Development of balance

and orientation in space while walking among children with children's cerebral paralysis

Desarrollo del equilibrio y la orientación en el espacio al caminar entre niños con parálisis cerebral infantil.

Kielevyainen L. M.[1]
[1]Candidate of Pedagogical Sciences, Associate Professor, Petrozavodsk State University
Email: education.com.ru@gmail.com
Received/Recibido: 12/28/2020 Accepted/Aceptado: 01/15/2021 Published/Publicado: 03/10/2021 DOI: http://doi.org/10.5281/zenodo.4711810

Abstract

The article contains research materials aimed at developing and confirming the effectiveness of methods for developing individual coordination abilities among children with cerebral palsy. The method used in adaptive physical education classes with the use of unstable support while walking on a treadmill or in a mobile vertical simulator showed a positive effect on the formation of walking skills. Positive dynamics were also found in the performance of a complex exercise that includes the main locomotions present when walking.

Keywords: cerebral palsy, adaptive physical education, walking, coordination abilities, balance, stability.

Resumen

El artículo contiene materiales de investigación destinados a desarrollar y confirmar la efectividad de los métodos para desarrollar las habilidades de coordinación individual entre los niños con parálisis cerebral. El método utilizado en las clases de educación física adaptativa con el uso de apoyo inestable al caminar en una cinta rodante o en un simulador vertical móvil mostró un efecto positivo en la formación de las habilidades para caminar. También se encontraron dinámicas positivas en la realización de un ejercicio complejo que incluye las principales locomociones presentes al caminar.

Palabras clave: parálisis cerebral, educación física adaptativa, caminar, habilidades de coordinación, equilibrio, estabilidad.

Introduction

Cerebral palsy is a group of stable developmental disorders of motor skills and posture maintenance leading to motor defects caused by non-progressive damage and/or anomaly of the developing brain in a fetus or newborn child[1,2]. Cerebral palsy is a polyetiologic disease. The pathophysiological basis of the formation of cerebral palsy is the lesion of the brain at a certain period of its development, followed by the formation of pathological muscle tone (mainly spasticity) while maintaining posotonic reflexes and a concomitant violation of the formation of chain adjusting rectifying reflexes. The main difference between cerebral palsy and other central paralysis is the time of exposure to a pathological factor[2,3]. Spastic diplegia is the most common form of infantile cerebral palsy. In terms of the prevalence of movement disorders, spastic diplegia is tetraparesis (arms and legs are affected), but the lower limbs are affected to a much greater extent. Chain attunement reflexes do not develop or develop late. With the vertical installation of the body, a characteristic posture of the arms, trunk, legs arise: the arms are bent at the elbow joints, the forearms and hands are pronated, the body is tilted forward, the legs are bent at the hip and knee joints, support on the front parts of the feet[4]. Despite some differences in the clinical manifestations of the disease, the walking stereotype of patients with cerebral palsy with spastic diplegia syndrome has typical features. When walking in patients with cerebral palsy, the normal ratio of the durations of the support and transfer phases of the step is disturbed: the latter is shortened by 16% in relation to the norm, the bipartition phase increases by 73%. All this indicates a decrease in the stability of patients when walking; along with this, a phase change occurs within the support phase, namely, the time of support on the heel and the entire foot decreases and the time of support on its front section increases. As a rule, such a rephasing of the reference phase is associated with equinus deformity or

incorrect positioning of the foot when walking. At the same time, the coefficient of rhythm (the ratio of the duration of the portable phases of the step) is approaching the norm, since we are talking about bilateral approximately the same lesion of the lower extremities. The stride length is reduced by an average of 25% of the norm, the tempo changes little, and the average walking speed is reduced by 27%[5].

Impaired coordination is observed in any type of cerebral palsy, therefore, there is a need for enhanced correction of each structural unit. In the general theory and methodology of physical upbringing, coordinating abilities are considered as a set of motor abilities that determine the speed of mastering new movements, as well as the ability to adequately restructure motor activity in unexpected situations[6].

In order to identify the most lagging coordination abilities, it is required to collect a certain amount of information (gender, age, structure of the main defect, its severity, presence and manifestation of concomitant diseases, general level of physical development). The main (basic) types of coordination abilities most often include such types of coordination manifestations, which are necessary when performing daily motor actions (every day and educational actions, walking, running, jumping)[7].

Among children with cerebral palsy, violations of basic movements are manifested in the form of inaccuracy of movements in space and time; instability or loss of balance, gross errors in the differentiation of muscle efforts; excessive or insufficient amplitude, insufficient reaction speed. Accordingly, the program for the development of the skill of independent walking is aimed at the formation of orientation in space, rhythmicity of movements (performing exercises under counting), balance, and differentiation of muscle efforts.

The body's natural tendency to move is the foundation and basic prerequisite for physical and functional development. Consequently, regular classes of adaptive physical culture should be the main link in the complex of all activities aimed at increasing the level of physical fitness of children with cerebral palsy[8]. However, one of the most obvious problems is the development of means and methods for optimizing and increasing motor activity for children with cerebral palsy, since they are primarily based on the specifics of the disease and the initial state of the child's body, in most cases they are individual in nature. All this is a sufficient basis for further search for ways to improve the methods of treatment and rehabilitation of patients with cerebral palsy.

For the development of coordination abilities in children with cerebral palsy, the same methods are often used that are used in healthy people. These exercises are aimed at correcting and improving the coordination of movements, performed with various supporting devices, movable and fixed support.

Materials and Methods

The research was carried out on the basis of the Center for Adaptive Physical Culture of Petrozavodsk State University. The duration of the study is 9 months. The experimental group included 16 children diagnosed with infantile cerebral palsy of varying severity (diplegia, 70% of children have severe spasticity, all have pathological tonic reflexes). All children move with the help of an adult or with special devices (tricycle canes and walkers). Children are 9-11 years old. The general level of coordination development was determined using the Romberg test (initial position - legs at shoulder level, arms extended forward).

Results and Discussion

The level of balance development in walking was determined based on the results of the following exercises:

1. Walking forward (6 meters)

2. Perform a 180 degree turn by stepping.

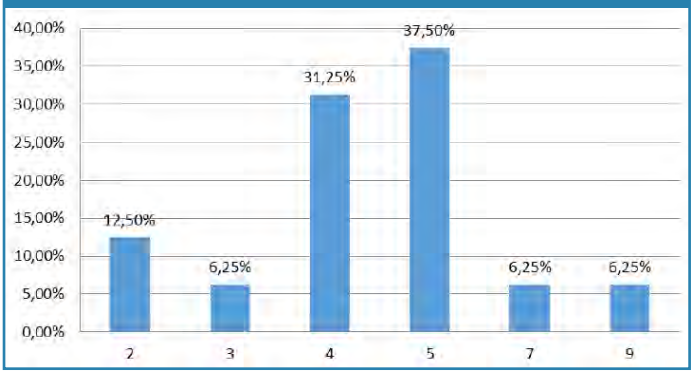
3. Walking to the left- side step (3 meters)

4. Walking to the right-side step (3 meters)

5. While walking, stop on command, maintain balance.

The results of each exercise were evaluated on a two-point scale: 0 points - lack of movement skill, 1 point - the child performs the exercise with an assistant, 2 points - performs the exercise independently, the maximum score is 10. The initial data on the development of balance in walking in group participants are shown in the figure 1. The average value in the group is 4.46 points. The majority of the participants (72%) have significant difficulty in performing the exercises "Stepping over to make an 80-degree turn" and "While walking, stop on command, maintain balance."

Fig. 1. Assessment of balance during walking by the sum of points.



To train balance, correct foot placement, and transfer body weight from the back of the foot to the front, various types of walking on an electric treadmill were used with an initial speed of 0.3 km/h at a pace of 60 - 70 steps per minute with a consistently changing support:

1. Holding with both hands on the side rails (3-5 minutes);

2. Holding with both hands on the hard handrail located in front (3-5 minutes);

3. Holding one hand on the side handrails alternately (change hands in 1-1.5 minutes);

4. Holding with both hands on a soft support (elastic band, fixed parallel to the front hard handrail) with two hands (1-2 minutes)

5. Holding on to a soft support with one hand (change hands in 1-2 minutes).

The proposed types of walking are used both on a horizontal and on an inclined surface (walking uphill about 4-5 degrees). When walking in the lift, the ankle joint is more actively involved in the work, the step begins with placing the heel on the surface, there is a dynamic stretching and lengthening of the muscles and tendons of the back of the leg. On average, walking balance training takes 15 to 20 minutes, depending on the child's degree of fatigue. The heart rate of the practitioners is from 120 to 135 beats per minute, which provides an aerobic effect while walking.

Balance training is also carried out using a verticalizer (Gross simulator). The Gross trainer consists of a tensioned cable with a movable block, which allows free movement along it, elastic rods, a lever-karabiner mechanism, a safety belt and hand rings[9]. During the execution of exercises in the Gross simulator, a sequential change in support is also applied with increasing complexity:

1. Walking in full gear (the child is held by a belt), holds both rings with both hands.

2. Walking in full gear (the child is held by a belt), without rings.

3. Walking in a straight line without a belt, with hands resting on both rings.

4. Walking in a straight line without a belt, with support by hands for both rings, stopping after a given number of steps.

5. Walking in a straight line without a belt, with support with one hand on the ring, including stopping after a specified number of steps.

It is noted that children experience certain difficulties in maintaining balance when stopping while walking; in this case, simple mathematical examples can be used to distract attention and maintain interest. Let's say the child is asked to solve the example "2 + 5", the child counts seven steps and stops. It is advisable to select examples in such a way that the answers to them are odd numbers, then the stop will be carried out alternately under the right and left legs. When performing each variant of the exercise, a distance of 20 meters was covered at a different pace.

Work on the sense of orientation in space was also carried out using the Gross simulator with different fixations (from full equipment to support on a movably fixed ring) by turning off the visual analyzers (a mask is put on the child's eyes). In this study, an outdoor game was used in which the child moves by ear in the direction of the signal given by the instructor. Thus, using the auditory analyzer, moving in the direction of the sound signal, the feeling of orientation in space and balance is activated. The game forms of conducting classes significantly improve the general emotional background, which contributes to the formation of a child's stable interest in adaptive physical education.

Analyzing the obtained results of the study, it was revealed that positive dynamics is observed in the temporal characteristics of the fulfillment of all exercises, the greatest increase in the fulfillment of the exercise is "Walking forward" (table 1).

Table 1. The results of walking exercises before and after the experiment.

		n	
Walking forward (6 meters), c	const. stage	16	26,4±0,7
	final stage	16	14,9±0,3
Perform a 180 degree turn by stepping, c	const. stage	16	25,5±1,2
	final stage	16	14,5±0,5
Walking to the left-side step (3 meters), c	const. stage	16	16,4±0,7
	final stage	16	12,6±0,2
Walking to the right-side step (3 meters), c	const. stage	16	14,9±0,3
	final stage	16	13,2±0,2

The dynamics of changes in the Romberg simple posture indicator is also positive, the proportion of children with an index of 3 points increased from 31.25% to 56.25%, for the rest the indicator remained unchanged.

The control exercise, which determines the development of such indicators as balance, orientation in space, differentiation of muscular efforts, is complex and represents an obstacle course 20 meters long, including the sequential fulfillment of the following tasks:

1. To walk a distance of 3 meters, with the setting of feet on tracks marked at a distance of 10 cm with an accurate hit and correct transfer of body weight;

2. To move sideways with side steps along the gymnastic hoop located on the floor;

3. Step over 4 barriers located at a height of 15 cm from the floor

4. Climb, walk on a gymnastic beam 2 meters long, 20 cm wide and 20 cm high,

5. Walk along a 2 m straight line marked on the floor;

6. Stand in a ring with a diameter of 60 cm, overstep, make a 180 degree turn without going beyond the boundaries of the ring.

The performance of the control exercise (obstacle course) on average in the group improved by 60% in qualitative terms - the children perform the task practically without errors, the foot placement is carried out quite accurately, and by 36% in

quantitative terms - the passage of the strip became much faster. Average indices of complex exercise fulfillment in the group changed from 2m 47 sec (± 0.62) to 2 min 02 sec (± 0.67).

The results are not always consistent because the quality of the exercise is influenced by many facts - from the child's well-being at the moment to the weather conditions. However, after the systemic use of exercises for the development of the main components of coordination abilities, the quality of the exercises on the obstacle course has increased significantly, and the children have a sense of confidence.

Conclusions: Children with infantile cerebral palsy, as a rule, do not perform the required amount of physical activity, move a little on their own. In order to motivate such children and their parents to activate the motor regime, it is important to offer those methods and complexes of exercises that can be performed, including at home, for example, the proposed options for exercises on a treadmill and in a Gross simulator with a variable support. The conducted studies allowed quantitatively and qualitatively confirm the effectiveness of the use of exercises with a consistently changing support when walking to form the feelings of balance and orientation in space.

References

1. Dan B, Paneth N, Rosenbloom L. Cerebral palsy: science and clinical practice. London: Mac Keith Press. 2014.
2. Badalyan LO. Cerebral palsy. Kiev: Health. 1988.
3. Semenova KA, Mastyukova EM, Smuglin MY. Clinic and rehabilitation therapy of infantile cerebral palsy. Moscow: Meditsina. 1972
4. Kurenkov AL, Batysheva TT, Vinogradov AV, Zyuzyaeva EK. Spasticity in infantile cerebral palsy: diagnostics and treatment strategies. Journal of Neurology and Psychiatry. 2012. no 2. 24-28.
5. Petrushanskaya KA. Study of the structure of walking in patients with infantile cerebral palsy. Russian Journal of Biomechanics. 2005. no 3. 56-69.
6. Kholodov ZhK. Theory and methodology of physical education and sports. Moscow: Physical culture and sport. 2000.
7. Shapkova LV. Private methods of adaptive physical culture. Moscow: Soviet sport. 2007.
8. Kharchenko LV. Development of the locomotor function of walking in preschoolers with infantile cerebral palsy in the conditions of sanatorium treatment. Modern issues of biomedicine. 2017. no 1 (1).
9. Gross NA. Modern approaches to the development of motor skills in children with impaired functions of the musculoskeletal system and cerebral palsy. Adaptive physical culture. 2006. no 4 (28). 46-49.