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Changes in gross motor function in patients with cerebral palsy during treatment by the Intensive Neurophysiological Rehabilitation System (the Kozyavkin Method)

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Abstract

Background and aim: Changes in gross motor function during the course of intensive neurophysiological rehabilitation were studied in 61 patients, aged 2-15 years, with spastic forms of cerebral palsy.

Methods: All patients were examined before and at the end of a two-week course of treatment, using the Gross Motor Function Measurement GMFM - 66 item set test to calculate the scores of motor development.

Results: Statistical analysis indicated a significant increase in the level of motor development of children after treatment from 45.1 to 47.6 ($p > 0.01$). The most significant progress was noted in patients at level II of the Gross Motor Function Classification System. The score of motor development increased from 66.2 to 69.6 with a difference of 3.42 points ($p < 0.01$).

Conclusions: The results suggest the effectiveness of the Kozyavkin Method (Intensive Neurophysiological Rehabilitation System) for the improvement of gross motor functions in patients with cerebral palsy. Further studies and blinded randomized clinical trials are needed according to the requirements of evidence-based medicine.

Key words: cerebral palsy, movement disorders, Intensive Neurophysiological Rehabilitation System, rehabilitation

Introduction

Assistance for patients with organic damage to the nervous system is an important task of medical rehabilitation. In Ukraine, diseases of the nervous system are the top ailments in the structure of paediatric disabilities while infantile cerebral palsy (ICP) constitutes one fifth of them. ICP includes non-progressive diseases caused by brain damage during pregnancy, delivery and postpartum periods characterized by impaired control of movements and body positions. Over 70% of patients with ICP are severely disabled and require substantial expenditures for their treatment, maintenance and social help [1,2].

Children with cerebral palsy significantly vary in their level of motor, mental and social development, which is not surprising as the disease may be caused by many various factors. Over 400 various etiological factors have been determined, which cause polymorphism of clinical symptoms of cerebral palsy. Since each patient is a special and unique case, there cannot be one universal method of rehabilitation applicable to all patients. Unfortunately, traditional methods of physical therapy alone do not always lead to desirable outcomes. The combination of various medical modalities is required to achieve the expected results [1].

One of such multicomponent methods of rehabilitation of patients with ICP is the Intensive Neurophysiological Rehabilitation System (INRS), also called the Professor Kozyavkin method. By

stimulating the compensatory abilities of the affected body and activating brain plasticity, the INRS creates a new functional status in the body, which enables quicker motor and mental development. Various medical effects of the method discussed, which supplement and strengthen one another, are focused on achieving the main goal of rehabilitation, i.e. the improvement of the quality of life of patients [3].

Pathophysiology of medical effects of the Kozyavkin method

In cerebral palsy, organic damage to the nervous system is accompanied by secondary changes in the skeletomuscular system as well as other organ systems. Increased muscle tone, unreduced tonic reflexes, asymmetrical body position and pathological motor models in patients with ICP gradually result in trophic joint changes, disorders of circulation as well as metabolism an shorten spastic muscles, ligaments and tendons.

The pathological changes mentioned above are accompanied by motor limitations of the limb and spine joints as well as functional blockages (FBs) formed in them. In cerebral palsy, BFs are present in most joints. Nevertheless, the majority of researchers concerned with ICP issues, did not pay much attention to the spine although it contains over 100 joints in which FBs can occur. Articular FBs intensify the trophic damage as well as haemocirculatory, vegetative, neurogenic and other pathological changes, which leads to further delay and impairment of the motor development of ICP children. Gradually, the pathological vicious circle is created that is difficult to break [4].

Analysis of the importance of the vertebrogenic component in the pathogenesis of cerebral palsy has showed that FBs in the affected individuals are not confined to one joint but result in multi-segmental blockages of vertebral motor segments. Beside limiting the mobility of a certain spinal segment, they also negatively affect the coordinated work of organs and systems of the human body, which are innervated by the respective spinal cord segment. Moreover, the vertebral ligaments of these segments with hierarchically superior levels of the nervous system (brain stem, cerebellum, subcortical structures, cerebral cortex) are impaired.

Another important element in the pathogenesis of ICP is the pathology of proprioceptor systems which ensure kinaesthetic sensibility of the body necessary for the organisation of movements, learning of motor activities, and sensory-motor integration. In cases with functional blockages of the vertebral joints, the proprioceptor information flows from the skeletomuscular system to the central structures of the nervous system, which either further drives the patient`s motor ontogenesis or inhibits it at a certain developmental stage.

Considering the effects and correlation of the above-mentioned pathological symptoms, we designed a biomechanical method of correlation of vertebral and limb joints, which is one of the basic components of INRS. Our method eliminates FBs of vertebral motor segments and opens "the gateway" for the flow of proprioceptor information to the CNS.

Beside changing the biomechanics of joint movements, the method alters the work of almost all systems, which clinically manifests itself in the formation of a new functional status of the organism during rehabilitation by normalising the muscle tone, improving blood supply, metabolism and tissue trophism, which substantially widens the child`s possibilities regarding quicker motor and mental development.

The isolated use of the method of biomechanical correlation of the spine and mobilisation of large joints, however, is not sufficiently effective and is only the basis for further development of children.

Considering the above, in order to achieve the desired effects on the entire body, multi-component, multimodal measures have to be applied. By affecting simultaneously various levels of the pathological process using medical resources, the main task is achieved – the pathological vicious circle is broken and a new functional status of the body is created [4,5].

The pathophysiological mechanisms described above are only one of the hypotheses of medical impact of our method on rehabilitation, which undoubtedly requires more profound diagnosis and further development.

Main components of the rehabilitation system

The Intensive Neurophysiological Rehabilitation System consists of two sub-systems: the subsystem of intensive correction and the subsystem of stabilisation as well as potentiation of the effect. Intensive correction is carried out in the centre of rehabilitation and lasts one-two weeks. During stabilisation and potentiation of the effect, the treatment is continued according to the instructions in the home setting and lasts from 1-3 to 6-12 months; subsequently the patient is invited for another course of intensive correction [4,5].

The system of rehabilitation involves a polymodal approach, in which various methods of affecting the patient are used. The action of some methods supplements and potentiates the other methods. The main set of medical measures presented below connects biomechanical correction of the spine, mobilisation of limb joints, reflexotherapy, mobilizing physical exercises, a special massage system, rhythmic exercises, apiotherapy, and mechanotherapy (Fig. 1).

Material and methods

The aim of the present study was to evaluate the changes in motor functions in patients with cerebral palsy during a two-week course of intensive rehabilitation.

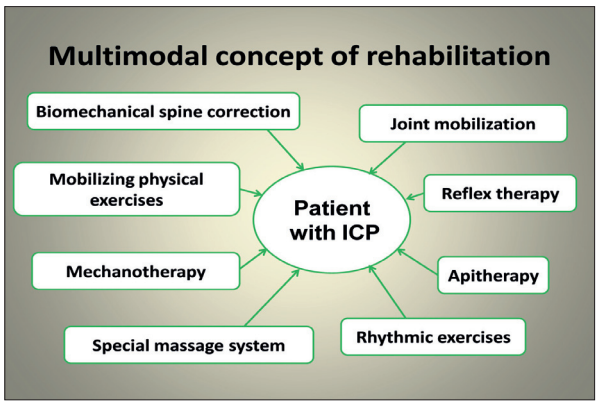

Fig. 1. The Kozyavkin method – multimodal concept of rehabilitation

The study was carried out in a group of patients with spastic forms of infantile cerebral palsy treated in the Kozyavkin International Clinic of Rehabilitation. The group consisted of 61 patients aged 2-15 years, who did not undergo any orthopaedic surgery and showed a sufficient level of communication.

All patients were divided into five groups according to the level of motor development determined using the Gross Motor Function Classification System (GMFCS), which classifies patients with cerebral palsy into five levels. The division into levels is based of functional possibilities of children, including movement (walkers, crutches, canes) and the quality of movements, although to a lesser degree. The Level I includes children who can walk without limitations yet do not manage more complicated motor tasks. The Level V encompasses children with limited possibilities of unaided walking even with auxiliary devices and poor control of trunk and head positions [1] [i].

The study patients were divided into groups according to their age - < 4 years, 406 years, 7-9 years, 10-12 years and > 12 years. The division of patients according to diagnosis, age and motor development is presented in Table 1.

Table 1. Division of patients according to diagnosis, age and motor development

Criterion	Number of patients
Diagnosis	
Spastic tetraparesis	46
Spastic diparesis	10
Spastic hemiparesis	5
Age group	
> 4 yrs	4
4-6 yrs	39
7-9 yrs	8
10-12 yrs	5
12-15 yrs	5
GMFCS level	
Level I	4
Level II	13
Level III	19
Level IV	16
Level V	9

In the study group, the majority of children had spastic tetraparesis – 46, were 4-6 years of age -39 and showed the III level of motor development – 19.

All the patients were examined twice- at the beginning and the end of a two-week treatment course. The main instrument used was the Gross Motor Function Measure, a standard device with confirmed reliability and validity credibility. A short variant of the GMFM-66 Item Set [2] [2] was used; instead of assessing all66 tasks, this variant evaluates only one task from four sets, depending on the level of motor development. The reliability and validity of this short test has been proven and its main asset is that only the tasks corresponding to the child development are performed.

The tasks performed by children are recorded using the digital video control program. Moreover, some unprocessed results were available; using the Gross Motor Ability Estimator, points of motor

Table 2. Dynamics of motor development points in patients with cerebral palsy according to the level of development

Level of motor development	No. of exams	Mean score before treatment	Mean score after treatment	Paired difference	Standard deviation	Two-way significance
I	4	84.4	86.0	1.56	2.12	0.238
II	13	66.2	69.6	3.42	2.58	0.001 *
III	19	50.0	52.5	2.47	1.46	0.002 *
IV	16	37.6	39.3	1.69	1.78	0.002 *
V	9	22.4	24.6	2.26	1.26	0.001 *

* denotes a statistically reliable difference

Table 3. Dynamics of motor development changes in patients from different age groups

Age group	No.of exams	Mean score before treatment	Mean score after treatment	Paired difference	Standard deviation	Two-way significance
< 4 yrs	4	37.3	38.9	1.67	1.62	0.465
4-6 yrs	39	43.8	46.3	2.51	2.05	0.001 *
7-9 yrs	8	53.3	56.0	2.79	1.41	0.001 *
10-12 yrs	5	69.7	71.5	1.86	1.72	0.073
13-15 yrs	5	63.7	66.2	2.54	1.48	0.019 *

*denotes a statistically reliable difference

development were calculated. The assessment of gross motor functions was carried out by an instructor who attended to a child during the treatment course.

The data were statistically analysed using the IBM SPSS; means were analysed according to T – criteria for paired samples.

Results

Analysis of the entire group of patients demonstrateed a statistically reliable increase in motor development points from 45.1 to 47.6 (p> 0.01), which evidences that motor abilities improved (Table 2).

Moreover, changes in motor functions in patients with various severity of disease (according to GMFCS) were analysed.

The highest progress was observed in level II patients. The motor development points in them increased from 66.2 to 69.6 with a difference in 3.42 points (p <0.01). The less pronounced positive changes were found in level III patients; their rate of motor development increased to 2.47 points (p <0.02).

To compare the treatment outcomes according to age, the study patients were divided into the following age groups : <4 years, 4 - 6 years, 7 -9 years, 10 -12 and 13 - 15 lat.

Almost in all age groups, the motor functions developed with an improvement ranging from 1.67 to 2.79 points. The highest results were noted in the 7-9-year-old and 4-6 -year -old groups; a statistically reliable increase to 2.79 and 2.51 points, respectively. In the group < 4 years of age, the changes observed were smaller (1.67 points); these data were not statistically reliable, most likely due to a low number of observations. In the 4-6 year-old group, statistical reliability was found to be particularly high - p <0.001. The highest increase in motor points was observed in 7-9-year-old children – 2.79 (p <0.05).

Our study was pilot in nature; therefore, the findings should be interpreted with caution. The results could have been affected by subjective attitudes of instructors to patients. The instruments for assessing large motor functions in patients with cerebral palsy were approved during the study.

During the study and recruitment of patients all children reporting to treatment and fulfilling the criteria as well as those consented to be involved in the study. Therefore, the division into age subgroups according to GMFCS levels was not even, which affected the reliability of analysis. In further randomised studies, a stratified group division should be applied to provide even sizes of subgroups.

Summary

Our findings confirm the effectiveness of the Kozyavkin method (Intensive Neurophysiological Rehabilitation System) in developing motor function in children with infantile cerebral palsy.

The experience gained will be useful for further studies on this method of rehabilitation and randomized, blinded trials according to evidence-based medicine.

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