a head shift back and rotation of the shoulders forward-left, which leads to instability of the body and increased vicious postures [10].

Table 1. Average deviations of body segments (cm, degrees, %) along the frontal (1) and sagittal (2) in children with cerebral palsy

Average deviations of body segments along the front (cm, degree, %) in children with cerebral palsy												
Values	A head		B shoulder		C torso		D pelvis		E knee		F foot	
	right	left	right	left	right	left	right	left	right	left	right	left
	Girls											
cm	5,3	2,3	4,7	2,7	4,3	2,6	3,6	2,6	2,4	1,5	0,0	0,0
degrees	7,8	2,2	3,6	1,9	2,6	1,3	3,8	2,1	7,6	12,5	5,6	9,0
%	68,3	31,7	65,2	32,6	59,4	38,6	61,8	38,2	58,6	40,2	0	0
Boys												
cm	3,7	2,6	2,9	2,2	2,6	2,0	2,4	1,7	1,3	1,0	0,0	0,0
degrees	4,1	5,0	5,0	3,6	1,9	1,5	5,9	3,0	6,6	13,4	9,4	4,8
%	59,2	40,5	55,5	44,2	52,8	46,3	60,0	40,7	59,8	38,5	3,8	0,0
Average deviations of body segments along the sagittal (cm, degree, %) in children with cerebral palsy												
Values	A head		B shoulder		C torso		D pelvis		E knee		F foot	
	back	forward	back	forward	back	forward	back	forward	back	forward	back	forward
	Girls											
cm	9,6	1,1	8,6	0,7	10,1	0,3	7,6	0,6	3,5	1,1	0,0	0,0
degrees	1,2	5,0	1,4	8,4	1,6	7,6	2,3	9,1	3,3	8,2	0,0	0,0
%	77	23	83	17	93	6,75	75,5	24	66,5	33,5	0	0
Boys												
cm	5,1	2,1	5,0	1,7	6,3	1,2	5,3	1,4	3,0	1,9	0,0	0,0
degrees	1,7	2,9	2,1	3,4	2,3	5,0	3,4	6,1	5,1	5,3	0	0
%	67,2	32,7	70,0	29,9	81,8	18,2	76,0	22,6	63,3	35,0	0,0	0,0

In girls, in the position of the head, there is a deviation to the right and back by 5.3 and 9.6 cm with a rotation of 7.8 and 1.2 degrees. In boys, the deviations in the same directions were 3.7-5.1 cm, with a rotation of 4.1-1.7 degrees. Such a deviation of the head is characterized by the manifestation of a syndrome caused by tonic postural activity or an unadapted oculomotor disorder [5]. In some cases, girls have a variant of slight (2.7 and 0.7 cm) displacement of the shoulders in the frontal and sagittal planes with a significant rotation of 8.4 degrees. In boys, there is a shift of the shoulders to the right (by 2.9 cm) and back (5.0 cm) with a rotation of 5.0 degrees.

The reason for the imbalance of the shoulder girdle is, apparently, the asymmetry of the range of motion of the upper limbs due to spasticity of the muscles of the shoulder girdle or different heights of the shoulders (long walking with the right arm raised, relying on the parent), as a result of reflex muscle contraction at different levels: hand, forearm, shoulder [8, 9].

In addition, with a long stay in a vicious position, there is a deviation of the body back in the sagittal plane in both girls (10.1 cm) and boys (6.3 cm) with a minimum deviation in degrees (1.6-2.3).

It was revealed that with a vertical stance, there is a shift of the pelvis back to the right, with a compensatory function of the head and hands and rotation of the knee to maintain balance. So, in girls in the pelvic segment, there is a posterior displacement of 7.6 cm with a rotation of 2.3 degrees, in boys - a posterior displacement of 5.3 cm with a rotation of 3.4 degrees, with simultaneous rotation of the knee forward by 8.2 degrees in girls and 5.3 degrees in boys.

In the sagittal plane, in girls, the body is mainly shifted back with a predominant rotation of the knee segment back (by 3.3 degrees), which leads to an increase in vicious postures.

In the frontal plane in girls, there is a displacement of the pelvis to the right by 3.6 cm with a rotation of 3.8 degrees, while the knee is displaced by 2.4 cm and rotated by 7.6 degrees. In boys, when the pelvis is displaced to the right by 2.4 cm, the knee is displaced to the right by 1.3 cm with a rotation of the pelvis by 5.9 degrees, and the knee by 6.6 degrees. Such an imbalance in the frontal plane is formed with unilateral shortening of the iliopsoas muscle and muscles of lateral stabilization synergy, which leads to functional imbalance of the lower extremities [7, 10].

Thus, the revealed structural and functional imbalance in children with cerebral palsy when taking a vertical position is characterized by postural tonic asymmetry of body segments, a limited structure of the kinematic chain, reduced support ability of the lower extremities, which, apparently, is a consequence of a sedentary lifestyle due to the underlying disease [10].

Conclusions. Children with cerebral palsy are characterized by reduced stato-locomotor stability, limited by deviations in the relative position and rotation of body segments and limbs in the frontal and sagittal planes.

The use of the Habilect system makes it possible to identify the localization of the main pathological disorders, the presence of dysfunctions and weak links in children with cerebral palsy and contributes to decision-making on the formation of motor skills in children with cerebral palsy.

The work was carried out within the framework of the state task of the FGBU FNTs VNIIFK No. 777-00026-22-00 (subject code No. 001-21/3)

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