

Methods of Hydrokinesis Therapy for Children 3-5 Years with Cerebral Palsy of Spastic Form

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Abstract: *Today there is a need to develop a method of hydrokinesis therapy as a means of gradual formation of motor skills in children with spastic diplegia of cerebral palsy of the chronic-residual stage of the disease in a comprehensive program of physical rehabilitation. The purpose of the study is to develop a method of hydrokinesis therapy for children 3-5 years with cerebral palsy of spastic form. The main novelties of the developed technique of hydrokinesis therapy: development of application of complexes of exercises in hydrokinesis therapy, which differs in structure from the generally accepted methods for patients with cerebral palsy of spastic form in the chronic-residual stage of the disease; combination of means of physical rehabilitation with the technique of hydrokinesis therapy during the annual cycle. The study involved 24 children 3-5 years of age with a diagnosis of "cerebral palsy, spastic diplegia" of the chronic-residual stage of the disease of moderate severity. To achieve this goal, theoretical analysis and generalization of data from scientific and methodological literature were used; pedagogical experiment and observation; medical and biological methods (used anthropometry and Pinier index; goniometry, assessment of basic motor functions (ABMF) on the Likert scale, muscle tone on the Ashfort scale, muscle strength on the Lovett scale; assessment of manipulative activity and speed response of the hands on trapping- the test made it possible to determine the level of development of fine motor skills); sociological methods (surveys of parents on questionnaires of social and emotional state and level of children's play activities); methods of mathematical statistics were used to process the actual experimental material, assess the reliability of the data. There were significant ($p < 0.01$) changes in the indicators of social and emotional state in children with main group (MG) by 15.5%, in comparative group (CG) - by 11.7%, and there was a slight improvement in play activity in children with MG by 9.6%, in CG - by 5.75%. The developed method of hydrokinesiotherapy is effective and helps to improve the functions of general and fine motor skills, socio-emotional state and the level of activity of play activities of children 3-5 years with cerebral palsy of spastic form.*

Keywords: *gradual formation; motor skills; physical rehabilitation; therapeutic physical culture; chronic-residual stage of the disease; socio-emotional state.*

How to cite: Taran, I., Vasylieva, N., Gurova, A., Karpukhina, Y., Konkov, A., Koziiy, T., Kolomyichuk, A., & Biriukova, T. (2020). Methods of Hydrokinesis Therapy for Children 3-5 Years with Cerebral Palsy of Spastic Form. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, 11(4), 244-264.
<https://doi.org/10.18662/brain/11.4/151>

Introduction

Disability is a social phenomenon that no society can avoid. According to WHO experts, the number of children with disabilities and social functions is about 10% of the world's population. In Ukraine, children with disabilities average 2-3% of the total number of children (Kachan, 2010). Among the causes of disability in children in the first place are diseases of the nervous system - 18.2% (Vashchenko et al., 2012), the prevalence of which has almost doubled over the past 10 years, children with cerebral palsy are leading place - 2.6% (Khozbey, Mishchenko, Golik, & Gondulenko, 2011; Korneev et al., 2012).

The problem of cerebral palsy (CP) has not only medical and social (Mysula, & Vakulenko, 2005), but also universal significance. Cerebral palsy is primarily manifested by a violation of movements, balance and body position (Badalyan et al., 1988), the inability to distribute muscular effort causes significant difficulties in manipulative activity (Mastyukova, 1991). Mental retardation is manifested by speech disorders, limited communication with healthy peers, there are difficulties in concentration and attention, reduced emotionality and motivation to play. The variety of clinical manifestations and pathophysiological mechanisms of their development create certain difficulties in the formation of the gradual development of motor skills in the process of long-term rehabilitation (Semenova, 2007). Different aspects of the problem under study are covered in the works of many scholars (Sheremet et al., 2019; Maksymchuk et al., 2020).

Many scientists have worked on the problem of organic lesions of the nervous system, in particular cerebral palsy (Mastyukova, 1991; Kozyavkin et al., 1999). According to these authors, an important component of the treatment process is physical rehabilitation, which currently involves the use of various types of massage, physical therapy (PT), balneotherapy and physiotherapy, mechanotherapy, non-traditional methods (hippotherapy, dolphin therapy, etc.). One of the important forms of exercise therapy is hydrokinesis therapy.

As scientists have already noted (Bulgakova, 2002; Kopchak, 2002; Hlazyrin, 2006), the beneficial effects of water on the human body are determined by its physical, chemical and biological properties. Hydrokinesiotherapy has a positive effect on the functional state of the body (Odynets, 2012), it is successfully used to achieve certain therapeutic objectives in the practice of exercise therapy. Due to its effectiveness and

availability, hydrokinesiotherapy is used in the rehabilitation of patients with cerebral palsy (Porshneva, & Shchedrina, 2004; Avramenko, & Kuznetsov, 2006; Shmakova, Nikitushkina, & Skripak, 2011).

Many scientists worked on the method of hydrokinesis therapy to solve the problem of motor disorders of children with cerebral palsy (Zholus, 1980; Mosunov, & Sazykin, 2002). Methods of hydrokinesis therapy provides for the formation of motor skills in infants, without taking into account the specific form of cerebral palsy. According to Mosunov, & Sazykin (2002), the purpose of hydrokinesis therapy is to teach a child to swim with the consequences of cerebral palsy.

Isolated foreign studies have focused on the use of water exercises to reduce muscle tone, increase joint amplitude, muscle strength, and overcome pathological attitudes (Zwich, Leistriz, & Milleit, 2004).

According to many authors (Martyniuk & Zinchenko, 2005) and others, the vast majority of patients with cerebral palsy are observed with spastic forms, namely with spastic diplegia.

The basis of all elements of human motility is the development of normal tonic and adjusting reflexes, the formation of motility of a healthy child occurs in stages (Kozyavkin, & Shestopalova, 1999). In children with cerebral palsy of spastic form, the pathological activity of tonic reflexes remains for many years, which is one of the most important factors in the formation of stable pathological postures and attitudes. Insufficient experience of movements not only increases motor disorders, but also impairs sensorimotor development (Katz, & Rymer, 1989). Physical rehabilitation of cerebral palsy should be comprehensive, which will contribute to much better results in rehabilitation treatment (Voronin, & Trach, 2008).

The leading methods of physical rehabilitation of cerebral palsy (Semenova, 2007) and others are focused on the use of exercise therapy and massage, all of which have many positive features. However, hydrokinesis therapy, due to the properties of water (Bulgakova, 2002; Kopchak, 2002; Hlazyrin, 2006; Shulha, 2008) has priority over physical exercises performed on land (Odynets, 2012) and is one of the leading means of physical rehabilitation of children with injuries of the nervous system (Shmakova et al., 2011). However, in the identified methods of hydrokinesis therapy (Zholus, 1980; Mosunov, & Sazykin, 2002; Shpak, 2002) insufficiently developed guidelines for the gradual formation of motor skills in children with cerebral palsy according to the form and stage of the disease.

Today there are no methodological developments in hydrokinesis therapy for the gradual formation of motor skills in the program of physical

rehabilitation of children 3-5 years with cerebral palsy of spastic form, because in the chronic-residual stage of the disease arbitrary motility is sharply delayed in its development, pathological synergies increase, formed motor stereotype and organic contractures of joints (Semenova, 2007), which complicates the process of formation of neuropsychological functions of the child.

It can be assumed that the development and implementation of rehabilitation of patients with this severe pathology techniques of hydrokinesis therapy as a means of gradual formation of motor skills of children 3-5 years with cerebral palsy spastic form will allow to more effectively influence the correction of motor functions, suppress the suppression of pathological disorders.

The purpose of the study is to develop a method of hydrokinesis therapy for children 3-5 years with cerebral palsy of spastic form.

Materials & methods

The following research methods were used: theoretical analysis, generalization of data from scientific and methodological literature; pedagogical experiment and observation; medico-biological methods (anthropometry to determine body length (cm), body weight (kg), chest circumference (cm), Pinier index, assessment of basic motor functions on a 4-point Likert scale, which in turn was divided into five tasks) groups (lying and turning, sitting, crawling, standing, walking, running and jumping), goniometry of the lower extremities ($^{\circ}$), assessment of muscle tone of the upper and lower extremities on a 5-point scale of Asfort and muscle strength for 6- Lovet score; evaluation of manipulative activity (grabbing a pencil on a 5-point scale); determining the speed of reaction of the hands on the trapping test (the number of points applied in 5 seconds)); sociological methods (analysis of medical histories, surveys of parents of sick children on questionnaires of social and emotional state and level of play activity in points); methods of mathematical statistics (arithmetic mean, standard deviation, arithmetic mean error were processed by statistical programs Microsoft Excel and Statistica 6.0, for unrelated samples used Mann - Whitney test ($p < 0,05$), for related samples - Wilcoxon test ($p < 0,01$)).

At the first stage of the study (November 2017 - April 2018) the analysis and generalization of information from scientific and methodological sources was conducted, which allowed to substantiate the goal, to formulate the objectives of the study.

At the second stage (May 2018 - July 2018) the place of the study was determined - Kherson Regional Center for Social Rehabilitation of Disabled Children (Kherson). The study involved 24 children 3-5 years of age with a diagnosis of "cerebral palsy, spastic diplegia" of the chronic-residual stage of the disease of moderate severity. Two groups of 12 people each were created by random sampling main group (MG) and comparative group (CG). The scheme of individual examination of a child with cerebral palsy was made and the initial study was conducted, which allowed us to determine the functional state of the musculoskeletal system, stages of development of motor skills (lying and turning, sitting, crawling and standing, standing, walking), assess socio-emotional state. and the level of activity of patients' play activities. A method of hydrokinesis therapy as a means of gradual formation of motor skills of children 3-5 years old with cerebral palsy of spastic form has been developed.

The third stage (August 2018 - August 2019) was to experimentally test the effectiveness of hydrokinesis therapy in the program of physical rehabilitation. The scheme of the rehabilitation process consisted of the following components: rehabilitation examination to determine the functional state of the motor sphere and socio-emotional disorders; formation of tasks of physical rehabilitation; development of hydrokinesis therapy exercise complexes; implementation of rehabilitation intervention; evaluation of the effectiveness of the developed method of hydrokinesis therapy in the program of physical rehabilitation.

The experiment lasted one year, the physical rehabilitation programs in both groups differed only in the methods of hydrokinesis therapy, the purpose of which is the formation of motor skills. In the CG, the goal was achieved by using the method of hydrokinesis therapy, which was used in the Kherson regional center for social rehabilitation of children with disabilities and which provided for teaching the child to be able to swim, and in the MG, the developed method of hydrokinesis therapy using physical exercises in water to suppress pathological muscle reactions and stimulate the development of set rectifying reflexes. The authors of the study carried out exercises in the pool in the MG and CG. Children from MG and CG under the same conditions underwent a physical rehabilitation program. During the year, during the working week, the children attended three exercises in exercise therapy and twice in hydrocolonotherapy, which lasted 30-40 minutes. Additionally, 4 times a year for 10 days, courses on physical rehabilitation were intended, involving the use of physiotherapy, massage, kinesitherapy, mechanotherapy.

The study scheme is as follows: the indicators of basic motor functions assessment (IBMFA) were measured before, after 6 months and after the experiment, since the development of motor skills is slow and very difficult, due to the immaturity of nervous processes and the influence of tonic muscle reactions, which is confirmed by many years of scientific practice (Kozyavkin, Shestopalova, & Podkorytov, 1999; Mastukova, 1991) determination of indicators of joint mobility, muscle tone and strength, speed of hand reaction and manipulative activity was carried out before, after 4 months, after 8 months and after a one-year course of rehabilitation to track the dynamics of development of indicators of the functional state of the musculoskeletal system; assessments of the influence of hydrokinesis therapy on the social-emotional state and activity of playing activity were determined before and after rehabilitation, since the main task of the work is to overcome tonic muscular reactions, pathological attitudes and, on this basis, to form step-by-step motor skills.

The fourth stage (September 2019 - July 2020) was the analysis of the results of the study of the main and comparative groups. At this stage, it was proved that the developed method of hydrokinesis therapy as a means of stage-by-stage formation of motor skills more effectively affects the development of the motor sphere, social-emotional state and the level of activity of playing activity than the generally accepted method of hydrokinesis therapy.

The main novelties of the developed method of hydrokinesis therapy: the development of the use of exercise complexes with hydrokinesis therapy, which differs in structure from the generally accepted methods for patients with spastic cerebral palsy in the chronically residual stage of the disease; a combination of physical rehabilitation means of hydrokinesis therapy during the annual cycle

The developed methodology is based on the general principles of physical rehabilitation, it is built taking into account the results of preliminary research and consists of stages in accordance with the reflex development of the general motor skills of a healthy child.

The first stage of the technique contains the following tasks: the formation of an installation reflex from the neck to the head, which makes it possible to hold the head vertically while moving; the development of hand support makes it possible to improve orientation in space, forms the interaction of fixing vision on an object with movements of the hands to this object.

The second stage provides for the development of a symmetric cervical chain reflex, promotes the child's mastering the skills of turning and

turning the body, reducing the pathological attitudes of the lower extremities.

At the third stage of the development of the asymmetric chain cervical reflex, with the help of consolidating the achieved skills at the first and second stages, the child begins to form complex motor skills, such as sitting, crawling on all fours, knees, developing support, balance, straightening the body and walking.

According to the data of the primary study, the majority of children with MG began to develop motor skills characteristic of the third stage, but the ability to hold the head position for a longer time, to master turns and turning the body required consolidation, since in the chronically residual stage of the disease, joint contractures, defective postures and the attitudes become stable, so we continued to perform the exercises of the first and second stages of the hydrokinesis therapy method. Each new movement was formed by repeated repetition, therefore, the exercise was explained and shown to the child in more detail, paying attention to symmetrical and coordinated performance, learning to self-control over the actions performed.

An important element in the formation of motor skills was outdoor play, since in many people the motivation for activity was violated, to a large extent determines the difficulties of the formation of each new movement that is absent in the child's motor stereotype. With the help of games, they trained, formed and consolidated certain motor skills for the purpose of the lesson: to help the child to adapt in the water, to feel its resistance, to cope with the water resistance; develop reciprocity of movements and overcoming the drive position of the lower extremities; teach a child to move in water, train a high-speed reaction of movements; train the support reaction of the lower limbs, develop muscle strength, body balance, and the like.

During the training, time was allotted for exercises to develop fine motor skills and training the speed response of the hands (grab stones or toys, boil water, catch water, perform splashing), as children with cerebral palsy at the age of 3-5 years are just beginning to appear manipulative activity, which is insufficient and may not be formed in the future.

Sound and speech stimuli were widely used during the exercises. Emotional and clear language instruction was important, which had a positive effect on the child's mental activity, improved perception of tasks, and developed purposefulness.

Exercises on the water were performed from different starting positions: lying on your chest, back, sitting and standing. The main support

for the children was provided by a specialist. Inflatable circles, armbands, a rubber ball, a swimming board, and handrails were auxiliary supports for keeping lying and sitting. A rubber ball, a swimming board, a gymnastic stick, a gymnastic rope and a hoop were offered to the child to maintain body balance when learning standing and walking skills. Supports not only helped to get used to the water and exercise faster, but also insured and guaranteed safety.

Classes with hydrokinesis therapy in an individual form during the year took place 2 times a week for 30-40 minutes. The air temperature was 22-24 ° C, the water temperature was 30 ° C. Before each lesson, the children were necessarily explained the course of action, they tried to set the child up for active participation in order to achieve the goal of the lesson. Each lesson consisted of preparatory, main and final parts. At the beginning of the lesson, the child was emotionally prepared for active work in the aquatic environment. In the preparatory part of the lesson, the child and a specialist gradually immersed themselves in the water, began to perform passive exercises, passive with the help and exercises for muscle relaxation. The main part of the lesson was aimed at overcoming the pathological attitudes of the lower extremities, performing exercises for stretching muscles, strength and speed-strength exercises, the formation of motor skills in accordance with the stage of development and the capabilities of the child, training of coordination abilities and body balance, stimulation to independent active movements. In the final part of the lesson, a significant place was devoted to breathing exercises, exercises for relaxation, swimming movements in a free style were performed, so they freely rested in any stable position that does not cause muscle tension and negative emotions in the child.

When performing the exercises, a special training was used aimed at the development of the impaired function, taking into account the duration of the exercise, the intensity, the duration of the rest intervals between exercises, the nature of the rest, the number of repetitions of the exercises.

Hydrokinesis therapy was used in a comprehensive physical rehabilitation program for children with cerebral palsy. During the year, classes in the pool were held twice, and PT - three times a week. Additionally, 4 times a year, physical rehabilitation courses were intended, which consisted of certain means: amplipulse therapy No. 10; paraffin-ozokerite applications and hydromassage every other day according to No. 5; general therapeutic massage daily No. 10; passive development of joints, verticalization in the dynamic parapodium and mechanotherapy daily at No. 10; treatment by position twice a day.

The program of physical rehabilitation of children with cerebral palsy of spastic forms of MG and CG for the period of the experiment differed only in the methods of hydrokinesis therapy. Children from the MG were trained according to the developed method of hydrokinesis therapy as a means of gradual formation of motor skills, presented above. Patients with CG continued to work according to the method of hydrokinesis therapy, which was used in the Kherson regional center for social rehabilitation of disabled children. In both study groups, the main goal of hydrokinesis therapy was the formation of motor skills. In the MG, we achieved the set goal mainly through repeated repetition of the developed physical exercises in the water, and in the CG - mainly through teaching the child to be able to swim, which also helps suppress pathological tonic reflexes, stimulates the development of chain adjusting rectifying reflexes.

For the successful implementation of the method of hydrokinesis therapy in the organization of the process of physical rehabilitation of centers of social and medical rehabilitation, practical recommendations have been developed for specialists in physical rehabilitation.

Results

The results of the analysis of the indicators of the primary examination of IBMFA indicate a delay in the development of motor skills in children with cerebral palsy. Indicators were lower than the norm in the performance of skills "lying and turning" in the MG by 21.4%, in CG - by 20%; "Sitting" in the exhaust - by 37.7%, in the CG - by 34.4%; "Creeping and crawling" in MG - by 44.1%, in CG - by 38.1%; "Standing" in the MG - by 71.2%, in the CG - by 69.9%; "Walking, running and jumping" in the MG by 78.7%, in the CG - by 75.7%. Such data indicate the presence of unreduced pathological reflexes, which interferes with the correct formation of corrective reactions, significant disturbances of statics and locomotion, which is associated with pathological mechanisms of reciprocal inhibition of antagonist muscles, which complicates coordinated movements.

When measuring goniometry, there were restrictions on movement in the joints of the lower extremities: flexion of the right hip joint in children with MG by 52.5 ° (43.7%), in CG - by 56.5 ° (43.5%), left in children with MG - by 51.9 ° (43.2%), in CG - by 57.1 ° (47.5%); removal of the right hip joint in children with MG by 27 ° (60%), in CG - by 27.5 ° (61.1%), the left - in MG similar to the right, in CG - 27.4 ° (61.3%) ; flexion of the right knee joint in children with MG by 66.1 ° (49%), in CG - by 68 ° (50.7%), left in children with MG - by 65.9 ° (48.4%), in CG - similarly to the right; flexion

of the right ankle joint in children with MG 28 ° (56%), in CG - by 29.9 ° (59.8%), left in children with MG - by 27.6 ° (55.2%), in CG - 29.8 ° (59.6%); removal of the right ankle joint in children with MG by 11.9 ° (59.5%), in CG - 12.2 ° (61%), left in children with MG - by 12 ° (60%), in CG - similarly to the right.

Indicators of increased muscle tone of the triceps are less pronounced (in MG - by 40%, in CG in the right hand - by 32.5%, left - by 35%) than in the quadriceps muscle of the thigh (in MG) - by 67.5%, in CG - by 70%). Such data indicate a violation of the mechanisms of central regulation of muscle tone in patients with cerebral palsy. The recorded indicators of the strength of the triceps in the exhaust were lagging behind in development by 36%, in CG in the right - by 32%, left - by 34%, quadriceps in the exhaust - by 48%, in CG - by 50%. Insufficiency of development of manipulative activity is revealed: capture of a pencil by a brush at children of MG - by 61.2%, at CG - by 57.5%. The trapping test revealed a significant delay in the rapid reaction of the hand in children with MG by 90.8%, in CG - by 89.7%. Such indicators indicate a decrease in muscle strength and the speed of nerve processes.

At the beginning of the experiment, a decrease in the social and emotional state of the children of the contingent was observed in the MG by 40.4%, in the CG - by 39.4%, and the lack of activity of the game activity in the MG by 22.5%, in the CG - by 12.5%, which manifested itself in a decrease in the ability to control their emotions and purposefulness of behavior, inadequacy of the nature of play actions with a toy and inability to take part in the organizational moments of the group.

The results of the conducted studies indicate significant disorders in the development of the motor sphere, social-emotional state and the level of activity of playing activity in 3-5 year old children with spastic cerebral palsy.

Analysis and comparison of the results of the primary examination of children with MG and PG according to the Mann - Whitney test ($p < 0.05$) did not reveal statistically significant differences, which indicates the homogeneity of the composition of the groups and allows further comparison and assessment of the results of the application of hydrokinesis therapy techniques in the physical rehabilitation program.

The results of the final rehabilitation examination.

The dynamics of the indicators of IBMFA is the main criterion for assessing the effectiveness of the developed method of hydrokinesis therapy as a means of gradual formation of motor skills (Table 1). After the course of rehabilitation, children with spastic cerebral palsy showed significant (p

<0.01) changes in the development of general motor skills. Indicators in the MG developed more than in the "lying and turning over" - by 1.9%; "Sitting" - by 3.8%; "Crawling" - by 6.4%; "Standings" - by 14.2%; "Walking, running and jumping" - by 7.2%. The final score of the MG relative to the initial state increased by 16.2 points (12.7%), in the CG - by 10.4 points (7.7%).

Table 1. Dynamics of indicators of assessment of basic motor functions in children with cerebral palsy of spastic form of the main and comparative groups, $x \pm m$

Item s	Main group, n=12			Comparative group, n=12			Norm (point)
	I	II	III	I	II	III	
«A»	40,1±2,1	41,2±2,1 *	43,8±2,1*	40,8±2,1	41,7±2,1*	43,8±2,1*	51
«B»	37,4±2,5	38,3±2,5 *	40,8±2,4 *	39,4±2,5	39,8±2,5	41,5±2,4*	60
«C»	23,5±2,1	25,1±2,1 *	26,8±2,1*	26,0±2,1	26,3±2,1	28,0±2,0*	42
«D»	11,25±2,3	13,2±2,2 *	15,1±2,1*	11,7±2,3	12,25±2,3	14,1±2,2*	39
«E»	15,35±3,0	15,9±3,0 *	17,3±3,0*	17,2±3,0	17,4±3,0	18,15±3,0 *	72
Total point	127,6±2,4	133,8±2,4	143,8±2,3	135,1±2,4	137,4±2,4	145,5±2,3	264

Notes: I - to the rehabilitation course; II - in 6 months; III - after the rehabilitation course; "A" - lying down and turning over; "B" - crawling; "B" - sitting; "G" - standing; "D" - walking, running, jumping; * - $p < 0,01$ according to the initial state.

Indicators of goniometry of the joints of the lower extremities of MG and CG tended to increase, by the end of the rehabilitation course in children MG improved by 3.4° (10% at $p < 0.01$), in CG by -2° (6.4% at $p < 0.01$). The greatest changes occurred in children with MG when performing flexion of the left hip joint, the rate of which after the course of rehabilitation was 75.0 ± 6.2 ($p < 0.01$), i.e. increased by 6.9% according to the initial state, which is with a decrease in muscle tone of the quadriceps femoris.

The use of the developed method of hydrokinesis therapy had an effect on the improvement of muscle strength indicators more in the MG

than in the CG: the triceps muscle of the shoulder in the right hand - by 13.4%, in the left - by 12.9%, and the quadriceps femoris muscle - by 7%. The muscle tone of the upper and lower extremities in patients of this contingent is increased, but due to the properties of water, the indicators relative to the initial state in children with MG decreased more than in the CG: the triceps brachii muscle in the right arm - by 15.8%, in the left - by 16.9%, quadriceps femoris by - 7.9%. The process of function is associated with an increase in the rate of biochemical processes in muscles, an improvement in intersystem coordination and an improvement in the mechanisms of central regulation.

After the course of rehabilitation, a significant improvement in the indicators of the speed of the hand was noted (Fig. 1). The greatest changes occurred in children with MG when applying points with the right hand; the indicator after the rehabilitation course was 3.9 ± 0.9 with $p < 0.01$, that is, increased by 1.8 times. Indicators of CG children began to change only after 4 months of rehabilitation.

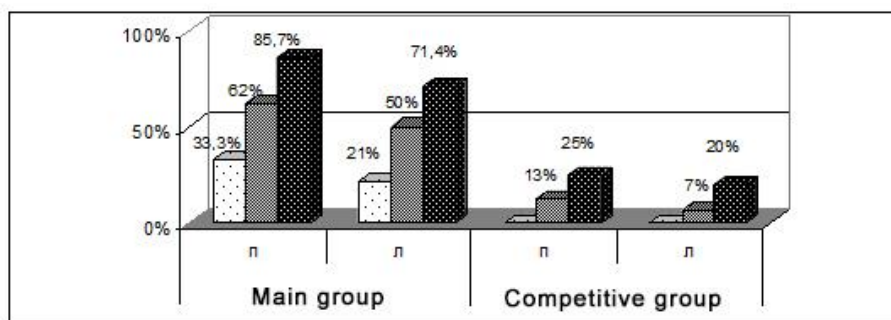


Fig. 1. Changes in the indicators of the speed of reaction of hands during the course of rehabilitation relative to the initial state (%): n - right upper limb; l - left upper limb;
- after 4 months; - after 8 months - after the rehabilitation course

The insignificant receipt of positive results of indicators of manipulative activity in children with cerebral palsy indicates an improvement in nervous processes. Thus, the indicators of gripping a pencil with a brush improved in the MG in the right hand by 0.3 points (18.7%), in the left - by 0.2 (13.3%); in CG the indicators began to increase only after 8 months of rehabilitation and by the end of the rehabilitation course they increased equally in the right and left hands by only 0.1 points (6.2%).

Under the influence of the aquatic environment and thanks to motor games on the water, they were actively used in the classroom according to the developed method of hydrokinesis therapy, there were significant ($p < 0.01$) changes in the indicators of the social-emotional state (Table CG - by 11.7%, and there was also a slight improvement in the activity of play activity in children from MG by 9.6%, in CG - by 5.75%. So, the children of the MG began to better fulfill the requirements of teachers, achieve the goal of the task, regulate their emotions, their play activity improved.

Table 2. Changes in indicators of social-emotional state and activity of play activity in children with spastic cerebral palsy in the main and comparative groups, $x \pm m$

Indicators	Main group, n=12		Comparative group, n=12	
	before the course	after the course	before the course	after the course
Socio-emotional state	15,5±1,9	17,9±1,9*	15,75±1,9	17,6±1,7*
Game activity	6,2±0,8	6,8±0,7	7,0±0,8	7,4±0,6

*Note. * - $p < 0,01$ according to the initial state.*

Thus, the presented research materials show that the developed method of hydrokinesis therapy is effective and contributes to the improvement of the functions of general and fine motor skills, social-emotional state and the level of play activity in 3-5 years old children with spastic cerebral palsy.

Discussion

For the first time, the necessity of the gradual formation of motor skills in children of 3-5 years old with cerebral palsy of the spastic form by the method of hydrokinesis therapy in the program of physical rehabilitation has been scientifically substantiated.

The positive effect of hydrokinesis therapy on the development of motor functions (rolling, sitting, crawling, standing, walking), improving the manipulative activity, social-emotional state and the level of play activity in 3-5 year old children with spastic cerebral palsy has been scientifically proven.

Supplemented with theoretical information on the use of means and methods of physical rehabilitation to reduce muscle tone and prevent the development of joint contractures.

In-depth knowledge of the use of hydrokinesis therapy to overcome tonic muscle reactions in children with spastic cerebral palsy in the chronic residual stage of the disease.

The practical significance of the results obtained is in the development of a card for rehabilitation examination of patients 3-5 years old with cerebral palsy of a spastic form, helps to establish the stage of the formation of motor skills, allows to assess the presence of pathological damage to the joints, the state of muscle tone and muscle strength of the upper and lower extremities, the development of manipulative activity of the hands, as well as the social-emotional state and the level of activity of the game activity. The data obtained make it possible to individualize the approach to physical rehabilitation and determine the effectiveness of the developed methodology.

The results of the study were introduced at Kherson State University in the process of training third-year students in human health in the disciplines "Methods of physical rehabilitation" and "Physical rehabilitation for diseases of the nervous system" cycle of professional and practical training; at the Lviv State University of Physical Culture in the process of training 5th year students majoring in "physical rehabilitation" in the discipline "Physical Rehabilitation in Pediatrics"; in the practice of the Kherson Regional Center for Social Rehabilitation of Disabled Children, Lviv City Rehabilitation Center "Djerelo", Odessa Center for Rehabilitation of Children with Disabilities "Maybutne".

The research results can be used in medical, treatment-and-prophylactic and rehabilitation institutions for physical rehabilitation of patients with spastic cerebral palsy, as well as training, retraining and advanced training of physical rehabilitation specialists in educational institutions.

Practical recommendations for physical rehabilitation specialists on the use of hydrokinesis therapy in work with a certain contingent have been developed.

It was confirmed by the researchers' data that among the causes of disability in the child population in the first rank places are diseases of the nervous system (Vashchenko et al., 2012), among which cerebral palsy has a leading place (Kachan, 2010) and the overwhelming number of patients is observed with spastic forms, namely with spastic diplegia (Martynyuk, & Zinchenko, 2005).

The results of the study confirm (Badalyan et al., 1988; Kozyavkin et al., 1999; Semenova, 2007) that movement disorders in children with cerebral palsy are a kind of deviation of motor development, without appropriate correction affects the formation of neuropsychic functions of the child. Information has been confirmed that the success of the application of physical rehabilitation measures depends on the timing of application, the appropriateness of the selection of funds, the observance of the principles of physical education (Efimenko & Sermeev, 1991) and should be of a complex nature (Voronin, & Trach, 2008). It has been determined that there are no methodological developments in hydrokinesis therapy as a means of gradual formation of motor skills in complex physical rehabilitation of persons with a spastic form aged 3-5 years.

The results of the research supplement information about the features of the pathological development of the nervous system and the musculoskeletal system (Semenova, 2007; Badalyan, Zhurba, & Timonina, 1988; Mastjukova, 1991; Kozyavkin et al., 1999).

The data (Badalyan et al., 1988) on the psychoemotional state of patients of this contingent have been supplemented.

Some information (Zholus, 1980) has been proven about the positive effect of exercise in water on reducing muscle tone, increasing the range of motion in the joints and muscle strength in children with cerebral spastic paralysis.

For the first time scientifically substantiated, developed, tested and proved the effectiveness of the hydrokinesis therapy method in the program of physical rehabilitation of children with spastic cerebral palsy in the chronically residual stage of the disease, based on an individual approach to each child, involves overcoming the identified disorders, taking into account the phased reflex development of general motor skills, manipulative activities, a positive impact on the social-emotional state and activity of play activity of sick children.

We can see prospects for further research in the development of a physical rehabilitation program for children with organic lesions of the central nervous system of various age groups and in the study of the peculiarities of the influence of physical rehabilitation measures on the physical state of the body of children of this contingent.

Conclusions

The analysis of literature sources showed that physical rehabilitation remains the main method of treating infantile cerebral palsy. The available

methods relate mainly to young children with the use of therapeutic exercises and massage, however, the method of hydrokinesis therapy for patients with cerebral palsy in the chronically residual stage of the disease has not been sufficiently developed and processed, while they do not contain systematic rehabilitation examinations, guidelines for the implementation of exercises, allowed to individualize the process of physical rehabilitation.

At the beginning of the study, functional disorders of the musculoskeletal system in children 3-5 years with cerebral palsy of spastic form were delayed development of motor skills ("lying and turning" in the MG - by 21.4%, in the CG - by 20%; "sitting" in the MG - by 37.7%, in the CG - by 34.4%, "crawling" in the MG - by 44.1%, in the CG - by 38.1%, "standing" in the MG - by 71, 2%, in the CG - by 69.9%, "walking, running and jumping" in the MG - by 78.7%, in the CG - by 75.7%), increased muscle tone, decreased mobility of the lower joints limbs, muscle strength and manipulative activity in accordance with age norms. It was found that children with cerebral palsy of spastic form lag behind their peers in social and emotional development in the MG by 40.4%, in the CG - by 39.4% and in play activities in the MG - by 22.5%, in the CG - by 12.5%.

The developed method of hydrokinesis therapy provided for the formation of the gradual development of motor skills in children with spastic cerebral palsy in the physical rehabilitation program, which consisted of stages in accordance with the reflex development of the motor skills of a healthy child. The methodology was built taking into account the results of a preliminary examination, it contained a combination of special exercises for relaxation and stretching of muscles, an increase in joint mobility, strength and speed-strength exercises, exercises for balance and coordination of movements, breathing exercises using various initial positions, using inflatable circles, swimming boards, gymnastic sticks, rings, rubber ball ropes and toys. Classes were held in a playful way.

The results of the IBMFA showed that the final score, according to the initial state, in the MG increased by 16.2 points (12.7%), and in the CG - by 10.4 points (7.7%). The greatest changes took place in the MG children in the development of the "standing" skill, that is, the indicator after the rehabilitation course increased by 3.8 points (34.2% $p < 0.01$). The motor skills of the MG children developed better than the skills of the PG children, by 5% in accordance with the initial state and approached the norm by 2.3% more observed in the performance of the skills of rolling over, sitting, crawling, standing and walking.

The indices of the range of motion in the joints of the lower extremities in children with MG, according to the initial state, improved on

average by 3.4° (10%), and in CG - by 2° (6.4%). The greatest changes occurred in children with MG when performing flexion of the left hip joint, the index of which after the rehabilitation course was 75.0 ± 6.2 ($p < 0.01$), that is, increased by 6.9% in accordance with the initial state, which is associated with a decrease in the muscle tone of the quadriceps muscle of the thigh.

The level of muscle spasticity, due to the properties of water and exercise, tended to decrease. After the course of rehabilitation, the indicators of the triceps brachii muscle and quadriceps femoris muscle, in accordance with the initial state, decreased in the MG by 22.2%, and in the CG in the right arm - by 15.4%, in the left arm, lower limbs - by 14.3%.

The results of the final testing of muscle strength in children with cerebral palsy in MG showed that the strength of the triceps brachii muscle and quadriceps femoris muscle during the experiment changed towards improvement. Muscle strength indicators increased: in the exhaust gas in the right hand - by 28.1%, in the left - by 25%, in the lower limbs - by 23%; in the CG in the right hand - by 14.7%, in the left - by 12.1%, in the lower limbs - by 16%.

Hand response rates tended to improve more than pencil grip rates. Thus, the frequency of drawing dots increased maximally in children with MG in the right hand - by 85.7% (3.9 ± 0.9 with $p < 0.01$), that is, the indicator approached the norm by 11.3%. CG indicators began to increase only after eight months of rehabilitation.

Under the influence of the aquatic environment and thanks to motor games on the water, they were actively used in the classroom according to the developed method of hydrokinesis therapy, there were positive changes in the indicators of social and emotional state in the MG by 15.5%, in the CG - 11.7%. There was an improvement in the indices of activity of gaming activity in the MG by 9.7%, in the CG - by 5.75%.

The developed method of hydrokinesis therapy as a means of gradual formation of motor skills is effective and can be recommended for use in medical and preventive institutions involved in the rehabilitation of patients with this nosological group.

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