CORRELATION OF NEUROLOGICAL AND NUTRITIVE STATUS IN CHILDREN WITH CEREBRAL PARALYSIS

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Abstract: Cerebral palsy is a neuromuscular disease that is often complicated by nutritional problems in children and adolescents. At the same time, violations of the nutritional status are a frequent manifestation of the underlying disease, worsen its course and reduce the effectiveness of rehabilitation. The currently used classification of forms of cerebral palsy does not reflect the overall severity of the disease, expressed in the degree of impairment of motor functions, which is important in clinical practice. The article discusses the possibility of using the GMFCS classification to assess the severity of movement disorders in children with cerebral palsy.

Keywords: cerebral palsy, GMFCSS, malnutrition, food.

Introduction

The term "infantile cerebral palsy" (CP) refers to persistent disorders in the development of motor skills and posture maintenance resulting from perinatal damage or anomalies of the developing brain [1]. Damage to the central nervous system (CNS) in cerebral palsy occurs at the earliest stage of a child's development and affects motor abilities, coordination, postural control, as well as other - non-motor - spheres of his life [2]. Despite the non-progressive nature of the neurological deficit, patients with cerebral palsy show deterioration in motor functions. In childhood and adolescence (up to 21 years of age), the loss of previously mastered motor skills is characteristic, first of all, for children with III-V levels according to the Gross Motor Function Classification System (GMFCS) [3, 4] as in adulthood, a gradual decrease in motor capabilities occurs regardless of the level of GMFCS [5]. According to a systematic review [6], approximately 25% of patients with cerebral palsy experience a deterioration or loss of walking with age. Patients with initially worse motor abilities, bilateral forms of cerebral palsy and the presence of pain or significant muscle weakness are at the highest risk zone [6]. However, even children with cerebral palsy with an initially high level and quality of motor activity have an increased risk of loss of the ability to move independently and the emergence of the need for aids for movement in adulthood [7–9]. Traditionally, such changes are explained by the accumulation of secondary orthopedic deformities [10].

However, today the problem seems to be complex. More and more researchers' attention is drawn to the issue of structural muscle pathology in cerebral palsy and the phenomenon of "early aging" of the musculoskeletal system against the background of the initial damage to the central nervous system [11, 12]. In the structure of modern rehabilitation of children with cerebral palsy, there is a clear prevalence of tone-reducing methods [13]. However, spasticity

is recorded only in 75–80% of cases, while muscle weakness (paresis) is present to varying degrees in all patients with cerebral palsy [11, 14]. There are more and more arguments in favor of the fact that it is the degree of muscle weakness, and not spasticity, that determines motor deficit and disability in patients with cerebral palsy in the long term [15, 16]. With the provision of adequate medical care, the life expectancy of most patients with cerebral palsy with mild and moderate motor impairments (GMFCS I – III) is now approaching the general population [7]. The ability for independent movement and self-service is one of the key factors that determine the quality of life and social adaptation in adults with cerebral palsy [8]. Understanding the pathogenesis of muscle weakness and progressive deterioration of motor function in cerebral palsy is necessary to correct existing approaches in the rehabilitation of pediatric patients and to maximize their activity and self-care in adulthood.

A relatively new area of research in cerebral palsy for neurologists is the problem of chronic pain (and the means for its pharmacological correction), as well as sleep disturbance in this group of diseases [7, 10]. There are many types of rehabilitation, denoted by the terms "physical rehabilitation", "habilitation", "motor rehabilitation", "neurophysiological rehabilitation", "complex rehabilitation", etc. [1,3,9,10]. Among the methods of rehabilitation are Vojta therapy (reflex locomotion method), Bobat therapy (neurodevelopmental), system 48 of intensive neurophysiological rehabilitation according to V.I. Kozyavkin, conductive pedagogy by Pete and others [2,3]. In a systematic review, Ryan J.M. et al. (2017) consider the methods of physiotherapy exercises in the rehabilitation of patients with cerebral palsy, and Reedman S. et al. (2017) evaluate the effectiveness of methods to increase physical activity in children with cerebral palsy [8,9]. Martín-Valero R. et al. (2018) in their “observational review” describe the beneficial effects of hippotherapy on children with cerebral palsy [2]. When analyzing foreign publications in recent years, there is a clear awakening of interest in "therapeutic suits" and artificial walking technologies for cerebral palsy. The works of Almeida K.M. are devoted to this problem. et al. (2017), Booth A.T.C. et al. (2018), Carvalho I. et al. (2017), Rose J. et al. (2017), Wang Q. et al. (2017), as well as Zanudin A. et al. (2017) [8, 10, 11]. It should be noted that these aspects of rehabilitation in cerebral palsy have been intensively studied by domestic neurologists and rehabilitologists more than 30 years ago. The work of N.V. Novikova is devoted to the peculiarities of physical rehabilitation in cerebral palsy. and Fedoskina E.M. (2018) [5]. In this regard, Yanovskaya N.V. et al. (2017) pay special attention to the peculiarities of rehabilitation of children of the first year of life with delayed static-motor and psycho-speech development of various etiologies [8]. Legkaya E.F. et al. (2016) call for the maximum use of information technologies in the complex rehabilitation of patients with cerebral palsy, and Vechkaeva O.V. (2017) indicates the need for quality management in the rehabilitation process for this pathology [7, 8].

Sherman V. et al. (2018) describe difficulties with swallowing and eating in children with cerebral palsy [10]. It is well known that problems associated with the intake and assimilation of food and the metabolism of nutrients can be accompanied by impaired nutritional status (malnutrition, obesity) [6,14]. Nutritional disorders in children with cerebral palsy are reported by V.M. Studenikin. and A.A. Buksh (2016), Aydin K. et al. (2018), Scarpato E. et al. (2017) and also García Íñiguez J.A. et al. (2018) [6,8]. To assess the risks of nutritional disorders in the practice of epidemiological research, along with anthropometric methods, methods for assessing body composition are used [5, 8]. Body composition is a measure of water, fat and non-fatty solids (bone and muscle) — lean body weight. The body composition is influenced by the ratio of the amount of adipose and muscle tissue, changes in the volume of the total, extracellular and intracellular fluid [5, 6].

Various methods are used to assess body composition (caliperometry, bioelectrical bioimpedance analysis, plethysmography, ultrasound of the subcutaneous fat and muscle

tissue, CT, MRI, X-ray absorptiometry, etc.). Thus, bioimpedance analysis of body composition allows, on the basis of the measured values of electrical resistance (impedance) of the human body and anthropometric data, to assess the state of protein, fat and water metabolism, the intensity of metabolic processes, to assess the reserve capabilities of the body and the risks of diseases. This method has become widespread in the world and has found application in large-scale epidemiological studies of the health of the population in Brazil (the Pelotas Birth Cohort Study), Great Britain (CHASE), countries of the WHO European Region and the European Union (MONICA, NUGENOB), China (KSCDC), USA (Framingham Heart Study, NHANES), South Korea (KNHANES), Japan (the Hisayama Study) and other countries of the world.

Fundamental research on mathematical modeling of bioimpedance measurements using high-resolution three-dimensional geometric models of the human body made it possible to visualize the measurement sensitivity areas and confirmed the importance of the method for assessing changes in body composition and fluid balance [5,9,10]. According to the ESPGHNG recommendations, it is this method of functional diagnostics that makes it possible to determine the absolute and relative values of the parameters of individual components of body composition and metabolic correlates and to objectively assess the patient's nutritional status [8].

Purpose of the study to study the prevalence of movement disorders in children with cerebral palsy based on the classification of motor functions (GMFCSS) and their impact on the development of nutritional deficiency.

Materials and methods. The study involved 53 girls (53%) and 47 boys (47%) aged 1.3–17 years with an established diagnosis of cerebral palsy (mean age 6.4 ± 4.1). Somatometry was performed according to the standard technique and included the determination of body weight using a floor scale (with an accuracy of 10 g), determination of height in the supine position (with an accuracy of 0.5 cm) on a special height rod. For children with pronounced limb deformities and contractures, body length was determined segmentally using a flexible measuring tape.

To assess the severity of movement disorders in patients with cerebral palsy, the Gross Motor Function Classification System (GMFCSS) was used, developed in 1997 by the staff of the Canadian University (McMaster University). This classification is used to assess the level of motor impairment in children with cerebral palsy [3,4], taking into account their functionality, the need for assistive devices and mobility. Define five levels in five age groups. Particular attention in the classification is paid to determining the level that is most suitable for skills and characterizes the limitations of the child's motor functions. The emphasis is based on the child's daily activities at home, at school, in public places.

The form of cerebral palsy was established according to the results of neurological using the working classification (K.A. Semenova, 1978): spastic diplegia (SD) - 52%, hemiparetic form (HPF) - 23%, double hemiplegia (DH) - 10%, hyperkinetic form (HF) - 8%, atonic-astatic form (AAF) - 7%.

Assessment of the form and severity of protein-energy malnutrition was carried out using the international classification of malnutrition Waterlow J.C. When assessing physical development, regional regressive tables of the city of Samarkand were used [5].

To assess the difficulties that children with cerebral palsy may experience while eating, a questionnaire survey of the parents of the patients was carried out. They were asked to assess the child's motor abilities and the level of his self-care skills: the ability to eat independently or the need for outside help, the presence of regurgitation and vomiting during the meal, signs of dysphagia.

Mathematical processing of the obtained data was carried out using the Statistica 10 package, using standard descriptive techniques, correlation analysis, and Pearson's chi-square.

Research results. According to the results of assessing the motor abilities in children with cerebral palsy, level I was registered in 22%, level II - 31%, level III - 24%, level IV - 10%, level V - 13%. Depending on the form of infantile cerebral palsy, patients had different levels of motor abilities (Diagram 1). In more severe forms of cerebral palsy, such as double hemiplegia (DH), level V according to the classification of motor capabilities is up to 90%, which corresponds to pronounced impairments of motor functions. In the hemiparetic form (HPF), levels I and II prevail - 39% each. Clinically, this is manifested by minor movement limitations that do not require additional means of movement (wheelchairs, walkers) and assistance from an adult. The atonic-astatic form (AAF), according to the data obtained, is the most favorable form of cerebral palsy, in which the severity of motor disorders is less pronounced. In these children, the levels of motor functions vary from I - 14% to IV - 14%, with a predominance of level II - 43%. It is with this form that the V level according to GMFCSS is not registered. This level is characterized by the most severe impairment of motor functions, there are very pronounced restrictions on independent movements and almost always the impossibility of self-service.

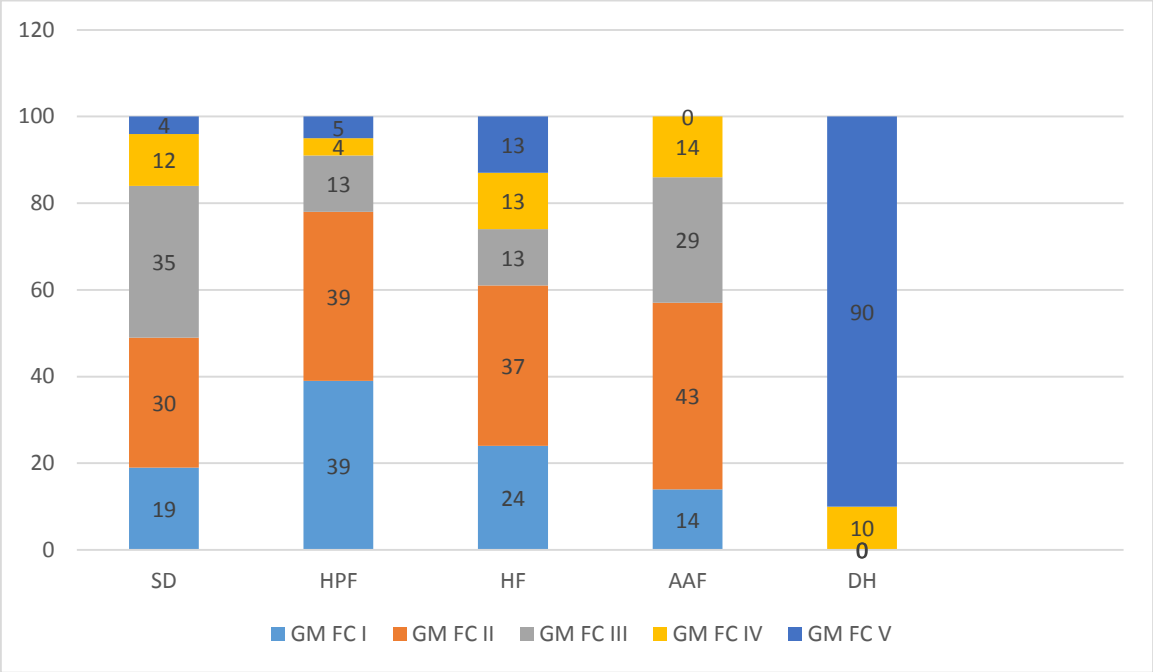

Diagram 1. Frequency of occurrence of certain forms of cerebral palsy at different levels of motor function impairment on the GMFCSS scale

A relationship was found between the severity of cerebral palsy and the severity of movement disorders according to the GMFCSS classification. Most children with moderate severity of the disease belong to the I-III level, while those with severe severity to the IV-V level. It was reliably confirmed that there is a correlation between the variables of average strength (-0.576 at $p < 0.05$), negative direction. Children who were rated III level by GMFCS had moderate and severe infantile cerebral palsy.

In a comparative assessment of the levels of motor activity and the incidence of protein-energy deficiency (Table 1), it was noted that with an increase in the severity of movement disorders, the number of children with protein-energy deficiency increases. With a mild degree of movement disorders (corresponding to level I according to GMFCS), protein-

energy malnutrition is recorded in 50% of cases. In the group of children with severe movement disorders (GMFCS level V), protein-energy deficiency was detected in 100% of cases. Thus, the risk of developing malnutrition in children belonging to level V is two times higher than at level I (the reliability of Pearson Chi-square differences is statistically confirmed: 9.48, p = 0.002078).

Table 1. The incidence of protein-energy malnutrition at different levels on the GMFCSS scale

GMFCSS	Presence of protein-energy insufficiency			
	There is (n = 63)		Not (n = 37)	
	%	abs	%	abs
1 (n=22)	50	11	50	11
2 (n=31)	48	15	52	16
3 (n=24)	63	15	38	9
4 (n=10)	90	9	10	1
5 (n=13)	100	13	0	0

Eating difficulties are more often experienced by children with more severe motor impairments. For example, children with the first level according to the GMFCS classification have feeding problems in 14% of cases (Table 2). At the most severe - level V, volitional control over voluntary movements is limited. Patients cannot control the position of the head and torso and resist the force of gravity; they need the help of adults with self-care, movement and feeding.

Table 2. Frequency of eating difficulties at different levels of motor skills impairment according to GMFCSS (based on questionnaire results)

GMFCSS	The difficulties during the meal			
	There is (n = 63)		Not (n = 37)	
	%	abs	%	abs
1 (n=22)	86	19	14	3
2 (n=31)	77	24	23	7
3 (n=24)	63	15	38	9
4 (n=10)	60	6	40	4

5 (n=13)	8	1	92	12

In this group, difficulties in feeding are noted in 92% of the examined children. Levels I-III babies are significantly less likely to experience feeding difficulties than levels IV-V. Statistically significant differences were found in the incidence of feeding difficulties in children with levels I and V of motor abilities (Pearson Chi-square: 20.65, p = 0.000006).

Conclusion. As a result of the study, it was found that the frequency of protein-energy malnutrition depends on the level on the GMFCSS scale. The risk of developing insufficiency at level V is two times higher than at level I. There is a dependence of the levels of motor capabilities on the form of cerebral palsy and its severity. Feeding difficulties for children with cerebral palsy are directly related to their motor abilities, such as independent movement and self-care. The GMFCS system of classification of large motor functions is an easy-to-use technique and can be used for a rough assessment of motor abilities in children with cerebral palsy.

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