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Dynamics of Changes in Performance Indicators in the Application of Physical Rehabilitation to Students with Flaccid Paresis

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Abstract

In the article, the dynamics of changes of indicators of performance of applying physical rehabilitation to students with flaccid paresis are considered in terms of the learning process in higher education institutions. The study involved 40 students with various forms of flaccid paresis. Indicators of the functional state of the students were obtained using external inspection, palpation, goniometry, dynamometers, and pedagogical testing. It was determined that students with flaccid paresis have various violations of postural and locomotor function of varying severity with a predominance of secondary pathological changes in particular joint contractures and trophic disorders that lead to a shortening of the limbs and foot deformities and the musculoskeletal system as a whole. Efficacy of physical rehabilitation programs has been confirmed with positive trends that are reflected in terms of muscle strengthening and endurance strength of individual muscle groups, reduced muscle atrophy of the lower extremities, and improvements in the vestibular apparatus and coordination capabilities.

Keywords

Students; People with disabilities; Sluggish paresis; Physical rehabilitation

Introduction

Over recent years the Russian Federation like most developed countries has maintained a consistent policy of the transition of disability from a medical to a social model. This model considers disability as a social problem and involves fundamental changes in the relations between the state and society toward people with disabilities and suggests appropriate approaches to economic and social life [1–3]. A modern system of social protection of persons with disabilities covers not only state social assistance and pensions, a system of benefits and compensation, and welfare services but also provides health, education, and employment for persons with disabilities, as well as social and occupational rehabilitation and social integration in society [4,5]. Providing adequate education for children with disabilities is an important component of social development of the children involved [6]. Effective adaptation and integration of children with impaired physical and (or) mental development in society is impossible without their full education. It is important to have a proper educational process in place to provide suitable conditions for a successful integration of students with disabilities in the microsocial environment that encourage further construction of effective strategies for self-realization. It is worth noting that adaptation processes in the body of students with disabilities are specific because they are caused by the presence of primary pathology leading to disability. Disabilities affect the functioning of major body systems and moreover make it difficult to the natural process of adaptation, accompanied by limited social contacts and interaction with society, causing the formation of an inferiority complex, negative personality structures, and egocentric and antisocial tendencies [7–10]. Access to qualitative higher education is significantly reduced in the absence of the so-called rehabilitation components of higher education, which requires additional budget allocations and should be provided side by side with educational services. Therefore, the development of effective remedial and restorative rehabilitation programs for students with disabilities is a very urgent task.

The development of rehabilitation assistance to disabled people is based on three basic directions, forming a single system: (1) the preservation and restoration of vital body functions, (2) human adaptation to conditions of life, (3) the creation of adequate living and working conditions. Each of these directions requires a detailed design: structuring content and temporary positions, the implementation of the relationship, and eventually systematization as a whole [11,12]. Significant problems among students with disabilities constitute postural and motor (movement) disorders that are caused by pathological changes in the musculoskeletal system and the nervous system and can progress under the influence of negative micro- and macrofactors (psychological stress during the learning process, the complexity of social and living conditions, etc.) [13–17]. The need of purposeful application of physical rehabilitation using the optimum propulsion mode, metered physical activity, artificial and natural factors, and different types of massage confirmed a significant positive impact on the human body. At the same time, the use of means and methods of physical rehabilitation in the complex therapeutic and correctional and rehabilitation activities for students with disabilities today is not always effective due to interbranch inconsistencies; a significant narrowing of tasks regarding physical rehabilitation; the lack of a system on objective diagnosis of the severity and dynamics of changes in the motor pattern, violations of the structure and functions of the individual biological systems of the human body with disabilities, and limitations of life and social failure of persons with disabilities; and aborted objective criteria for assessing the effectiveness of individual rehabilitation programs (IPR) and others [18–21].

The stage should be set to elaborate on the issues of effective use of means and methods of physical rehabilitation in the overall system of

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therapeutic and correctional and rehabilitation activities for students with disabilities. Therefore, the aim of our study was to determine the dynamics of changes in the functional status and effectiveness of differentiated application of means and methods of physical rehabilitation of students with flaccid paresis in the process of learning in higher education.

Methods

The study involved 40 students with various forms of flaccid paresis—generic brachial plexus palsy (Duchenne-Erb's palsy); generic paralysis of brachial plexus (Duchenne-Erb's palsy); and operated congenital spinal hernias, spinal injuries, and certain forms of children's cerebral palsy—as well as a number of hereditary or acquired neuromuscular diseases (polyneuropathy of different origin, hereditary muscular dystrophy, arthrogryposis, neural atrophy, Charcot-Marie's disease, Friedreich's ataxia).

During the study the following methods were used: dynamometry (carpal, strength of the extensor muscles), modified Kraus-Weber's test to determine the strength endurance of different muscle groups, goniometry to determine the range of motion in the joints, and Bondarevsky's test and Yarotsky's sample to determine the status of the vestibular apparatus and coordination capabilities, palpation and external examination, anthropometry, and podometry. To study the biomechanics of walking, students were examined for the following: symmetry, rhythm, constant length, and duration of the step. Level of anxiety was measured on a scale of situational and personal anxiety proposed by Charles D. Spielberger, which was adapted into Russian by Y.L. Khanin. The results of studies were analyzed using methods of mathematical statistics.

Results

3.1

Our observations showed that the contraction that formed as a result of the students' flaccid paresis had some differences from spastic contractures. Thus low muscle tone of the lower extremities accompanied for students recurvatio of knee joints, which is due to the weakness of the quadriceps extensor and hip and thigh. The volume of active movements in the joints of the feet was severely limited when, due to paresis of the lower extremities, the rotation of the hip is limited and extension of the lower leg and dorsiflexion of the foot are practically absent. Malnutrition extends to the gluteal muscles and the muscles of the thigh and drumstick. Since the gluteus maximus is one of the most powerful trunk extensor, its weakening enhances the formation of lumbar lordosis. Among students with flaccid paresis, who participated in the survey, weak muscular corset was observed, which usually led to an increase in the angle of the pelvis. Thus pelvic ring shifts downward and leads to nonlocking in leg joints. In 78% of cases, there was hyperextension of the joints of the lower extremities, which is often found in the knees with varus or valgus formation of installation, as well as genu recurvatum. Valgus and equinus were observed in some students, and some students had varus deformity. All of these disorders in students with flaccid paresis were accompanied by severe muscle weakness in the lower extremities, which severely limited the vertical position of the body and bipedal locomotion and forced students to use auxiliary orthopedic devices. Research on walking demonstrated that for students with paresis of lower limbs, violations of temporal and spatial parameters of walking were observed. In particular the characteristic violations of time parameters of walking include: increase in the total period of support is mainly due to the increase doubly period with a corresponding reduction in the time spent on one-pillar between pitch and time increases reliance on the whole foot. There is a temporary redistribution in walking compensatory and adaptive mechanisms to achieve maximum stability when walking.

Muscle weakness, sensory disorders, inability to close joints, their hyperextension, hanged down stop complicate the spatial movement of the limbs, lower resistance and cause incoordination common center of gravity. Reduction of motor acts reduction or loss of certain elements of movement becomes characteristic.

In this study of students with flaccid paresis of the upper limbs, the following common violations were observed: hyperextension of the elbow joint (in 15% of students) and hypermobility of the wrist joint (in 13%). In the work the fingers of the hands, determined reduction manipulative opportunities, difficulty keyboard finger movements, their breeding, opposition, flexion and extension and more.

Thus biomechanics of movement is changed and formed a pathological dynamic stereotype for students with flaccid paresis. Violations of locomotor function manifested in function support, walking and grasping functions, the formation of complex combinations of movements, slowed down tempo of walking, change in pattern of spatial and temporal asymmetry, and reduction or loss of certain elements of the cycle of motion.

3.2

All of these types of disorders in students with flaccid paresis were systematized and considered in the selection and application of differentiated means and methods of physical rehabilitation. The effectiveness of these programs for students with flaccid paresis was proved to be positive and is reflected in terms of strengthening of the muscles (Table 1).

The figures in the table are indicative of improving strength and strength endurance of muscles as a result of the positive impact of the use of the recommended rehabilitation programs. It should be noted that in contrast to the indicator is strength and endurance performance change indicators of dynamometry hands have not statistically probable value. However, it should be noted that some of the boys in the evaluation of the test muscle strength brush healthy hands met carpal dynamometer performance above 30 kg. It was especially clearly observed in students who had a unilateral lesion of the musculoskeletal system, which was probably due to their compensatory adaptations in the performance of essential functions of the healthy upper limb. On the affected side, due to anatomical and morphological changes of the upper limbs, the use of the wrist dynamometer in half of the cases was technically not possible;

Indicators	Before rehabilitation ($N = 20$)	After rehabilitation ($N = 20$)
Carpal dynamometry, kg	24.85 ± 2.75	31.60 ± 2.0
Strength of the extensor muscles, kg	94.10 ± 3.60	114.2 ± 3.23*
Strength endurance of muscles of the back, c	17.80 ± 0.43	21.3 ± 0.52*
Strength endurance of muscles of the back, c	17.00 ± 0.47	19.3 ± 0.60*

*Significant differences at $p < 0.05$.

Table 1: Dynamometry indicators of students with flaccid paresis before and after rehabilitation programs (M ± m)

for other students, this indicator averaged 18.0 ± 6 kg. Therefore, such a significant variation is not allowed to establish the likelihood of change, but it should be noted that the majority of students (58%) during the application of rehabilitation programs experienced a significant increase in muscle strength. There was a positive trend of circumference size limbs. So hip circumference increased by an average of 2.1 ± 0.43 cm and legs by 1.1 ± 0.33 cm. Along with the increase in indicators that reflect the quality of muscle power in the process of rehabilitation for students with flaccid paresis, there were positive changes in the indicators characterizing focal features.

For greater objectivity in obtaining reliable results, all surveyed students with flaccid paresis were divided into two groups. The first group consisted of students who participated in the program of physical rehabilitation, and the second group consisted of students who underwent IPR, recommended by specialists of MSEK without additional changes. At the end of training and accordingly the completion of the rehabilitation program, the state of the vestibular apparatus and coordination capabilities of these students was observed (Table 2).

Dynamics of changes in individual indicators in students with flaccid paresis during IRP showed improvement in vestibular and coordination capabilities. By changes in the values obtained during Bondarevsky's test, it was found that all students participating in the survey held static balance significantly longer with eyes closed. At the same time, students who underwent IPR also showed better retention time of equilibrium in comparison with the one taken in the beginning of the survey to 86.9% and in relation to indicators of students who have additional physical rehabilitation program is not used, above 38.7%. After Yarotsky's sample, the students with flaccid paresis who participated in the supplementary program in physical rehabilitation maintained balance longer by 2.34 times, with respect to the indicators taken at the beginning of the survey and in relation to the results of students with disabilities who underwent IPR, recommended by experts of MSEK 55.3%. Improvement in the functional state of the musculoskeletal system and working of vestibular apparatus and coordination capabilities of students with flaccid paresis led to a substantial improvement in the results of movement selected line. Path deviations compared with the initial results were less than 24.6% and in terms of additional applications in the IRP individually tailored physical rehabilitation programs by 42.5%. Accordingly biomechanical parameters of walking were improved. Thus by reducing the restrictions of movements in joints, improvement muscular system and improvement coordinating opportunities, reduce the amount of locomotion in passing in the distance a group of students with disabilities who additionally perform physical rehabilitation program by 14.2% in the group that performed the standard IPR by 4.1%. In these groups of students, course time was decreased by 21.4% and 7.1%, respectively.

In addition there was found that students with flaccid paresis in the IRP that do not apply the means and methods of physical rehabilitation, during the learning process at the university at the end of the learning process remained somewhat elevated levels of anxiety, which was not observed among those in which additionally applied individually selected physical rehabilitation programs. It should be noted that a certain level of anxiety is natural and is required by a person for remaining active, but the negative aspect of anxiety often leads to a decrease in efficiency and productivity and difficulties in communication. A person with increased anxiety could be faced with various somatic diseases. Among a group of students with flaccid paresis who additionally followed the author's program of physical rehabilitation at the end of the training period compared with a group of students with disabilities who followed the IRP recommended by MSEK, the following indicators showed significant improvement: health, reflecting the strength and fatigue; activity, reflecting the mobility and the rate of flow functions; and mood, reflecting the emotional state.

Discussion

The main goal of rehabilitation of flaccid paresis is to achieve the greatest possible effect in improving the disturbed functions with optimal compensation and restructuring of the entire body at its various levels of functioning. The most complete implementation of this program can only occur against the backdrop of a sufficient reserve of physical, mental, and social potential of the disabled with adequate integration into the society. Of particular importance is the prevention of complications during the acute period of the underlying disease and the prevention of recurrent or any concomitant disease.

Defining the changes in individual indicators of students with flaccid paresis confirmed the urgent need for additional correctional and rehabilitation activities as part of their IPR, which provided for suitable use of means and methods of physical rehabilitation. The need to address general issues concerning the development and implementation of effective rehabilitation separates the problem not only to commit the changes that occur under the influence of negative factors, the degree of severity and manifestations in time, but also to identify the functional reserves of the organism, and students with disabilities.

Sluggish paresis primarily differs in terms of polyetiology. Analysis of data testified that for students surveyed, sluggish paresis occurred due to birth or acquired trauma. The general law of development of pathogenic changes in the development of the above nosology is that one of the defining pathological components consists of anatomical and

Indicators	Study beginning ($N = 20$)	Upon completion of study	
		With the use of the Fr ($N = 20$)	Without the use of the Fr ($N = 20$)
Static equilibrium, c	6.9 ± 0.48	12.9 ± 0.56*	9.4 ± 0.42*⁰
Retention time of equilibrium (Yarotsky's sample), c	12.4 ± 0.60	29.05 ± 1.01*	18.7 ± 1.41*⁰
Deviations from this path, sm	51.3 ± 3.83	29.5 ± 1.2*	38.7 ± 2.95*⁰
Number of locomotion	9.9 ± 0.56	8.5 ± 0.40*	9.5 ± 0.39
Passage time, c	8.4 ± 0.41	6.6 ± 0.39*	7.8 ± 0.31

*$p < 0.05$ compared with those obtained at the beginning of training; $p < 0.05$ compared with the indicators of students who underwent IPR, which includes additional physical rehabilitation programs.

Table 2: Coordinating opportunities for students with sluggish paresis before and after rehabilitation programs (M ± m)

morphological changes in the tissues of the musculoskeletal system in varying degrees of severity, as well as significant violations of postural and locomotor functions. The feature of recommended rehabilitation programs was strictly an individual-based approach, taking into account the specificity of the primary disease, its course as well as the current status of the individual with flaccid paresis. Positive dynamics of the rehabilitation of students with these pathologies, given their often progressive nature, considered the overall stabilization of the active processes that lead to damage in different parts of the musculoskeletal system, inhibition of their further degradation, and achievement of a state of stable remission. At the same time improving individual performance was evaluated as a significant improvement and objective justification for the appropriateness and effectiveness developed for this category of students rehabilitation program.

When flaccid paresis, almost any etiology, occurs due to primary muscle damage that results in a decrease in muscle tone, patients develop secondary pathological disorders, namely, joint contractures and trophic disorders that lead to further shortening of the limbs and foot deformities and reconstruction of the whole musculoskeletal system. Surveys have shown that the most common violations include myogenic contractures, which are a consequence of biomechanical muscular balance with redistribution of traction between damaged muscle and healthy antagonists. Because of these changes set new, pathological condition of the musculoskeletal system, which is formed due to contraction of the muscles that have retained their activity and resistance deprived of their antagonists.

Conclusion

Thus primary research has shown that students with flaccid paresis below the parameters of age are anthropometric measures, the development power and coordinating abilities is insufficient. Speed and strength features were less by 32% and the reaction rate was 2.5 times worse than the performance of healthy peers. Characteristically there was reduction of strength of the back muscles, shoulder girdle, and lower limb muscles; 15% of students with flaccid paresis had hyperextension of the elbow, and 13% had hypermobility of the wrist joint, declined manipulating capabilities, difficulty of keyboard finger movements, their breeding, opposition, flexion and extension. Indicators of Bondarevsky's test among them showed they are 54% worse than their healthy peers, and according to Yarotsky's sample, they lose their balance after an average of 12.4 $\pm$ 3.3 sec. Their healthy peers managed 31.5 $\pm$ 5.8 sec. Deviations from the correct trajectory while walking in a straight line were 51.2 $\pm$ 4.7 cm for students with flaccid paresis, which is twice as worse when compared with their healthy peers. Among students with flaccid paresis, phase shift support was fixed. Resistance on the heel was shortened, and roll of the foot carries out through the sock. Changed turn of foot when most frequently observed their internal rotation. Biomechanics of movement was changed for students with flaccid paresis, and a pathological dynamic stereotype was formed. Violations of locomotor functions manifested in function disorder support, walking, and grasping. Walking temp is slowed down, changing its pattern is asymmetrical movements, reduction or loss of certain elements of the cycle of motion.

During research it was proved that the use of individual programs of rehabilitation for students with flaccid paresis in terms of the learning process in higher education has a positive effect on the functional state of the body, the working of the vestibular system and coordination abilities and leads to an improvement (increase) in muscle tone and strength endurance of individual muscle groups. Additional differentiated application of means and methods of physical rehabilitation in general PRI students with flaccid paresis significantly increases the effectiveness of correctional and rehabilitation activities.

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