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IMPROVING THE LOWER LIMBS' FUNCTION IN SPASTIC DIPLEGIA IN PRESCHOOL CHILDREN BY MEANS OF PHYSICAL REHABILITATION

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Annotation. At present, there are many methods of using physical rehabilitation means for patients with cerebral palsy, but the reliable effectiveness of many of them has not been confirmed. The complex use of means and forms of physical rehabilitation will increase mobility in the joints of the lower limbs, reduce their spasticity and improve the balance function in children with cerebral palsy. The aim of the work is to improve the function of the lower limbs, balance and reduce muscle spasticity in preschool children with cerebral palsy. As a result, the range of motion in all joints of the lower limbs increased, spasticity reduced and the balance function improved, which indicates their effectiveness in preschool children with spastic diplegia. Efficiency is confirmed by the positive dynamics of indicators of goniometry of the hip, knee and ankle joints, muscle spasticity of the lower limbs and balance function.

Keywords: cerebral palsy, physical rehabilitation, hydrokinesiotherapy, therapeutic gymnastics, mechanotherapy, massage, cycling, skiing.

Introduction. Cerebral palsy (CP) makes a group of neurological disorders that lead to disorders of motor activity, spatial body positions, as well as to contracture development. These disorders may occur as a result of developmental delay or brain damage in the early ontogeny [1]. High CP incidence among children lead to the point that this disease takes the first place among the reasons leading to disability [2].

Therapeutic gymnastics (TG) is the main way of physical rehabilitation of children with CP. It is necessary to commence TG classes as early as possible to prevent irreversible consequences such as contractures, deformities of the upper and lower limbs, disturbed balance and coordination functions, occurrence of improper motor stereotypes. Inclusion of the Gross training device, hydrokinesiotherapy, therapeutic massage, cycling and skiing has a positive effect on physical state of children with CP [3].

Currently, there is a lot of physical rehabilitation methods for CP patients, but many of them were not proven as reliably effective. There is an assumption that a comprehensive application of such methods will contribute to the increase of mobility in the joints of the lower limbs, reduction of spasticity and improvement of balance function in children with CP.

The study's objective – to improve the lower limbs' function, balance and reduce muscle spasticity in preschool children with spastic CP.

Methods and organization. The study took place in the "Three sisters" rehabilitation center located in the Moscow region for 4 months from September to December 2022. Inclusion criteria: age – children aged 4-6 years; diagnosis – cerebral palsy with spastic diplegia, period – residual. The study included 6 preschool children, 3 boys and 3 girls. Functional characteristics of the lower limbs, in particular – mobility in the hip, knee, ankle joints – were identified with the goniometry method in the following initial positions – lying on the back and lying on the stomach. The muscle spasticity indices were identified with the Modified Ashworth Scale (MAS). The balance function was assessed with the Berg scale.

Math-and-stats methods were used to process the obtained results: we identified mean values of the indices and standard deviation. The significance level of differences for parametric indices was calculated with the Student's t-test ($p \geq 0.05$), for non-parametric indices – the Wilcoxon signed-rank test ($p \leq 0.05$).

Results and discussion. The comparative analysis of the goniometry indices of the lower limb's joints before and after the course

demonstrate a significant improvement of the studied indices (table).

Table

Comparative results of the goniometry indices in the hip, knee and ankle joints (°) in children with cerebral palsy

Goniometry, °	Groups		Difference		P≤
	Before rehabilitation (n=6)	After rehabilitation (n=6)			
	M±G	M±G	abs.u.	%	
Hip joint flexion	119.2±1.3	122.5±1.8	3.3	2.77	0.05
Hip joint extension	9.5±0.5	12.4±0.7	2.9	30.5	0.05
Hip joint adduction	19.9±1.8	22.9±1.8	3.0	15.08	0.05
Hip joint abduction	29.7±1.2	31.5±1.4	1.8	6.06	0.05
Hip joint external rotation	39.5±1.1	42.2±1.4	2.7	6.84	0.05
Hip joint internal rotation	29.8±2.5	33.9±2.5	4.1	13.8	0.05
Knee joint flexion	119.55±2.1	122.88±1.9	3.33	2.8	0.05
Ankle joint dorsiflexion	19.8±1.6	23.3±1.5	3.5	17.68	0.05
Ankle joint plantar flexion	33.5±0.7	42.5±1.0	9.0	26.87	0.05

The main tasks of physical rehabilitation of preschool children with CP were: development and improvement of proper motor skills, mobility in the limbs' joints, improvement of the balance indices and reduction of muscle spasticity in the lower limbs.

The course of physical rehabilitation measures with therapeutic gymnastics, mechanotherapy, hydrokinesiotherapy, therapeutic massage, cycling and skiing was divided into 3 periods of 4 months: introductory (1 month), main (2 months) and final (1 month), directed towards solving the tasks described above. The first period included adaptation of a child's body to physical loads, learning proper motor skills and motor stereotypies. The main period consisted of an active work with means and methods of physical rehabilitation to solve the set tasks. In the final period, the results were consolidated and improved.

The physical rehabilitation measures were aimed towards enhancing mobility of the lower limbs' joints, developing coordinated motor

movements, improving balance, correcting accompanying disorders and deformities of the musculoskeletal system (incorrect position of the feet, posture disorders, scoliosis, hip dysplasia, etc.), overall strengthening, improving health and adaptation to increasing loads.

All these goals were achieved by adding calisthenic exercises (CE) (20% of total volume of physical exercise (TVPE)) for medium and large muscle groups, breathing exercises (BE) (10% of TVPE), special exercises (SE) (70% of TVPE): exercises for improving mobility in the joints and preventing contractures, resistance exercises (with an instructor and various equipment), exercises to learn how to kneel, walk on the knees, elements of a step and physiological walk skills without an additional support. All the exercises were performed slowly, actively and passively with the help and under control of an instructor. The children were learning to independently perform exercises for home sessions with their parents. The "RIFTON" bicycle that fixates body and limbs

in a correct position was used for cycling. Riding on that bicycle contributed to an increase of muscle strength, being a training for the vestibular system and for the development of spatial awareness, correct posture support, increasing mobility and flexibility. SE were used to learn following skills: an ability to get on and off the bike, performing alternate pedaling, riding on the bike independently. After cycling, relaxing and stretching exercises were applied. Therapeutic massage was included in the course, during all periods, performed daily for 15-20 minutes, 15 to 30 procedures in total. Before gymnastics and cycling, segmental and full-body massage was applied, after – linear and point massage. The therapeutic leg massage was done slowly, deeply, with emphasis on the calf muscles, calf flexors, with deeper work of tendons and places of their attachment to bones, alternating with passive, stretching spastic muscles, movements in the hip, knee and ankle joints. Toning massage was also done for the antagonists of spastic muscles. The stressed muscles relaxed more easily when the antagonist muscles were stressed. During the main period, the therapeutic gymnastics sessions also included SE on the “BOSU” ball for improving balance, for developing endurance, strength exercises for enhancing the lower limb muscles and fixing the feet support function. Exercises on the Gross training device: CE – exercises with a stick, a ball; BE – dynamic exercises; SE – for learning and reinforcing following skills: walking on a rehab ramp (including walking down backwards); walking through obstacles; walking up and downstairs; walking on an uneven surface while preserving balance. The pool classes were conducted with an instructor and included exercises for all muscle groups, special exercises for learning how to move in water, relaxing exercises, exercises for improving joint mobility, imitating swimming movements that contributed to increase muscle strength of the lower limbs and reduced load on the joints. The following exercises were added in walking sessions: walking forward, backwards, sideways, cross-step, sidestep, high knee walks. The water level was slightly above the knee. Special exercises: strength exercises for the lower limbs' muscles; resistance exercises

for the lower limbs; “swimming under a pool float” exercises, with movement on the bottom of the pool. In order to perform such exercises, the water level was waist-high or chest-high. Elements of outdoor games were also added. The classes were held once a week, for 45-50 minutes, 10-15 exercises. The water temperature in the pool was 32-33 °C. The last period included skiing slowly with the instructor, with air temperature not lower than -10 °C, twice a week, 500 meters. The children were taught how to stand and walk on skis, proper technique of performing alternating movements with arms and legs, independent skiing. The relaxing exercises took place after skiing.

Before the course, the average index of balance according to the Berg scale scored 30.3 ± 4.03 points, which reflects an average risk of falling, and after the course this index has improved by 29.4% and scored 39.2 ± 4.96 points, which corresponds to a lower risk of falling and enhanced orthostatic stability.

According to the Ashworth scale, the average index of muscle spasticity scored 2.16 ± 0.75 points before the course, which indicates a pronounced increase in muscle tone. After the course the index reduced by 46.3% and scored 1.16 ± 0.75 points, which shows decreased spasticity in the lower limbs.

Conclusion. As a result of applying physical rehabilitation measures, the movement amplitude has increased in all joints of the lower limbs, spasticity has reduced and balance has improved, which demonstrated their effectiveness among preschool children with spastic diplegia.

The hip joint goniometry indices have improved: flexion – by 2.77%, from 119.2 to 122.5°; extension – by 30.5%, from 9.5 to 12.4°; adduction – by 15.08%, from 19.9 to 22.9°; abduction – by 6.06%, from 29.7 to 31.5°; external rotation – by 6.84%, from 39.5 to 42.2°; internal rotation – by 13.8%, from 29.8 to 33.9°. The knee joint goniometry has improved as well: flexion – by 2.8%, from 119.55 to 122.88°. The ankle joint goniometry has changed: dorsiflexion – by 17.68%, from 19.8 to 23.3°; plantar flexion – by 26.87%, from 33.5 to 42.5°. The muscle spasticity indices, according to the Modified Ashworth Scale, have

improved by 46.3%, from 2.16 to 1.16 points. The balance indices have improved as well according to the Berg scale by 29.4%, from 30.3 to 39.2 points.

Conflict of interest. The authors declare no conflict of interest.

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