

CHARACTERISTICS OF MOTOR DEVELOPMENT IN CHILDREN AGED 7-10 YEARS WITH CEREBRAL PALSY IN THE PROCESS OF HYDRO REHABILITATION

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Abstract: The paper describes the progress and results of the research aimed at identifying the characteristics of motor development of children aged 7-10 years with cerebral palsy in the process of hydro rehabilitation. Empirical research methods included the analysis of medical records, observation, expert assessments, calculation of the reliability of differences using the Mann-Whitney U-test. High efficiency of the hydro rehabilitation course for the formation of motor skills in the water in children with different forms of cerebral palsy was observed. Its efficiency for the correction of motor disorders was proved only in the group of children with spastic diplegia of the lower and upper extremities. The positive effect of the course on the reduction of spasticity of the underdeveloped extremities was not confirmed statistically.

Keywords: infantile cerebral palsy, motor dysfunction, motor skills, muscle spasticity, physical rehabilitation.

1 Introduction

Official data show that cerebral palsy (cerebral palsy) is one of the leading chronic diseases of children worldwide, including developed countries, and that it leads to long-term disability. The incidence of cerebral palsy remains a difficult problem for the foreseeable future (Hutchinson & Graham, 2008), which determines the continuing relevance of the search for effective methods of rehabilitation and social adaptation of persons in this nosological group.

The pathophysiological mechanisms of motor and cognitive dysfunction in cerebral palsy continue to be the focus of medical science (Himmelmann & Uvebrant, 2011; Qin et al., 2018). A further search for technologies for the treatment of spasticity in cerebral palsy is being carried out. At the same time, the need for using a multidisciplinary approach (Shamsoddini et al., 2014) and a wide range of modern recovery tools (Bach et al., 2003) is emphasized. At the same time, although the existing methods of medical and surgical treatment described in the medical literature (Flett, 2003; Graham et al., 2000; Labaf et al., 2015) are effective, they often significantly increase the cost of rehabilitation services (Kim et al., 2018), which forces the use of more affordable methods and tools. These, admittedly, include physical exercise, which can be applied not only in the framework of the physical rehabilitation programme, but also in the conditions of inclusive education of children with cerebral palsy (Hilderley & Rhind, 2012). In general, it is considered to be a proven effectiveness of motor activity in the development of both muscle and brain activity (Damiano, 2013), but not all aspects of the impact of exercise on the motor development of children with cerebral palsy are fully considered in the scientific literature, which specified the problem of the research.

2 Literature Review

It was found that for children with cerebral palsy, the main problem is motor dysfunction, which causes difficulties in solving functional tasks (Labaf et al., 2015; Machado et al., 2019). The scientific literature shows the effectiveness of physical exercise for improving walking while maintaining static and enhancing the dynamic balance of children of primary school age with cerebral palsy (Bar-Haim et al., 2013). The possibility of qualitative changes in the functional activity of hands in children with cerebral palsy was demonstrated even after the first course of adequate rehabilitation (Tinderholt Myrhaug et al., 2014). The use of instrumental methods based on biofeedback allows enhancing the positive effect of rehabilitation of children with neurological problems on their motor development (Vorobiev et al., 2016).

It is known that hydro rehabilitation is based on the use of magneto hydrodynamic mechanism of curative effect of the aquatic environment on a man, which reflects the consequences of physical and social laws (Ageevets & Mosunov, 2015). Assessing the effectiveness of hydro-kinesiotherapy, the authors note that during the session in the water, the patient has muscle relaxation, decreased muscle tone, increased amount of active movements in the joints of the extremities (Ghaffari, 2017; Korolev & Suslova, 2012), which leads, in particular, to improved walking function (Safina et al., 2009), body position control (Konovalova & Yaremchuk, 2017). Even sports swimming techniques are available for children with cerebral palsy (Petrunina et al., 2018).

The basics of methods of swimming lessons for children with cerebral palsy are described in the literature on adaptive physical culture. Its most characteristic features include the widespread use of various support tools, the separating method of training and the use of exercises aimed at holding the breath (Konovalova & Yaremchuk, 2017). The maintenance of an optimal temperature mode is important in the hydro rehabilitation process: the water temperature should be maintained at 30-32°C, the air temperature should be on average 28-30°C.

The experts emphasize the importance of further transfer of motor skills obtained in the water to the normal environment (Yalovenko & Gilev, 2018), so that in general, it would contribute to the motor development of a child.

3 Research Methodological Framework

The aim of the research was to identify the characteristics of motor development in children aged 7-10 years with cerebral palsy in the process of hydro rehabilitation. The research was conducted from September 2017 to May 2018 on the basis of the rehabilitation center for children and adolescents with disabilities "Preodolenie" (Cherepovets, Russia) and suggested that the following objectives should have been solved: 1) to assess the initial level of motor development of children with cerebral palsy in the beginning of the hydro rehabilitation course; 2) to conduct the re-assessment of the level of motor development of children according to the results of the course and to identify the characteristics of the dynamics of the values of its indicators in children with cerebral palsy; 3) to reveal the peculiarities of motor development in children aged 7-10 years with various forms of cerebral palsy in the process of hydro rehabilitation. A set of empirical methods for the solution of research objectives included analysis of medical records, observation, and the method of expert assessments and calculation of the reliability of differences using the Mann-Whitney U-test.

20 children were under study, among which there were 8 boys and 12 girls with an average age of 8.2±1.22 years at the start of the study. According to the form of cerebral palsy, the sample was not homogeneous and included children with different variants of the disease: spastic diplegia, tetraparesis (n=7), right-sided hemiparesis (n=6), left-sided hemiparesis (n=4), spastic diplegia of the lower and upper extremities (n=3). In several cases, cerebral palsy was accompanied by mental retardation (n=6).

In general, in this group of children, disorders of the upper and lower extremities of varying degrees, spasticity and rigidity of muscles, paresises, secondary changes in the course of the disease – the formation of contractures and joint distortions – were recorded. All children under study had various possibilities of motor activity: some of them did not have the ability to walk independently, the consistency of purposeful movements; there were restrictions in voluntary movements, violations of coordination of movements.

As indicators of motor development of children with cerebral palsy, the following indicators were selected for expert assessment: the level of formation of motor skills in the water (walking, swimming and diving from the surface of the water), the degree of manifestation of motor disorders, as well as the level of spasticity of the extremities underdeveloped in motor function.

The assessment of the formation of motor skills in the water was carried out using a diagnostic map developed by the authors (Varfolomeeva et al., 2017). To determine the manifestation of motor disorders, we used the scale of significance of clinical indicators in cerebral palsy, developed in the Research Institute of Traumatology and Orthopedics n.a. G.I. Turner, Saint-Petersburg (Shapkova, 2004), which was adapted to meet the objectives of the research. The assessment of spasticity of the extremities underdeveloped in motor function was carried out by using the Ashworth scale (Bulekbaeva et al., 2010). In general, all indicators of motor development of children were assessed on the basis of non-parametric scale of ranks, the assessment results were measured in points.

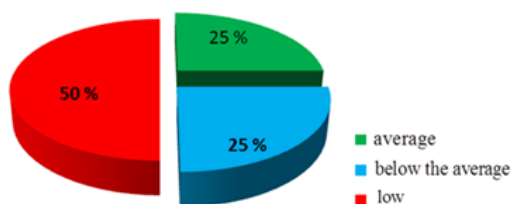
During this period, this group was engaged in the hydro rehabilitation programme twice a week with 30-minute duration of one session. The formed groups consisted of 5 people each. It is important to emphasize that within the framework of individual rehabilitation programmes, children underwent other rehabilitation courses, such as therapeutic gymnastics, full-body massage, and physiotherapy. It should also be noted that 5 children from among those under study were rehabilitated after surgical treatment for the main disease in the framework of this research.

In addition to the traditional method of training in the pool with children with cerebral palsy, we have proposed and applied the method of directed stimulation of movements of the underdeveloped extremity. When using this technique, the corresponding extremity of child was marked by a flicker – a flexible slap bracelet. The task of the child at the session was to show the bracelet from the water and get points, thus competing with other children. In total, 75 sessions were conducted according to this method.

4 Results and Discussion

The results of medical-pedagogical assessment of motor development of children in the experimental sample at the stage of ascertaining slice (September 2017) are presented in figures 1-3.

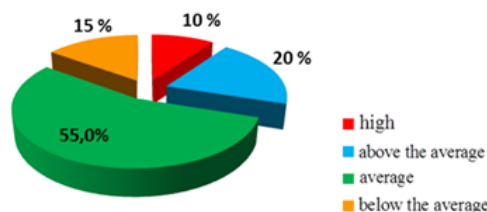
Figure 1 The distribution of the results of the assessment of the level of development of motor abilities in the water of children aged 7-10 with cerebral palsy



Source: authors

As can be seen from figure 1, before the beginning of the hydro rehabilitation course, half of the children had a low level of motor skills in the water, while the high level and the level above the average were not presented at this stage of study.

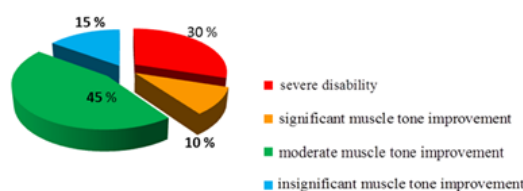
Figure 2 Distribution of the results of assessment of the degree of the manifestation of motor disorders in children aged 7-10 years with cerebral palsy



Source: authors

Figure 2 shows that at the beginning of the study, more than half of the children had an average degree of manifestation of violations.

Figure 3 The distribution of the results of the assessment of spasticity of the extremities underdeveloped in motor function in children aged 7-10 with cerebral palsy



Source: authors

As seen in figure 3, at the beginning of the hydro rehabilitation course, the results of the assessment of the level of spasticity of the children's extremities underdeveloped in motor function indicate that at the time of study, the majority of children had a moderate level of muscle spasticity. At the same time, none of the subjects had a low level of muscle spasticity. At the end of the hydro rehabilitation course, the expert re-assessment of the motor development of the children in this group was conducted, and its results were subjected to mathematical-statistical processing. Its results are presented in tables 1-4.

Table 1 The results of the calculation of the reliability of differences of averages of assessment of motor development in children of the experimental group in the process of hydro rehabilitation

Motor development indicator	$U_{critical}$	$U_{empirical}$	p
Level of formation of motor skills in the water	114	68.5	p<0.01
The degree of motor disorders`manifestation	138	138	p=0.05
The level of spasticity of the extremities underdeveloped in motor function	138	163.5	p>0.05

Source: authors

From table 1 it is seen that in general, the hydro rehabilitation course influenced the indicators of motor development of children in varying degrees in the group of children with cerebral palsy. The most pronounced positive effect was observed in the indicator of development of motor abilities in the water. For a more differentiated assessment, the results were processed for groups of children with different forms of cerebral palsy.

Table 2 The dynamics of the median values of assessment of development of motor abilities in the water

Form of cerebral palsy	Me_1 , points	Me_2 , points	U_{emp}	Statistical inference
Spastic diplegia,	5	11	6.5	The differences

Form of cerebral palsy	Me_1	Me_2	$U_{empirical}$	Statistical inference
tetraparesis (n=7)				are significant at $p \leq 0.05$
Right-sided hemiparesis (n=6)	22.5	40	1	The differences are reliable at $p \leq 0.01$
Left-sided hemiparesis (n=4)	9	18.5	0	The differences are reliable at $p \leq 0.01$
Spastic diplegia of the lower and upper extremities (n=3)	13	29	0	The differences are reliable at $p \leq 0.01$

Source: authors

Table 2 shows that despite the variability of motor disorders, the dynamics of the result of assessment of motor skills in the water are significantly positive in all groups, although they are less pronounced in the group of children diagnosed with "spastic diplegia, tetraparesis".

Table 3 The dynamics of the median values of the assessment of the degree of the manifestation of motor disorders (Varfolomeeva, Farber, Shestakov & Panova)

Form of cerebral palsy	Me_1	Me_2	$U_{empirical}$	Statistical inference
Spastic diplegia, tetraparesis (n=7)	32	25	14.5	The differences are unreliable, $p > 0.05$
Right-sided hemiparesis (n=6)	17	13	11.5	The differences are unreliable, $p > 0.05$
Left-sided hemiparesis (n=4)	23.5	20.5	4.5	The differences are unreliable, $p > 0.05$
Spastic diplegia of the lower and upper extremities (n=3)	19	16	0	The differences are reliable at $p \leq 0.01$

Source: authors

As can be seen in table 3, although the dynamics of median values are positive in all groups, the differences were statistically confirmed only in the group of children diagnosed with spastic diplegia of the lower and upper extremities. At the same time, it is possible that the positive result is due to the influence of other factors, such as surgical treatment before the study and other rehabilitation measures.

Table 4 The dynamics of median values of the assessment of the level of spasticity of extremities underdeveloped in motor function

Form of cerebral palsy	Me_1	Me_2	$U_{empirical}$	Statistical inference
Spastic diplegia, tetraparesis (n=7)	5	4	19.5	The differences are unreliable, $p > 0.05$
Right-sided hemiparesis (n=6)	2.5	2	12	The differences are unreliable, $p > 0.05$

Form of cerebral palsy	Me_1	Me_2	$U_{empirical}$	Statistical inference
Left-sided hemiparesis (n=4)	4	3.5	6	The differences are unreliable, $p > 0.05$
Spastic diplegia of the lower and upper extremities (n=3)	3	3	2	The differences are unreliable, $p > 0.05$

Source: authors

The analysis of the dynamics of the individual results of the assessment of motor development in terms of the spasticity of underdeveloped extremities showed that the positive changes as a result of the hydro rehabilitation course occurred only nine times out of twenty. Table 4 shows that these shifts are not statistically significant in any of the groups. This is probably due to the fact that muscle spasticity is the most permanent disability of motor functions of children with cerebral palsy. Therefore, it is no coincidence that the methods of correction of spastic muscle hypertension in cerebral palsy have occupied an important place in practical neurology and neurorehabilitation for many years.

5 Conclusions

The research allows us to conclude that in general, a series of sessions based on the use of hydro rehabilitation has a positive effect on the annual dynamics of the values of motor development indicators of children aged 7-10 years with cerebral palsy under the condition of directed stimulation of movements of the underdeveloped extremity. However, in this case, only changes in motor development related to the formation of motor skills in the water are reliable, the changed related to the indicator of the manifestation of motor disorders are reliable to a lesser extent. At the same time, the hydro rehabilitation course, even in combination with other methods of physical rehabilitation, is not sufficient to ensure a statistically significant positive change in the level of spasticity of the extremities underdeveloped in motor function of children with cerebral palsy.

The authors believe that the presented results reflect only the following tendency: each child with cerebral palsy is unique in the manifestations of motor analyzer disorders and its combinations with other diseases, so in some cases – with mild motor disorders, the absence of related diseases, the presence of intelligence – the effect of hydro rehabilitation on motor development can be quite effective.

The conducted research opens up prospects for a more in-depth study of the effectiveness of the use of the means of physical rehabilitation and their combinations in the correction of motor development of children with different forms of cerebral palsy.

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