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Correction of motor disturbances in children with cerebral paralysis and moderate mental retardation

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ABSTRACT

Children's cerebral paralysis is still a common pathology in children and it is often combined with moderate mental retardation. At the same time, the effectiveness of the schemes used for the rehabilitation of such children remains low. The purpose of this study was to evaluate the effectiveness of the method developed by the authors, including curative gymnastics, orthopedic adaptations, and equipment in children aged 6-10 years old with cerebral paralysis and moderate mental retardation. The study was performed on 33 children aged 6-10 years old with infantile cerebral palsy and moderate mental retardation in which 17 children were classified into the experimental group and the rest made up the control group. All the children examined had spastic diplegia or spastic tetraparesis. In the experimental group, the authors developed an option of complex correction with the help of medical gymnastics, strength training, orthoses, and verticals. In the control group, the traditional scheme of correction of infantile cerebral palsy was applied. In both groups, the dynamics of motor skills were assessed according to the Chailly scale, goniometry of the knee joints, the level of spasticity of muscles, the strength of the quadriceps muscle of the thigh. The results are processed by Student's test. As a result of the sessions, all the subjects observed a positive dynamics of the indicators taken into account. More pronounced positive dynamics of the strength of the quadriceps femoris muscle (by 19.0%), the level of the motor skill in different starting positions (from 9.8% to 28.5%), and spasticity of the limb (3.1 times) were noted in the experimental group. The dynamics of the amplitude of knee extension in both groups of observations was comparable. The use of the developed methodology in the daily practice of rehabilitation can increase the effectiveness of rehabilitation in children with infantile cerebral paralysis with moderate mental retardation and increase their social integration.

Keywords: children, a child cerebral paralysis, mental retardation, mental disorders, motor disorders, physical rehabilitation

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INTRODUCTION

In modern society, infantile cerebral paralysis remains one of the often-occurring diseases in children, whose frequency tends to increase. In recent years, the incidence rate of children of a child cerebral paralysis has increased in the world from 173.7 to 399.4 cases per thousand of births.[1] Annually in Russia, a child cerebral paralysis is diagnosed in almost 6,000 children, and the total number of disabled children in Russia has reached 150,000.[2]

All mechanisms that can lead to child cerebral paralysis have become the subject of study for modern researchers over the past decades.[3,4,5] Various cytogenetic aspects of disorders[6,7] and their leading capability to negative somatic manifestations, which were identical to child cerebral paralysis,[8,9] are now becoming clear.

Modern science is currently working on various ways to restore the impaired functions of the motor system with the help of medications,[10,11,12] but it is also active in the search for patients' recovery without medication.[13,14] Therefore, approaches to the rehabilitation of children continue to improve but remain far from ideal[15,16] despite its complex nature.[17,18] One of the most complex and insufficiently solved problems is the development of tools and methods for correcting motor disorders in children with cerebral paralysis who have moderate mental retardation.[19] A large correctional potential in children who had physical training with the use of special simulators was noted.[20] In this case, the recommended complexes of exercise therapy for

children with cerebral paralysis were performed mainly in the initial positions lying or sitting, which carried a high risk of developing secondary complications.[21] It was clear that exercises could positively influence the standing posture,[22] but their wide use was hampered by the low level of development of the methodical aspects of the use of specialized simulator devices, which allowed holding the child with cerebral paralysis having mental retardation in an upright position.

The purpose of the study to evaluate the effectiveness of the method developed by the authors, including therapeutic gymnastics, orthopedic adaptations, and technical means, in children 6-10 years old with cerebral paralysis who have moderate mental retardation.

MATERIALS AND METHODS

The study was approved by the local ethics committee of the Russian State Social University on September 15, 2016 (protocol No. 9). This study was conducted at the center for the promotion of family education "Yuzhnoe Butovo" in Moscow. We examined 33 children aged 6-10 years old with cerebral paralysis who had moderate mental retardation. All children had spastic diplegia or spastic tetraparesis. By random sampling, subjects were divided into a control group (16 children) and an experimental group (17 children) to correct their condition.

The control group was engaged in the plan of motor rehabilitation approved in this institution (therapeutic gymnastics in the form of passive exercises and the use of orthoses) for 107 days. The experimental group used the author's method of complex correction of motor disorders in children with cerebral paralysis who have moderate mental retardation within 107 days. In the first stage (1-14 days), the patients in the experimental group were engaged in therapeutic gymnastics, used the orthosis for daytime sleep, and additionally used force training (active-passive motor actions) and passive stretching of the muscles, which created the conditions to prepare the child for verticalization. These experiments were conducted in 10 lessons (19 hours). These classes were held in the gym for exercise therapy. The duration of each exercise was: passive exercise - 20 minutes; passive stretching of the muscles - 10 minutes; active-passive motor actions - 15 minutes; orthosis for daytime sleep - from 20-40 minutes. In the second stage (from day 15 to day 107), the children in the experimental group were treated with exercise therapy, which were supplemented by strength training (active-passive motor actions with weighting agents), applied passive muscle stretching, and used orthosis with verticalization. At the second stage, 84 sessions (157 hours) were conducted. These classes were held in the gym for exercise therapy. Their durations were: passive exercises - 20 minutes; passive stretching of the muscles - 10 minutes; active-passive motor actions with a weighting agent - 15 minutes; the use of orthosis and verticalizer - up to 60 minutes.

Assessment of the state of children in both groups was carried out at the beginning and at the end of classes using the same methods. Assessment of motor skills was conducted on the scale of Chaili. Evaluation of the child's motor skills was carried out by positioning in various positions on a 6-point scale. Based on the results of positioning, the degree of development of the child's gross motor skills in each posture was assessed: lying on his back, lying on his stomach, sitting on the floor, sitting on the cube and standing.[23]

To measure the level of spasticity, the Ashworth scale was used, then the severity and frequency of resistance to passive movements were measured by a five-point rating (from 0 to 4 points). During the test, the limbs of the patient were moved in the full range movement and the muscle tone was assessed.[23]

Evaluation of the strength of the quadriceps femoris was carried out during the extension of the leg in the knee joint. The subject was put on a chair and asked to unbend his leg in the knee joint. In this case, one of the examiner's arm resisted this movement, while other hand palpated the contracting muscle. The strength of the muscles was evaluated according to the 6-point system.[23]

Goniometry was carried out with the help of a protractor. The amount of movement in the knee joint was measured by placing the hinge of the protractor in the region of the projection of the joint space on the outer surface of the limb. One part of the device was placed along the axis of the shin, while another part was put on the hip axis[23].

Statistical processing of the data obtained during the study consisted of calculating the arithmetic mean (M), counting the error of the mean value (m), and determining the reliability of the differences in the mean values (Student's t-test).

RESULTS AND DISCUSSIONS

While assessing the initial motor skills in the control and experimental groups, the initially low level of their development was noted. Prior to the application of correction in both groups of children with cerebral paralysis and moderate mental retardation, a high degree of spasticity of the extremities was found. This was accompanied by a similar decrease in the angle of extension of the knee joint, as well as a weakening of the strength

of the quadriceps femoris muscle (Table 1). The subjects in this study had a mean age of 8.2 ± 1.4 years.

After the correction in both groups, there were positive changes of all the recorded parameters in comparison with the initial level (Table 1). For all the parameters of the motor skill taken into account, a pronounced increase in the experimental group was noted. The results achieved as a result of using the author's program of correction in children from the experimental group exceeded the same values in the control group for assessing the motor skill from the starting positions: lying on the back by 11.2%, lying on the abdomen by 9.8%, sitting on the floor 11.8%, sitting on the cube by 24.3%, standing at 28.5%.

Overcoming the lag in the physical development of mentally retarded children with cerebral paralysis to adapt to physical exertion was associated with compensation for their defeat of the central nervous system and it was a consequence of a decrease in hypokinesia. Expansion of motor activity within the framework of the author's method had stimulated the child's natural development, causing a chain of adaptive reactions of his body: resistance to colds and infectious diseases increased, and prerequisites for strengthening the heart muscle are created.[24,25] Overcoming hypokinesia led to the elimination of excess weight, which led to an even greater additional increase in their motor activity.[26-30]

As a result of the corrective actions carried out in the experimental group, there was a marked decrease in spasticity of the quadriceps femoris muscle. The degree of reduction of this indicator in the experimental group was 3.1 times higher than in the control group. The results achieved in the experimental group were associated with a more physiological redistribution of muscle tone in the form of a weakening of the overtaxes and excess

Table 1. Dynamics of motor abilities of children with cerebral paralysis and moderate mental retardation during the observation

Initial position	Control group, M±m, n=16		Experimental group, M±m, n=17	
	at the beginning of observations	at the end of observations	at the beginning of observations	at the end of observations
Motor skill with the initial position lying on the back, points	3.10±0.80	3.38±0.67 p<0.05	3.13±0.52	3.76±0.53 p<0.01 p_1<0.05
Motor skills in the initial position, lying on the abdomen, points	3.07±0.74	3.45±0.53 p<0.05	3.10±0.71	3.79±0.52 p<0.01 p_1<0.05
Motor skill with the starting position sitting on the floor, points	2.75±0.89	3.13±0.64 p<0.05	2.63±0.74	3.50±0.53 p<0.01 p_1<0.05
Motor skill at the starting position sitting on the cube, points	2.56±0.65	3.12±0.54 p<0.05	2.50±0.76	3.88±0.35 p<0.01 p_1<0.05
Motor skill with the initial standing position, points	1.75±0.46	2.14±0.35 p<0.05	1.63±0.52	2.75±0.46 p<0.01 p_1<0.05
Spasticity of the limb, points	3.03±0.35	2.75±0.46 p<0.05	3.00±0.53	2.13±0.64 p<0.01 p_1<0.05
The Strength of quadriceps femoris, points	1.38±0.52	1.63±0.52 p<0.05	1.25±0.46	1.94±0.35 p<0.01 p_1<0.05
Angulation of knee extension, degrees	148.2±0.12	162.0±0.23 p<0.05	146.8±0.17	169.0±0.26 p<0.05

Legend: p - reliability of indicator dynamics against the background of the impact; p_1 - reliability of differences between the groups at the end of the observation.

shortening in the muscles.[31-34] Apparently, against the background of correction by the author's program, the muscles started to be included in the work more synchronously and rhythmically, which made the movements more dexterous and full in volume. In this case, optimization of muscle tone could be associated with increased maturation of healthy brain structures.[35-38]

The dynamics of the strength of the quadriceps femoris muscle in the course of the health improvement measures increased significantly in the experimental group. Their levels in children who received correction for the author's program exceeded the control by 19.0%. Apparently, the technique used in the experimental group were able to cause more active muscle contractions and to excite a greater number of motor units with a pronounced involvement of them in volitional activity.[39,40] All of these contributed to a more pronounced restoration of the functions of the muscular system in children in the experimental group than in the control group. Apparently, a long-repeated excitation along the nerve pathways led to a gradual alleviation of neuromuscular conduction by decreasing the synaptic resistance.[41-44]

In both observation groups, by the end of the correction, the knee extension angle increased by 9.3% and 15.1% in the control group and experimental group respectively. Apparently, the use of a set of health effects in the experimental group more actively stimulated the activity of brain structures controlling locomotion acts and manipulation of objects.

CONCLUSION

A child cerebral paralysis is characterized by impaired motor and statokinetic functions, the correction of which is very complicated and difficult to compensate for. During the performed study, the effectiveness of the method developed by the authors for correcting motor disorders in children 6-10 years old with cerebral paralysis and moderate mental retardation was evaluated. This technique included curative gymnastics, orthosis, and verticalization. During the study, it was proved that the use of this technique had more advantages over the traditional correction in the dynamics of goniometry, the strength of the quadriceps muscle of the thigh and spasticity of the muscles. Its application provided an improvement in motor skills, compared to the results of traditional treatment. The use of the developed method in the daily practice of rehabilitation can increase the efficiency of rehabilitation in children with cerebral paralysis and moderate mental retardation, increasing their social integration.

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