American Journal of Medicine and Medical Sciences 2025, 15(11): 3948-3951
DOI: 10.5923/j.ajmms.20251511.43

Neurological Status and Modern Recovery Treatment Methods for Children with Residual Forms of Cerebral Paralysis

Ergasheva Maftuna Ozodovna[1], Abdullaeva Nargiza Nurmamatovna[2], Ergashev Sukhrob Saidovich[3]

[1]Samarkand State Medical University, Samarkand, Uzbekistan
[2]Doctor of Medical Sciences, Professor, Samarkand State Medical University, Samarkand, Uzbekistan
[3]Doctor of Medical Sciences, Samarkand State Medical University, Samarkand, Uzbekistan

Abstract Cerebral palsy (CCP) is a group of persistent disorders in the development of movement and posture, caused by non-progressive damage to the developing brain during the perinatal period. According to the European Register of Childhood Cerebral Palsy (SCPE), cerebral palsy is the most common cause of physical impairment in childhood, occurring with a frequency of 2-3 cases per 1000 live births. Despite the non-progressive nature of the main brain damage, the clinical manifestations of cerebral palsy undergo significant changes as the child grows and develops. Residual forms of cerebral palsy are characterized by the stabilization of neurological symptoms with the formation of persistent motor, postural, speech, and cognitive impairments of varying severity. These disorders significantly limit children's functional capabilities, affect their social adaptation and quality of life.

Keywords Pediatric cerebral palsy, Residual manifestations, Neurological status, Rehabilitation, Restorative treatment, Spasticity, Motor disorders, Neuroplasticity, Multidisciplinary approach

1. Introduction

The modern concept of cerebral palsy considers this condition not as a static lesion, but as a dynamically developing pathology, in which primary brain damage leads to a cascade of secondary disorders, including muscle contractures, skeletal deformities, and dysfunction of internal organs. Understanding these pathophysiological mechanisms is the basis for developing effective rehabilitation strategies [1]. The neurological status of children with residual forms of cerebral palsy is characterized by the polymorphism of clinical manifestations, which is due to the different localization, prevalence, and time of cerebral damage. The leading neurological syndromes are spasticity, dystonia, and ataxia, which can occur both in isolation and in various combinations. These motor disorders are often accompanied by epilepsy, cognitive impairments, visual, auditory, speech, and swallowing impairments. Spasticity, observed in 70-80% of children with cerebral palsy, represents a rate-dependent increase in muscle tone due to the hypersensitivity of the stretching reflex. Dystonic forms, accounting for 10-15% of cases, are characterized by involuntary muscle contractions resulting in repeated movements or abnormal postures. Atxic forms (5-10%) manifest as a disruption of movement coordination and balance [2]. The modern classification of functional disorders in cerebral palsy is based on the use of standardized scales: Greater Motor Function Classification Systems (GMFCS), Hand Function Classification Systems (MACS), Functional Communication Classification Systems (CFCS). These tools allow for an objective assessment of the degree of functional limitations and predict the child's development [3]. Restorative therapy for children with cerebral palsy has undergone significant evolution from traditional physiotherapy methods to comprehensive multidisciplinary programs based on evidence-based medicine principles. The modern approach to rehabilitation is based on the concept of neuroplasticity - the ability of the nervous system to undergo structural and functional changes in response to experience and learning. A revolutionary direction in the rehabilitation of cerebral palsy was the introduction of robotic technologies, including exoskeletons, robotic walking simulators, and systems with biological feedback. These technologies allow for high-intensity, repetitive, and precisely controlled training, which is a key factor in neuroplastic changes [4]. Virtual reality and game technologies open up new opportunities to motivate children to actively participate in the rehabilitation process. Virtual reality systems allow for the creation of a safe controlled environment for practicing motor skills that are not available in real settings due to disease-related limitations [5].

Received: Oct. 7, 2025; Accepted: Nov. 5, 2025; Published: Nov. 14, 2025
Published online at http://journal.sapub.org/ajmms

Functional electrostimulation (FES) methods have received significant development, which allow activating paralyzed or weakened muscles, improving muscle strength, endurance, and movement coordination. Modern FES systems are integrated with motion sensors and provide physiological patterns of muscle activity.

Pharmacological interventions for cerebral palsy are primarily aimed at correcting spasticity and dystonia. Modern approaches include systemic use of muscle relaxants, local administration of A-type botulinum toxin, intrathecal therapy with baclofen. The choice of method depends on the localization and prevalence of motor impairments. Surgical methods of treating cerebral palsy include orthopedic interventions to correct contractures and deformities, as well as neurosurgical operations - selective dorsal rhizotomy, deep brain stimulation [6]. These methods are used when conservative treatment is ineffective and require careful patient selection. The most important principle of modern rehabilitation of children with cerebral palsy is a family-centered approach, which involves the active involvement of parents and relatives in the rehabilitation process. Teaching the family the methods of care, positioning, and conducting homework significantly increases the effectiveness of treatment. The multidisciplinary approach to rehabilitation involves the coordinated work of a team of specialists: neurologists, physiotherapists, ergotherapists, speech therapists, psychologists, social workers. This approach ensures a comprehensive impact on all aspects of a child's functioning with cerebral palsy. Assessing the effectiveness of rehabilitation programs requires the use of validated tools, including assessment of motor functions, functional independence, quality of life, and social participation. Long-term observation of treatment results is of great importance [7]. A personalized approach to rehabilitation involves developing individual programs that take into account the specific needs, capabilities, and goals of each child. Modern technologies, including artificial intelligence and machine learning, open up prospects for creating adaptive rehabilitation programs.

Despite significant progress in understanding the pathophysiology of cerebral palsy and the development of rehabilitation technologies, many questions remain open. Further research is needed to determine the optimal training parameters, identify predictors of the effectiveness of various treatment methods, and develop new technological solutions. The relevance of the problem is exacerbated by the increasing number of children with cerebral palsy due to improved care for premature babies and children with critical conditions in the perinatal period. This requires the development of effective and accessible rehabilitation technologies capable of ensuring maximum possible functional independence and quality of life for children with cerebral palsy. Cerebral palsy (CCP) is a group of persistent movement and posture developmental disorders that cause activity limitations associated with non-progressive damage to the developing brain of the fetus or infant. According to international epidemiological studies, the prevalence of cerebral palsy is 2.0-3.5 cases per 1000 live births, while there is a trend towards an increase in morbidity due to an increase in the survival rate of premature babies with extremely low body weight.

Despite the non-progressive nature of the main brain damage, the clinical manifestations of cerebral palsy change during the child's growth and development, which 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 disorders in the form of epilepsy, cognitive impairments, speech disorders, and visual and auditory impairments [2].

The modern understanding of cerebral palsy's pathophysiology is based on the concept of neuroplasticity, according to which a child's brain has the ability to undergo structural and functional reorganization in response to damage. 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 primarily included physical therapy, massage, and therapeutic exercise. However, in recent decades, there has been a significant modernization of restorative treatment 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, which involves the coordinated interaction of specialists of various profiles: neurologists, orthopedists, physical therapists, ergotherapists, speech therapists, psychologists, and social workers, is of particular importance. The WHO International Classification of Functioning, Life Limitations and Health (ICF) 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 reach maturity and face new challenges related to 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 progress in the rehabilitation of children with cerebral palsy, the problem of individualizing rehabilitation programs, taking into account the specific features of each patient's neurological status, remains relevant. Predictors of the effectiveness of various rehabilitation interventions and optimal algorithms for their application, depending on the form and severity of the disease, have not been sufficiently studied [7].

Purpose of the study: to study the features of the neurological status of children with residual manifestations of cerebral palsy and to develop modernized approaches to restorative treatment based on personalized assessment of functional disorders.

2. Materials and Methods of Research

A prospective comparative study was conducted with elements of a randomized controlled clinical trial based on the pediatric neurology department and the rehabilitation center of Samarkand State Medical University for the period from 2023 to 2025.

Inclusion criteria: children aged 3 to 16 with established cerebral palsy diagnosis (according to SCPE criteria - Surveillance of Cerebral Palsy in Europe), with residual motor impairments, written informed consent of parents/ legal guardians to participate in the study.

Exclusion criteria: progressive neurodegenerative diseases, severe somatic diseases in the decompensation stage, epilepsy with frequent attacks (more than 1 time a week), pronounced cognitive impairments (IQ < 50), refusal to participate in the study.

The study included 180 children with residual manifestations of cerebral palsy. The average age was 8.4 ± 3.2 years. By gender: boys - 98 (54.4%), girls - 82 (45.6%). By forms of cerebral palsy: spastic diplegia - 68 children (37.8%), spastic hemiplegia - 52 (28.9%), spastic tetraplegia - 34 (18.9%), dyskinetic form - 18 (10.0%), ataxic form - 8 (4.4%). By the level of functional activity according to GMFCS (Gross Motor Function Classification System): I level - 45 children (25.0%), II level - 63 (35.0%), III level - 38 (21.1%), IV level - 24 (13.3%), V level - 10 (5.6%).

Examination methods:

1. Clinical and neurological examination included assessment of motor functions, muscle tone (Ashworth scale), reflexes, coordination, and sensitivity.
2. Functional diagnostics:
   - System of classification of major motor functions (GMFCS)
   - Manual Ability Classification System (MACS)
   - Functional Classification System of Communicative Abilities (CFCS)
   - Pediatric Disability Assessment Scale (PEDI)
3. Instrumental methods:
   - Brain MRI with assessment of structural changes
   - Electroneuromyography for assessing the functional state of the peripheral neuromotor apparatus
   - Stabilometry for the analysis of postural disorders
   - Computer podometry for evaluating walking parameters
4. Neuropsychological testing: a battery of cognitive function tests adapted for children with cerebral palsy.

Methods of rehabilitation. Patients were randomized into two groups:

- Main group (n=90): received a modernized rehabilitation program, including robotic therapy (Lokomat, Armeo), virtual reality, functional electrostimulation, and botulinum therapy according to indications.
- Control group (n=90): received a standard rehabilitation program (therapeutic exercises, massage, physiotherapy, mechanical therapy).

The duration of the rehabilitation course was 4 weeks, and the effectiveness assessment was conducted 1, 3, and 6 months after the completion of the course.

Statistical processing was performed using the SPSS 26.0 program. Descriptive statistics methods, Student's t-test for related and independent samples, $\chi 2$ criterion, Pearson and Spearman correlation analysis were used. Differences were considered statistically significant at $p < 0.05$.

3. Results

In all examined children, neurological disorders of varying severity characteristic of cerebral palsy were identified. Various localized spasticities were observed in 156 children (86.7%), with 89 (49.4%) patients showing pronounced spasticity (3-4 points on the Eshworth scale). Joint contractures were diagnosed in 124 children (68.9%), and foot deformities in 98 (54.4%). Pseudobulbar disorders of varying severity were identified in 67 children (37.2%). According to the GMFCS scale, the distribution was as follows: the ability to walk independently without restrictions (I-II level) was observed in 108 children (60.0%), with restrictions (III level) - 38 (21.1%), using wheelchairs (IV-V level) - 34 (18.9%). Significant limitations in manual functions (III-V levels according to MACS) were observed in 78 children (43.3%). Cognitive impairments of varying severity were identified in 134 children (74.4%). Mild cognitive impairment was diagnosed in 89 children (49.4%), moderate in 32 (17.8%), and pronounced in 13 (7.2%). According to MRI data, periventricular leukomalacia was detected in 67 children (37.2%), cortical-subcortical atrophy - in 45 (25.0%), and brain developmental defects - in 23 (12.8%). Electroneuromyographic signs of pyramidal tract damage were found in 142 children (78.9%). In the main group, a statistically significant improvement in indicators was noted compared to the control group:

1. Motor functions (GMFM-88):
   - Main group: initially 65.4 ± 18.7 points, after 6 months 74.8 ±19.2 points ($p < 0.001$)
   - Control group: initially 64.9 ± 19.1 points, after 6 months 68.2 ±19.4 points ($p < 0.05$)
   - Intergroup differences: $p < 0.01$
2. Spasticity (Ashworth scale):
   - In the main group, the average decrease was 1.2 ±0.4 points.
   - In the control group - 0.6 ±0.3 points ($p < 0.001$)
3. Functional independence (FDI):
   - The main group showed an improvement of 12.8 ± 4.6 points.
   - Control group - by 6.4 ±3.2 points ($p < 0.001$)

The most significant predictors of a positive response to rehabilitation were: age less than 10 years (OR=2.34, $p < 0.01$), I-III levels according to GMFCS (OR=3.17, $p < 0.001$), absence of pronounced cognitive impairments (OR=2.89, $p < 0.01$), spastic form of cerebral palsy (OR=1.87, $p < 0.05$). In both groups, the rehabilitation interventions were well-tolerated. In the main group, 3 cases (3.3%) of transient spasticity increase were noted, in the control group - 1 case (1.1%) of pain syndrome exacerbation.

4. Conclusions

Thus, the neurological status of children with residual manifestations of cerebral palsy is characterized by the polymorphism of clinical manifestations: spasticity is detected in 86.7% of patients, joint contractures - in 68.9%, cognitive impairments of varying degrees - in 74.4% of children. The severity of functional limitations correlates with the form of the disease and the degree of structural changes in the brain. The modernized rehabilitation program, which includes robotic therapy, virtual reality, and functional electrostimulation, demonstrates a statistically significant advantage over standard methods in improving motor functions ($p < 0.01$), reducing spasticity ($p < 0.001$), and increasing functional independence ($p < 0.001$). The most effective predictors of a positive response to rehabilitation are: age less than 10 years, functional level I-III according to GMFCS, absence of pronounced cognitive impairments, and spastic form of cerebral palsy, which allows for a personalized approach to choosing rehabilitation interventions. Comprehensive functional diagnostics using international classification systems (GMFCS, MACS, CFCS) provides an objective assessment of the initial state and recovery dynamics, which is the basis for developing individualized rehabilitation programs. A multidisciplinary approach using innovative rehabilitation technologies is a pathogenetically justified and clinically effective method of restorative treatment for children with residual manifestations of cerebral palsy, allowing for maximum activation of the nervous system's compensatory mechanisms and improvement of patients' quality of life. The implementation of modernized rehabilitation programs requires appropriate technical equipment of medical institutions and training of specialists, which justifies the need to develop specialized rehabilitation centers and improve the postgraduate education system in the field of pediatric rehabilitation.

REFERENCES

[1] Batysheva T.T., Bykova O.V., Vinogradov A.V. Modern technologies for the rehabilitation of children with cerebral palsy // Questions of Modern Pediatrics. - 2021. - Vol. 20, No. 4. - P. 285-291.

[2] Vlasenko S.V., Karkashadze G.A., Konovalov A.N. Robotic therapy in the rehabilitation of children with cerebral palsy: a systematic review and meta-analysis // Nervous Diseases. - 2022. - No. - P. 34-42.

[3] Lilin E.T., Doskin V.A., Kurbatova O.L. Medical and genetic aspects of cerebral palsy in children // Russian Pediatric Journal. - 2023. - Vol. 26, No. 2. - P. 112-118.

[4] Mamedyarov A.M., Badalyan O.L., Zavadenko N.N. Spasticity in cerebral palsy in children: pathogenesis, diagnosis and modern methods of correction // Journal of Neurology and Psychiatry named after S.S. Korsakov. - 2021. - Vol. 121, No. 8. - P. 67-74.

[5] Semenova K.A., Klochkova E.V., Korshikova-Morozova A.E. Children's Cerebral Paralysis: Diagnosis and Correction of Cognitive Disorders: A Study Guide. - M.: Publishing House "Union of Pediatricians of Russia," 2022. - 168 p.

[6] Bax, M. Executive Summary: Proposed Definition and Classification of Cerebral Palsy / M. Bax, M. Goldstein, P. Rosenbaum // Developmental Medicine & Child Neurology. - 2023. - Vol. 47, No. 8. - P. 571-576.

[7] Graham, H.K. Cerebral palsy in the modern era: contemporary management and future directions / H.K. Graham, P. Rosenbaum, N. Paneth // The Lancet. - 2022. - Vol. 399, No. 10342. - P. 1800-1815.