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COMPREHENSIVE ANALYSIS OF CLINICAL, NEUROPHYSIOLOGICAL, AND LABORATORY DATA IN PEDIATRIC NEUROPATHY

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Abstract: Pediatric neuropathies are a heterogeneous group of peripheral nervous system diseases characterized by a variety of etiological factors, clinical manifestations, and prognostic outcomes. Neuropathies occupy a special place in the structure of neurological pathology in children, which is due to their potential reversibility with timely diagnosis and adequate therapy, as well as the risk of developing persistent functional disorders with untimely detection and treatment.

Keywords: neuropathies in children; peripheral nervous system; clinical diagnostics; neurophysiological methods; electroneuromyography; laboratory markers; integrative approach.

Introduction: Modern diagnosis of neuropathies in children presents a complex multi-level task that requires the integration of various research methods. The clinical picture of neuropathies in children is often characterized by the polymorphism of symptoms, which can make early diagnosis and differential diagnosis with other neurological diseases difficult. The peculiarities of the anatomical and physiological development of the peripheral nervous system in childhood, the immaturity of myelination of nerve fibers, and the age-related characteristics of nerve impulse conduction create additional difficulties in interpreting diagnostic data.

Neurophysiological research methods, including electroneuromyography, induced potential examination, and electromyography, are the gold standard in diagnosing neuropathies. However, their application in pediatric practice requires consideration of age norms and the specifics of conducting research in children of different age groups. Laboratory diagnostics plays a key role in identifying the etiological factors of neuropathies, assessing metabolic disorders, and monitoring the effectiveness of ongoing therapy.

The relevance of a comprehensive approach to assessing clinical, neurophysiological, and laboratory data in pediatric neuropathies is due to the need to increase the accuracy of diagnostics, optimize treatment tactics, and improve the prognostic outcomes of the disease. Integrative assessment of various diagnostic parameters allows not only to establish an accurate diagnosis but also to determine the severity of the lesion, predict the course of the disease, and evaluate the effectiveness of the ongoing therapy.

Purpose of the study: to study the features of clinical, neurophysiological, and laboratory parameters in neuropathies in children.

The study was conducted on the basis of the intensive care unit, pediatric neurology unit, and the consultative-polyclinic unit of the Multidisciplinary Clinic of Samarkand State Medical University.

The study also included patients who were examined and treated in the pediatric neurology department of the Samarkand City Multidisciplinary Children's Hospital, private children's clinics in Samarkand, and the Samarkand City Infectious Diseases Hospital. Patient recruitment and examination were conducted between 2024 and 2025. 41 children aged 8 to 18 were included in the study, which constituted the main group, the average age of the examined was 13.2±2.6 years. All children had clinical signs of peripheral nervous system damage, corresponding to neuropathies of varying etiology and severity. The inclusion criteria in the study were the presence of clinical manifestations of neuropathy, including motor and/or sensory disorders, decreased or absent tendon reflexes, pain and paresthetic syndrome, as well as vegetative-trophic disorders confirmed by clinical and instrumental examination results. The criteria for exclusion from the study were signs of central nervous system damage, acute neuroinfectious diseases at the time of examination, decompensated somatic diseases, severe congenital malformations, as well as the refusal of parents or legal guardians of the child to participate in the study.

Among the examined children, boys constituted 24 (58.5%), and girls 17 (41.5%). For a comparative analysis, a control group was formed, which included 29 clinically healthy children (comparison and control group) comparable to the main group by age and gender. The inclusion of children in the control group was carried out after obtaining the informed written consent of parents or legal representatives for the examination. The research was observational and comparative. All children in the main and control groups underwent a comprehensive clinical and instrumental examination using a standardized approach. Clinical examination included a detailed collection of anamnestic data, analysis of complaints, assessment of disease onset and dynamics, as well as an extended clinical and neurological examination with assessment of muscle strength, muscle tone, superficial and deep sensitivity, tendon reflexes, movement coordination, and the presence of vegetative-trophic disorders. The severity and nature of the neuropathic syndrome were assessed taking into account the prevalence of the lesion, the symmetry of clinical manifestations, and the degree of functional limitations. Instrumental research methods. Electroneuromyographic examination (ENMG) was performed on the Nicolet Viking EDX multifunctional electrodiagnostic complex (Natus Medical Inc., USA, 2018). The study was conducted under standard conditions at an ambient temperature of 22-24 °C. The speed of excitation transmission along the motor and sensory fibers of peripheral nerves, the amplitude of M- and S-responses, distal latent periods, and the form of potentials were assessed. The research methodology corresponded to generally accepted international recommendations, taking into account age norms. Based on the obtained data, differentiation of axonal and demyelinating types of peripheral nerve damage was carried out. Ultrasound examination of peripheral nerves was performed on a GE Logiq P9 (General Electric, USA, 2020), an expert-class ultrasound device, using a linear high-frequency sensor (10-18 MHz). The study was conducted in longitudinal and transverse projections, assessing the thickness and cross-sectional area of the nerve trunks, their echostructure, contours, and signs of compression or inflammatory changes. The obtained indicators were compared with the normative values, taking into account age and anatomical location. Magnetic resonance imaging was performed according to clinical indications on a Siemens Magnetom Essenza tomograph (Germany, 2019), with a magnetic field strength of 1.5 T. The study included standard protocols (T1, T2-weighted images, STIR) and was used to rule out central nervous system damage and to clarify the nature of structural changes in complex diagnostic cases.

Laboratory studies were conducted in the clinical diagnostic laboratory of the Multidisciplinary Clinic of Samarkand State Medical University. General clinical blood analysis was performed on an automatic Sysmex XN-1000 hematological analyzer (manufactured in Japan, 2021) with determination of the main cellular parameters. Biochemical blood tests were performed using the Cobas c 311 automatic biochemical analyzer (Roche Diagnostics, Switzerland, 2020). Carbohydrate, protein, and electrolyte metabolism indicators, as well as markers of metabolic disorders, were determined, which are important for the differential diagnosis of neuropathies. Additional laboratory studies (inflammatory, infectious, and metabolic markers) were performed according to indications using standardized certified methods in accordance with the clinical objective of the study. Statistical

processing of data was carried out using descriptive and analytical statistics methods. Quantitative indicators are presented as average values and standard deviation. To compare the indicators between the groups, parametric and non-parametric methods were used depending on the nature of the data distribution. Differences at $p < 0.05$ were considered statistically significant.

Results of the study: Characteristics of the main group and stratification of patients, depending on the severity of clinical manifestations of neuropathy, all children of the main group (n = 41) were divided into three subgroups. The subgroup with mild disease included 14 children, which constituted 34.1% of the main group; the clinical picture was characterized by predominantly moderate sensory impairments and minimal motor disorders without pronounced functional limitations. The subgroup with moderate severity consisted of 17 children (41.5%), who had combined motor and sensory impairments with moderate decrease in muscle strength and reflexes. The subgroup with severe neuropathy included 10 children (24.4%).

Focal forms (mono- and multiple mononeuropathies) were identified in 3 children (7.3%). In the first stage, according to the goal, an analysis of the clinical and neurological symptoms of neuropathies in children was conducted, assessing complaints, motor and sensory impairments, muscle tone, tendon reflexes, the presence of paresis, and vegetative-trophic changes. The obtained data were analyzed depending on the severity, etiology, and type of neuropathy and compared with the indicators of the control group of clinically healthy children (n=29). In children with mild neuropathy (n=14; 34.1%) reported periodic paresthesia (71.4%), fatigue (64.3%), and episodic limb pain (42.9%). Objectively, moderate surface sensory disturbances were detected in 57.1% of children, tendon reflexes decreased in 50.0%, and muscle tone changes were noted in 42.9% of cases. Paresis in this subgroup was minimal and was observed in only 14.3% of patients. The duration of the disease up to 12 months was recorded in 78.6% of children. In the subgroup with moderate severity (n = 17; 41.5%) complaints of pain, numbness, and weakness in the extremities were noted in 88.2% of patients. Moderate motor disorders were detected in 70.6%, where sensory disturbances were found in 82.4% of children in the main group, and decreased or asymmetrical tendon reflexes in 76.5%. Paresis of the distal parts of the extremities was diagnosed in 58.8% of children, changes in muscle tone were noted in 64.7% of children. Disease duration of more than 1 year was noted in 65.0% of patients in this subgroup. In children with severe neuropathy (n=10; 24.4%) the clinical picture was characterized by pronounced motor disorders. 100% of patients complained of significant muscle weakness and limited motor activity. Paresis was detected in 90.0%, and gross sensory disturbances were detected in 80.0% of cases. Vegetative-trophic disorders were registered in 70.0% of patients. Disease duration of more than 2 years was noted in 60.0% of children in this subgroup. In hereditary neuropathies (n=12; 29.3%) gradual onset of the disease was noted in 83.3% of patients, symmetrical limb involvement was characteristic in 75.0%, distal muscle weakness was detected in 66.7%, hypo- or areflexia in 83.3%. In the group of inflammatory neuropathies (n=9; 22.0%) the acute or subacute onset of the disease was registered in 77.8% of children, with pronounced pain syndrome in 66.7%, rapid progression of motor disorders in 72.2% of cases. Metabolic and toxic neuropathies (n=11; 26.8%) were characterized by combined motor and sensory impairments in 81.8% of patients, as well as vegetative-trophic disorders in 54.5% of children. In neuropathies of mixed and unspecified etiology (n=9; 22.0%) clinical polymorphism with a heterogeneous combination of symptoms was noted in 88.9% of patients. Axial type of neuropathy (n=16; 39.0%) were accompanied by predominantly motor disorders in 75.0% of children and the formation of paresis in 68.8% of patients. In the demyelinating type (n=13; 31.7%) sensory disturbances (84.6%) and diffuse decrease in tendon reflexes (92.3%) prevailed. Mixed type of neuropathy (n=9; 22.0%) was characterized by the most severe course with a combination of pronounced motor and sensory impairments in 88.9% of children. Focal forms (n=3; 7.3%) showed asymmetric clinical symptoms. Correlation analysis revealed a significant positive correlation between the severity of neuropathy and the frequency of paresis ($r=0.69$; $p<0.01$), as well as between the duration of the disease and the decrease in tendon reflexes ($r=0.57$; $p<0.05$). A statistically significant correlation was established between the type of neuropathy and the nature of clinical manifestations ($r=0.61$; $p<0.01$).

At the time of the study, laboratory deviations in children with mild neuropathy (n=14) were moderate. An increase in the level of creatine phosphokinase (CPF) was detected in 21.4% of patients, metabolic disorders according to biochemical blood analysis in 28.6%, electrolyte disorders were noted in 14.3% of children. Symptoms of systemic inflammation were registered sporadically and were noted in 7.1% of patients. In the subgroup with moderate severity (n=17), the frequency of laboratory changes was significantly higher. Elevated CFC levels were detected in 47.1% of children, electrolyte deviations were found in 41.2% of children. Inflammatory markers (increased ESR and/or C-reactive protein) were registered in 29.4% of patients. Hyperglycemia was detected in 35.3% of the examined individuals. In children with severe neuropathy (n=10), laboratory disorders were most pronounced. Elevated CFC levels were noted in 80.0%, electrolyte disorders manifested in 70.0% of cases, i.e., it can be seen that signs of inflammatory activity were detected in 50.0% of children in the main group. Statistical analysis (correlation indicator) revealed a significant positive correlation between the severity of neuropathy and the frequency of metabolic disorders ($r=0.65$; $p<0.01$).

A statistically significant correlation was established between the duration of the disease and the presence of electrolyte disorders ($r=0.58$; $p<0.05$). Consequently, laboratory indicators reflect the severity of neuropathies in children and are reliably correlated with clinical-neurological and electroneuromyographic data, confirming the role of metabolic and inflammatory factors in the formation and progression of peripheral nervous system damage.

Conclusions: The conducted study showed that neuropathies in children are characterized by pronounced clinical-neurophysiological and laboratory heterogeneity, the degree of which reliably depends on the severity of the disease, the etiological factor, and the type of peripheral nervous system damage. The integration of clinical and neurological data, electroneuromyographic indicators, and laboratory markers allows for an objective assessment of the nature and severity of the pathological process, increases the accuracy of diagnosis, and justifies a differentiated approach to the management of children with neuropathies.

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