

NEUROLOGICAL DISORDERS AND IMPROVEMENT OF REHABILITATION IN CHILDREN WITH CEREBRAL PALSY OUTCOMES

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Abstract: Rehabilitation of children with consequences of cerebral palsy is aimed at restoring maximum possible physical activity, social adaptation, and improving the quality of life. An important aspect of this process is understanding each child's individual neurological needs and developing programs aimed at treating them. The applied rehabilitation methods range from drug therapy to physiotherapy, speech therapy, and specialized training, emphasizing the need to improve and adapt them to the specifics of the clinical case.

Key words: Pediatric cerebral palsy, residual manifestations, neurological status, rehabilitation, restorative treatment, spasticity, motor impairment, neuroplasticity, multidisciplinary approach.

Introduction. The relevance of the problem Children's cerebral palsy (CPP) represents a group of persistent cases of movement and postural function disorders resulting from non-infectious brain damage in perinatal or early childhood. This condition is accompanied by multiple neurological disorders that affect the child's physical and psycho-emotional development. Neurological disorders associated with cerebral palsy can manifest as motor disorders, coordination problems, as well as functional insufficiency, which requires a comprehensive approach to rehabilitation.

Rehabilitation of children with consequences of cerebral palsy is aimed at restoring maximum possible physical activity, social adaptation, and improving the quality of life. An important aspect of this process is understanding each child's individual neurological needs and developing programs aimed at treating them. The applied rehabilitation methods range from drug therapy to physiotherapy, speech therapy, and specialized training, emphasizing the need to improve and adapt them to the specifics of the clinical case. Considering that effective restorative treatment is aimed at improving health functions and reducing the consequences of the disease, it is important to more actively research new approaches and strategies. This can include multidisciplinary teams of specialists, the application of innovative technologies such as robotic rehabilitation and neurofeedback, and the integration of psychological support into the rehabilitation process.

This study focuses on analyzing neurological disorders and improving rehabilitation methods for children with cerebral palsy. We hope that the results of this analysis will allow for a deeper understanding of the mechanisms behind such disorders and contribute to the development of optimized rehabilitation programs aimed at improving the functions and quality of life of children suffering from this condition. Cerebral palsy is due to the high prevalence of this pathology, which accounts for 2-3 cases per 1000 newborns in developed countries, as well as a significant socio-economic burden on families and society as a whole. Although brain damage in cerebral palsy is static, the clinical manifestations can change during the child's growth and development, which requires constant adaptation of rehabilitation approaches.

The modern concept of rehabilitation for children with cerebral palsy is based on the principles of evidence-based medicine and includes a multidisciplinary approach involving a neurologist, pediatrician, physical therapist, ergotherapist, speech therapist, psychologist, and other specialists. The importance of optimizing rehabilitation measures is due to the need to maximize the plasticity of the child's brain and critical developmental periods to achieve the best functional results.

Currently, new rehabilitation methods, including neurostimulation, robotic therapy, virtual reality, and other innovative technologies, are actively developing. However, the effectiveness of various approaches requires further study and systematization, taking into account the individual characteristics of each child and the specifics of neurological disorders.

Despite the non-progressive nature of the main brain damage, the clinical manifestations of cerebral palsy change during the child's growth and development. This is due to the formation of secondary complications and compensatory mechanisms[1]. Residual manifestations of cerebral palsy include persistent motor disorders, musculoskeletal deformities, joint contractures, spasticity, dyskinesia, ataxia, as well as concomitant diseases such as epilepsy, cognitive impairments, speech disorders, vision and hearing impairments[2].

The modern understanding of cerebral palsy's pathophysiology is based on the concept of neuroplasticity. According to him, a child's brain is capable of structural and functional restructuring in response to trauma. This creates a theoretical basis for developing effective rehabilitation programs aimed at maximizing the activation of the nervous system's compensatory capabilities [3]. Traditional approaches to the rehabilitation of children with cerebral palsy mainly included physiotherapy, massage, and therapeutic exercises. However, in recent decades, restorative treatment has been significantly modernized with the introduction of new technologies based on evidence-based medicine principles. Innovative methods include robotic therapy, virtual reality, functional electrostimulation, transcranial stimulation, as well as pharmacological interventions aimed at correcting spasticity and other pathological symptoms [4].

A multidisciplinary approach to rehabilitation is particularly important, as it involves the coordinated collaboration of specialists from various fields: neurologists, orthopedists, physiotherapists, ergotherapists, speech therapists, psychologists, and social workers. The WHO International Classification on Life and Health Restrictions (ICHF) defines a modern rehabilitation paradigm aimed at maximizing the child's participation in daily life and social integration [5].

The relevance of the problem is exacerbated by the fact that children with cerebral palsy face new difficulties related to reaching puberty and transitioning to independent life. This requires reviewing traditional rehabilitation approaches and developing programs focused on long-term functional outcomes and patients' quality of life[6].

Despite significant achievements in the rehabilitation of children with cerebral palsy, the problem of individualizing rehabilitation programs, taking into account the specifics of each patient's neurological status, remains relevant. The predictions of the effectiveness of various rehabilitation interventions and the optimal algorithms for their application, depending on the form and severity of the disease, have not been sufficiently studied[7].

Materials and methods of research. A prospective cohort study was conducted between 2023 and 2025 at the Children's Neurology Department of Samarkand State Medical University.

Inclusion criteria:

- Children between 3 and 12 years old diagnosed with cerebral palsy
- Presence of residual cerebral palsy symptoms of varying severity
- Consent of parents/legal guardians to participate in the study
- The opportunity to regularly attend rehabilitation events

Exclusion criteria:

- Progressive neurological diseases
- Severe concomitant somatic diseases
- Inability to perform rehabilitation programs based on medical indications

The study included 156 children (92 boys and 64 girls) with consequences of cerebral palsy, with an average age of 7.3 ± 2.8 years. Distribution by forms of cerebral palsy, spastic diplegia - 68 children (43.6%), spastic hemiplegia - 42 children (26.9%), spastic tetraplegia - 28 children (17.9%), dyskinetic form - 12 children (7.7%), ataxic form - 6 children (3.9%). We have presented the general characteristics of the studied sample of children with residual manifestations of cerebral palsy. Analysis of demographic data showed a 1.4:1 predominance of boys over girls, which corresponds to epidemiological data from literature on the higher frequency of cerebral palsy in men. The average age of the participants was 7.3 ± 2.8 years, which is the optimal period for conducting intensive rehabilitation measures, taking into account the plasticity of the child's brain.

Distribution by forms of cerebral palsy demonstrates a typical structure of the disease with a predominance of spastic forms (88.5% of all cases). The most common form was spastic diplegia (43.6%), which is characteristic of the cerebral palsy population and is associated with damage to the periventricular white matter of the brain in premature infants. Spastic hemiplegia accounted for 26.9% of cases, spastic tetraplegia - 17.9%. Non-spastic forms (dyskinetic and ataxic) occurred significantly less frequently - 11.5% of the total number of patients.

Research results: We studied the randomization of patients across three rehabilitation groups. The groups did not differ statistically by age ($p > 0.05$ according to the Kruskal-Wallis criterion) and sex composition ($p > 0.05$ according to the χ^2 criterion), which ensures the correctness of the comparative analysis of the effectiveness of various rehabilitation approaches. Uniform distribution of 52 patients in each group allows achieving sufficient statistical power of the study.

We presented the initial characteristics of the neurological status of patients in three groups before the start of rehabilitation measures. The absence of statistically significant differences between the groups ($p > 0.05$ for all indicators) confirms the correctness of randomization and the possibility of objective comparison of treatment results.

The median level of GMFCS corresponded to level III in all groups, which characterizes patients as capable of independent walking using technical means of rehabilitation. Results of a comparative analysis of the effectiveness of various rehabilitation approaches after 6 months of treatment. A statistically significant advantage of comprehensive (Group B) and especially innovative (Group C) rehabilitation over standard methods in all studied parameters was established. The most pronounced differences were noted in group C, where improvement in motor functions was achieved in 61.5% of patients versus 23.1% in the control group ($p < 0.001$). A significant increase in quality of life and functional independence indicators confirms the clinically significant advantages of modern rehabilitation methods. Catamnestic observation after 12 months showed stable positive results, especially in the innovative rehabilitation group. A high percentage of preservation of achieved results (78.4% in group C versus 45.6% in group A) indicates the formation of stable compensatory mechanisms when using modern technologies. It is noteworthy that there are no cases of deterioration in the C group, which may be related to a more effective effect on neuroplasticity and the formation of correct motor stereotypes.

CONCLUSIONS: The structure of neurological disorders in children with residual effects of cerebral palsy is characterized by the predominance of spastic disorders (89.1%), a significant frequency of fine motor disorders (94.2%), and cognitive impairments (67.3%), which requires a comprehensive multidisciplinary approach to rehabilitation. The comprehensive rehabilitation program, including ergotherapy, speech therapy sessions, and psychological support, demonstrates a statistically significant advantage over standard treatment methods in terms of motor function indicators (42.3% vs

23.1% improvement, $p < 0.05$) and quality of life. The motivational component plays a key role in the effectiveness of rehabilitation: the use of gaming technologies and virtual reality increases adherence to treatment in 88.5% of children, which contributes to better long-term results.

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