














## CASUISTIC PAPER

# Application of kinesitherapy within the process of rehabilitation of patients with Charcot-Marie-Tooth nerval amyotrophia

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### ABSTRACT

**Introduction and aim.** Researching inherited polyneuropathy is vastly topical in the course of the contemporary practice of physical therapy and ergotherapy. The article unveils the results of the application of kinesitherapy in the process of rehabilitation of patients with Charcot-Marie-Tooth nerval amyotrophia. Inherited Charcot-Marie-Tooth neuropathy is a genetical disease, which is manifested with the slow reduction of the size of muscles of limbs and weakening of distal locations, is the most widespread clinical form of inherited polyneuropathies, which affect people regardless of generational and gender-based; mostly young and workable people become the objects suffering from its impact.

**Description of the case.** Due to the relatively low frequency of the multiplication of the disease within the population (according to the data from clinical statistics, the prevalence of all types of Charcot-Marie-Tooth amyotrophia per 100 thousand people is approximately 36 cases) four patients with Charcot-Marie-Tooth nerval amyotrophia aged in the area from 14 to 20 years took part in the research. In the course of the research, we applied the method of electroneuromyography, which provided the opportunity of detecting the rate of impulse impact via afferent and efferent ways, the duration of M-response and the number of movable entities within lower limbs.

**Conclusion.** As a result of classes being held and carried out according to the experimental kinesitherapy study program, there was the detection of positive tendencies of changing the psychophysical state of patients, diagnosed with “Charcot-Marie-Tooth nerval amyotrophia”.

**Keywords.** Charcot-Marie-Tooth, kinesitherapy, nerval amyotrophia

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## Introduction

Charcot-Marie-Tooth nerval amyotrophy is one of the most widespread inherited neurological diseases in the world, which is diagnosed in 36 persons per 100000 population. In Ukraine inherited amyotrophy cases include 15000 persons, which corresponds to the correlation of 1 case per 2.5 thousand persons. Inherited Charcot-Marie-Tooth neuropathy is the most widespread clinical form among inherited polyneuropathies. This genetic disease affects all races and nationalities regardless of generational and gender-based differences, but the most frequent objects of affection are young and workable people in their 20s and 30s. Progressive course of the disease along with possible swift development of complications and absence of effective treatment of patients with Charcot-Marie-Tooth amyotrophy leads to the declination of life quality and premature corporal incapability. The disease does not affect the fertile capabilities and life duration of the objects of affection, which provides for a relatively large amount of people affected by Charcot-Marie-Tooth amyotrophy within the population.<sup>1</sup>

A group of developed countries bear the functioning associations, organizations and foundations concerning the provisions of medical and social aid to those who suffer from Charcot-Marie-Tooth amyotrophy and to their families. These organizations carry out active research activity seeking new methods of premature diagnosing and treatment of the disease, great emphasis is set on the measures of social and medical rehabilitation of individuals affected by Charcot-Marie-Tooth amyotrophy. Unfortunately, such organizations are nowhere to be found in Ukraine, although several scientific studies of clinical, genetic and epidemiological courses of different forms of Charcot-Marie-Tooth amyotrophy take place.<sup>1-3</sup>

The effective methods of physical therapy for people with the consequences of Charcot-Marie-Tooth nerval amyotrophy are prescribed individually. The amount of variations of means and methods of physical therapy is shaped by the stage of the progression of the disease, individual peculiarities of a patient and the availability of other adjoint diseases about them. Elaborated by the group of scientists and scientifically-backed kinesitherapy study program is aimed at patients with Charcot-Marie-Tooth nerval amyotrophy and leads to the improvement of indications of functioning of the neuromuscular system of patients with Charcot-Marie-Tooth nerval amyotrophy and, also, positively impacts on the psychoemotional state of the patients.<sup>2-4</sup>

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Inherited Charcot-Marie-Tooth neuropathy is the most widespread clinical form among inherited polyneuropathies.<sup>2</sup> This genetic disease affects all races and nationalities regardless of generational and gender-based differences, but the most frequent objects of affection are young and workable people in their 20s and 30s. Progressive course of the disease along with possible swift development of complications and absence of effective treatment of patients with Charcot-Marie-Tooth amyotrophy leads to the declination of life quality and premature corporal incapability.<sup>4,5</sup> The disease does not affect the fertile capabilities and life duration of the objects of affection, which provides for a relatively large amount of people affected by Charcot-Marie-Tooth amyotrophy within the population.

A group of developed countries bear the functioning associations, organizations and foundations concerning the provisions of medical and social aid to those who suffer from Charcot-Marie-Tooth amyotrophy and to their families. These organizations carry out active research activity seeking new methods of premature diagnosing and treatment of the disease, great emphasis is set on the measures of social and medical rehabilitation of individuals affected by Charcot-Marie-Tooth amyotrophy.<sup>6</sup> Unfortunately, such organizations are nowhere to be found in Ukraine, although several scientific studies of clinical, genetic and epidemiological courses of different forms of Charcot-Marie-Tooth amyotrophy take place.

The effective methods of physical therapy for people with the consequences of Charcot-Marie-Tooth nerval amyotrophy are prescribed individually.<sup>2,7,8</sup> The amount of variations of means and methods of physical therapy is shaped by the stage of the progression of the disease, individual peculiarities of a patient and the availability of other adjoint diseases about them.

A scientifically justified kinesitherapy study program for patients diagnosed with Charcot-Marie-Tooth nerval amyotrophy will provide for the improvement of indications of the functionality of the neural and muscular system of patients, affected by Charcot-Marie-Tooth nerval amyotrophy and, additionally, will positively impact their psychological state.

## Aim

The aim of this study was to elaborate and scientifically justify the program with kinesitherapy classes for patients with Charcot-Marie-Tooth nerval amyotrophy and monitor its effectiveness.

## Analysis of the literature

Analysis and unification of the literature concerning the issues about physical therapy of patients with functional deviations related to the course of Charcot-Marie-Tooth nerval amyotrophy provided for the methodological

system of the research. For the examinations of functions of the neural and muscular system in limbs, there was the application of electroneuromyography, which provided the possibility of indicating the speed of execution of the impulse by afferent and efferent methods, along with the duration of M-response and the number of mobile entities in lower limbs. Additionally, there was the application of pedagogical inspection with the objective of detecting specifications of patients' behavior and its emotional components, particularly for the understanding of the type of reaction to success and misadventures. As a secondary method of pedagogical inspection, there was the application of conversations, which were held with patients and their parents to provide for the formation of motivation of attending kinesitherapy classes. For the detection of agitation and depression levels, there were some psychodiagnostic methods, were used as well. Processing of empirical data was executed via the method of comparison of patients' physical states before and after the execution of the experimental research. Experimental research was executed for 6 months (from 10.01.2021 to 03.16.2022) in the main workshop building specialising in adaptive and physical rehabilitation "Zdorovi Rukhy". Preparation for the research provided for the execution of the comparative analysis of tendencies of indications, the motion amplitude, electroneuromyography and psychodiagnostic of the patients aged from 14 to 20 years old, affected by Charcot-Marie-Tooth nerval amyotrophia, in the process of kinesitherapy classes. For 4 patients aged from 14 to 20 years old, affected by Charcot-Marie-Tooth nerval amyotrophia, there was elaboration of the program of physical rehabilitation in the course of kinesitherapy classes. The research was held in three stages.

The first stages assured the realization of theoretical analysis of the scientific literal sources for the references, dedicated to the topic of the research, there was the examination of anamnesis and epicrisis of the patients, which became the basis of the formation of clinical characteristics and specified physical therapy program, which included the provision of kinesitherapy classes for patients, diagnosed with Charcot-Marie-Tooth nerval amyotrophia (10.01.2016 - 10.16.2021).

The second stage included the approbation and verification of the effectiveness of the physical rehabilitation program for the patients affected by Charcot-Marie-Tooth nerval amyotrophia (10.16.2021 - 03.16.2022). Bearing the objective of estimating the effectiveness of the experimental methods of kinesitherapy, there was the forming experiment, which provided for continued execution of the comparative analysis of tendencies of indication of motion amplitude, electromyography and psychodiagnostic of the patients aged from 14 to 20 years old, affected by Charcot-Marie-Tooth nerval

amyotrophia, in the course of kinesitherapy classes. The third stage of the research is the concluding one.

## **Description of the case**

### *Ethics approval*

This study was approved by Institute Ethics Committee, National University Yuri Kondratyuk Poltava Polytechnic, Poltava, Ukraine (Ref: NUYKPP/IEC/2022/123). We adhered to the principles of ethics thereafter throughout the study.

### *Participants*

The course of the research, there was the elaboration of a theoretically justified and experimentally verified physical therapy program, which provided for the organization of kinesitherapy classes for the patients aged from 14 to 20 years old, affected by Charcot-Marie-Tooth nerval amyotrophia.

### *Procedure/Test protocol/Skill test trial/Measure/Instruments*

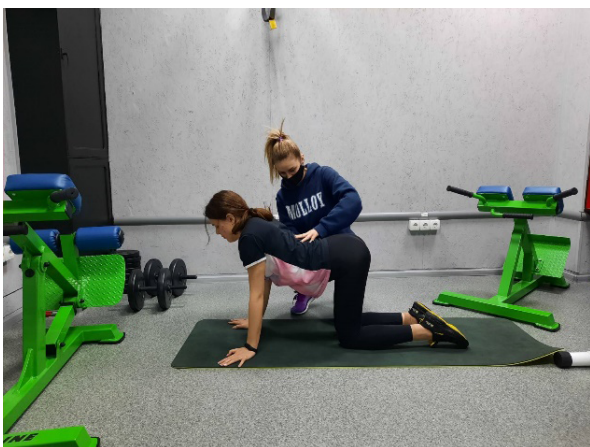
According to the experimental program, the rehabilitation course includes 3 cycles for 2 months of classes (6 months in total), with the gradual strengthening of the load charge of the physical exercises. Each class consisted of 3 stages:

1. The correct type of breathing;
2. The warm-up;
3. Kinesitherapy class;

Let us characterize each one of these stages in detail. In the course of the execution of the exercises, it's vital to remember, that inhaling must be done at the moment of muscular release, but exhaling is done at the moment of muscles being engaged when the maximum of effort is applied. Breathing must be deep (with the diaphragm being engaged), but comfortable at the same time, as one's belly must inflate in the course of inhaling. It may seem uncomfortable, but only with this way of breathing the organism is able to obtain the maximum of oxygen without losing much energy, similarly to surface-levelled frequent breathing. What also matters is what organ the patient uses - engaging their oral cavity or their nose. It is recommended to inhale using the nose of the patient, as it leads to moisturizing and purification of air from dust and microorganisms and exhaling is recommended to do using the patient's mouth, as it leads to quicker ejection of the air and organism spends much less of energy resources. Additionally, the maximum of energy is accumulated during the process of exhaling, the energy which is indispensable for the effective execution of exercises. Moreover, in the course of exhaling the air, the diaphragm and abs are engaged which provides additional endurance and helps to bear the loading without the patient's organism being harmed. At the moment

of exhaling muscles of the body are engaged in an unbalanced way, and this a person cannot apply all their energy for the execution of the exercises and loading always seems more unbearable.

The execution of second stage is initiated with the warm-up. The warm-up consists of these main exercises: “Dorsal relaxation on one’s laps”, “Stretching steps”, “Retraction of the belly (abs)” and “Hip-bone lifting”. Let us describe the indicated exercises in more detail. The first one is “Dorsal relaxation on one’s laps”. Executing these exercises, the initial position is pronated, with patients standing on their knees. Firstly, while exhaling, the patient steadily stretches out their back upward, then returns to the initial position, inhales and in the process of exhaling it’s necessary to steadily bend their back downward (Fig. 1). The patient returns to the initial position afterwards. In the course of the execution of this exercise, the warm-up provides for 20 repetitions of previously described instruction.



**Fig. 1.** Execution of the exercise “Dorsal relaxation on one’s laps”

“Extending steps”. In the course of execution of this exercise, the initial position is pronated with patients standing on their knees. Patients execute exercises for stretching muscles: steadily leaning on the left leg and stepping back with their

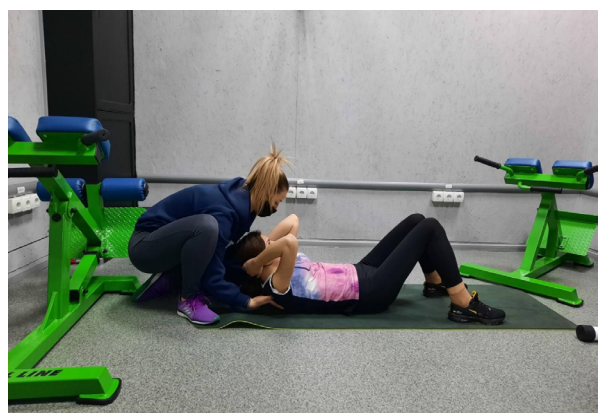
left arm stretching forward. While stretching patients inhale, up to the complete relaxation of their muscles and, afterwards, return to the initial position. Afterwards, patients inhale, lean on their right leg, step back with their left legs and stretch forward with their right ones (Fig. 2).



**Fig. 2.** Execution of the exercise “Dorsal relaxation on one’s laps”

“Retraction of the belly (abs)”. In the process of execution of this exercise, the initial position is patients laid down on their backs with their legs bent in their knee cups, with their heels on the floor, and their hands behind their heads. Patients press their chin to their chest, bend their torso while exhaling, try to lift their shoulder blades over the floor and make a motion with their elbows towards their laps (Fig. 3).

The amount of repetitions in the course of the exercise is unlimited, up to the burning sensation in the abdominal muscles.



**Fig. 3.** Execution of the exercise “Retraction of the belly (abs)”

“Hipbone lifting”. In the process of the execution of this exercise, the initial position is patients laid on their backs, with their legs bent in their knee cups, their heels on the floor, and arms along their body. While inhaling patients steadily lift their hipbone as high over the floor as possible and returns to the initial position (Fig. 4). In

the course of the execution of this exercise, the warm-up requires from 20 to 30 repetitions.

It is worth noticing, that in the course of the execution of the warm-up, as well as the next exercises, it is necessary to track patients' wellbeing, and sensations and, most importantly, respect the principle of individual approach (the variety of means and methods of physical rehabilitation is caused by the stage of the progression of the disease, individual peculiarities of the patients, and the availability of adjoint diseases).



Fig. 4. Execution of the exercise "Hipbone lifting"

Individual physical therapy program, which provided for the organization of kinesitherapy classes, consisted of a set of exercises, which are executed on the trainer "MTB-2". The exercises are "Lat Pull Down", "Abs workout", "Enhancement of quadriceps of the hips", "Enhancement of biceps of the hips", "Pulling off the knee cups towards to the abdomen", and "Pulling with a straight leg", "Triad", "Pull-over", "Rotation", "Abs enhancement + 5". Let us characterize the set of exercises, executed on the trainer MTB-2, in more detail. The exercise "Lat Pull Down". The exercise is executed with the aim of strengthening of dorsal muscles. The scheme of execution (Fig. 5).

1. The instructor sets the appropriate weight, with the preference towards the minimum one.

2. The patient sits down on the seat and adjusts the armpad roller in order for the hips to be tightly fixated and the legs tightly stood on the floor.

3. The instructor's hands are in the grip of the trainer. The patient gives it a wide grip with their hands situated slightly wider than the level of shoulder position.

4. The instructor slightly bends the torso backwards approximately to 25 degrees, which is the initial position.

5. The instructor slowly helps to pull the grip to the level of the chest, and then the patient lowers their elbows downwards to 45 degrees, with the contraction of the widest dorsal muscles. The pause must be done at the lowest point.

6. The patient returns to the initial position and maximally stretches the widest dorsal muscle at the highest point of the amplitude.

7. The amount of repetitions is from 12 to 15 times.



Fig. 5. Execution of the exercise "Lat Pull Down"

The exercise "Abs enhancement". The "Abs enhancement" exercise is executed for strengthening abdominal muscles and relaxation of the lower back. The exercise is executed on the trainer "MTB-2" with the cuffs on the legs. The scheme of the execution (Fig. 6) is the following: The patient lays down and grasps the fixated grips with their wrists.



Fig. 6. Execution of "Abs enhancement" exercise

The instructor attaches MTB cuffs with an additional weight of 30 kilograms to the legs of the patient. The patient's back must be able to freely attach back to the necessary surface. The instructor helps to gradually pull their knees to the ribcage at the moment of exhaling, extracting the abdominal muscles. The amount of repetitions is from 15 to 20 times.

The exercise "Enhancement of quadriceps of the hips". This exercise is used for the restoration of strength and length of muscles of the hips. The scheme of execution (Fig. 7). The patient lays down on their back with their head aimed towards the trainer. The instructor attaches one leg to the cuff from the higher block of 10 kilograms of MTB trainer. Under the pressure of the weight, one of the legs is bent in the knee, without detaching the leg from the floor, and in this phase, the patient inhales. At the moment of exhaling, the patient completely relaxes their leg in the area of the kneecap. The previously mentioned algorithm is repeated from 15 to 20 times for each leg.



Fig. 7. Execution of "Abs enhancement" exercise

The exercise "Enhancement of biceps of the hips". The exercise is executed for the restoration of the strength of hip muscles, as well as the restoration of the

length of these muscles. The scheme of execution (Fig. 8) is the following: The patient is laid on their back, with their head towards the trainer. The instructor attaches one leg to the cuff from the opposite MTB from the lower block with a weight of 2 kilograms. In the position of complete extension of the leg in a kneecap, the patient inhales. The patient performs the pulling by their legs by bending it in the kneecap after every exhaling. The amount of repetitions is from 12 to 15 times for each leg.



Fig. 8. Execution of the exercise "Enhancement of biceps of the hips"

The exercise "Pulling off the kneecaps towards the abdomen". The exercise is executed for the rehabilitating work with the joints of the legs in a decompressed mode, with the engaged area of the groin, muscle of illium and the lower back, muscular group of the hips, the muscles of the lower back, and the muscles of the rear side of the hips. In the process of stretching out of the leg backwards, there is the extension of the muscles of the frontal side of the surface of the hip. The scheme of execution (Fig. 9) is the following: There is the execution from the higher MTB block in the position of patients standing on their knees and hands. The objec-

tive of the patient is to maximally pull one of the knees to the abdomen with additional weight (20 kilograms). The number of repetitions for each leg must be from 12 to 15 times.



**Fig. 9.** Execution of the exercise “Pulling off the kneecaps towards the abdomen”

Exercise “Pulling with a straight leg”. The application of this exercise is devoted to the restoration of hip muscles, as well as the restoration of their length. The execution of the exercise assures the restoration of blood provision to femoral and lumbar areas, while the restoration of blood provision assures the reduction of swelling and pain relief. The scheme of execution (Fig. 10) is the following: the patient is laid down on their back with their heads towards the MTB stand. The instructor attaches the cuff weighing 15 kilograms to the upper block with the patient’s leg. The patient raises the lower limb with the weight, completely stretching out the leg in the area of the knee joint (as wide as it is physiologically possible). While exhaling the patient lowers the leg to the floor level, holding it straight (without bending). The amount of repetitions is from 15 to 20 for each leg.



**Fig. 10.** Execution of the exercise “Pulling with a straight leg”

“Triad” exercise. This exercise is applied for pain relieving in the arms and in the area of the shoulder joint (with the deep muscles of the shoulder joint being engaged). The scheme of execution (Fig. 11) is the following: the exercise is executed in the laid position. The patient holds the grip from the upper block of MTB attached to the cord in his hands. The weight of the block is 5 kilograms. While exhaling the patient pulls the hand towards their chin in the way to have the rearmost side of their palm pulled to the cheek and their arm being bent in the area of the elbow joint. The amount of repetitions for each hand is 15 times.

“Pull-over” exercise. This exercise is applied for the enhancement of blood circulation in the muscles of the upper part of the torso. It enhances the extension of shoulder joints, along with breath quality and cardio functioning. In the course of the execution of the exercise, abdominal muscles are normally engaged. The scheme of the execution (Fig. 12) is the following: the initial position is with the patient’s back towards the trainer, sitting on the versatile bench with the angled tilting. The wide grasp is with the patient’s hands of the short grip attached with the cord to the upper block (with a weight of 10 kilograms). Straight-hands-pulling from the rear side of the head is executed to the level

of the chest with exhaling. The amount of repetitions is from 12 to 15 times.



Fig. 11. Execution of "Triad" exercise



Fig. 12. The execution of the "Pull-over" exercise

"Rotation" exercise. This exercise is applied for the enhancement of decompression of the shoulder joint, with the rotators of the shoulder (subscapular, infraspinous, supraspinal, and teres minor muscles) being engaged. The scheme of execution (Fig. 13) is the following: the exercise is executed in a standing position with the patient facing toward the MTB trainer, holding for the additional handles. The arm grip is on the knot attached to the cord from the opposite upper block with a weight of 7.5 kilograms. The patient performs the rotation (the maximal turning) of the shoulder joint inwards.



Fig. 13. Execution of "Rotation" exercise

"Abs enhancement + 5" exercise. This exercise is applied for the strengthening of abdominal muscles and the relaxation of the lower back, as well as for the restoration of blood provision in the muscles of the upper part of the torso. The exercise improves the process of breathing and cardio functioning. In general, this exercise is the combined system of "Abs enhancement" and "Pull-over" exercises. The scheme of execution is in Fig. 14.



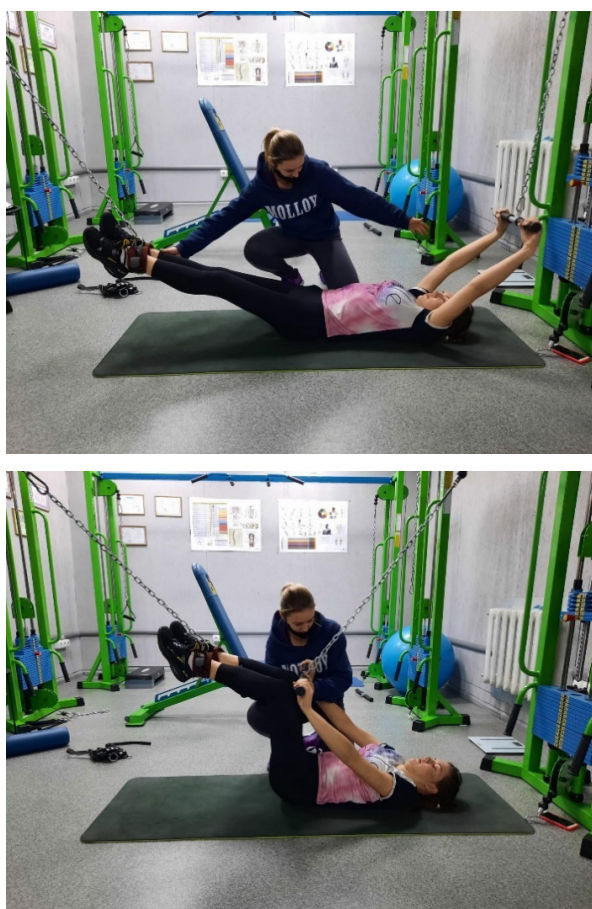


Fig. 14. Execution of "Rotation" exercise

## Discussion

The effectiveness of our elaborated program of kinesitherapy classes was verified via the method of electromyographia. The criteria for the estimation of the effectiveness of the experimental program were the velocity of the affection of the impulse in afferent and efferent ways, the duration of M-response, the number of mobile entities in lower limbs, as well as the levels of agitation and depression of the patients.

As a result of our execution of the classes, elaborated according to our experimental program, there were several positive changes in the psychophysical state of the patients aged from 14 to 20 with Charcot-Marie-Tooth nerval amyotrophia disease, as was justified by the positive tendency of monitored indications. There is the highlight of the genuineness of the changes in the indications of the velocity of impulse impacting in lower limbs (average estimate): 37.1 m/s before the experiment and 60.4 m/s after the experiment on the right, with 36.8 m/s before the experiment and 59.4 m/s after the experiment on the left. The average estimate of the duration of M-response was changed from 28.8 m/s at the beginning of the experiment to 19.3 m/s after the experiment in the lower right limb, as well as from 29.1 m/s at the beginning of the experiment to 20 m/s after the experiment in the lower left limb. The average in-

dications of the number of mobile entities in the lower limbs on the right as well as on the left at the beginning of the experiment were 117.9 and 115.9 respectively, while at the end of the experiment the indications were changed to 275.5 on the right and 269.8 on the left.<sup>3</sup>

There is the detection of several positive shiftings of the functional state of the neuromotor system, which admits the delay of pathological motion stereotypes (it is justified by the neurophysiological impact of the exercises, whose mechanism can be explained as the amplification of the influx of neural impulses via the connected canals and the activation of the upper areas of motion analyzer).

As criteria for the estimation of the effectiveness of the experimental program, there was the application of psychodiagnostic methodology (for detection of the levels of agitation and depression) and pedagogical methods (conversations, surveys, and pedagogical supervision). The comparative analysis of depression levels of the patients before and after the execution of our classes, elaborated according to the experimental program indicated that the qualified level of agitation levels was changed, which means that the subdepressive state was changed to a "depressionless" state. In the course of personal conversation within 2 or 3 weeks, patients acquired positive emotions, the amelioration of their mood, there was the highlighted appearance of a sense of relief and pain reduction.

The results concerning the improvement of the psychophysiological state of patients, acquired after the research, correlate with the results of domestic and foreign specialists, which are occupied with the issues concerning physical therapy, and ergotherapy related to Charcot-Marie-Tooth.

We theoretically justified and elaborated the physical therapy program, which provided for the execution of kinesitherapy classes for patients aged from 14 to 20 years old, diagnosed with Charcot-Marie-Tooth nerval amyotrophia. The physical therapy course was composed of 3 cycles of 2 months of classes (6 months in total) and its physical loading gradually was getting complicated. Every class consisted of 3 stages, which are correct breathing, warm-up, and kinesitherapy classes.<sup>1,2,4,8,15</sup>

As a result of the execution of the classes, elaborated according to the experimental program, there is the detection of physical changes in the psychophysical state of patients aged from 14 to 20 years old, diagnosed with Charcot-Marie-Tooth nerval amyotrophia, which is confirmed by the positive tendency of examined indications.<sup>3</sup>

Positive changes in the functional state of the neuromotor system, which provide the possibility of delaying pathological motion stereotypes, it is explained by the neurophysiological impact of the exercises, whose

mechanism is about the amplification of the influx of neural impulses via the canals and the activation of the upper parts of motion analyzer. The application of the elaborated kinesitherapy program assured the restoration of neural connections of the patients, as well as the formation of compensatory mechanisms and provided for the correction of the psychoemotional sphere.

## Conclusion

The research on the impact of the application of kinesitherapy in the sphere of rehabilitation of patients with Charcot-Marie-Tooth nerval amyotrophia, provides the possibility for us of making the following general conclusions:

1. Charcot-Marie-Tooth disease is the inherited disease of nerves, which is caused by the mutation, which admits several defects in the proteins of neurons. In the course of the progression of Charcot-Marie-Tooth disease, there is the progression of atrophy of muscular tissues, gradually progressing in the area of knuckles, and there is the deformation of the feet and wrists. Over time the disease progresses, bringing the affection of the muscles of other parts of the body, while, at the same time, only the symptomatic methods of treatment are applied. Methods of physical therapy for people with the consequences of nerval amyotrophia are composed individually for every patient.

2. We theoretically justify and elaborate a physical therapy program, which provided for the execution of kinesitherapy classes for patients aged from 14 to 20 years old, diagnosed with Charcot-Marie-Tooth nerval amyotrophia. The rehabilitation course consists of 3 cycles for 2 months of classes (6 months in total), and physical loadings were getting more complicated over time. Every class consisted of 3 stages: the correct breathing, the warm-up, and the kinesitherapy classes.

3. As a result of the execution of the classes, elaborated according to our experimental program, there are positive changes in the psychophysical state of the patients aged 14 to 20 years old, diagnosed with Charcot-Marie-Tooth nerval amyotrophia, which is justified by the positive tendency of inspected indications: 37.1 m/s before the experiment and 60.4 m/s after the experiment on the right, as well as, 36.8 m/s before the experiment and 59.4 m/s after the experiment on the left. The average estimate of the duration of M-response was changed from 28.8 m/s before the experiment to 19.3 m/s after the experiment in the lower right limb, as well as 29.1 m/s before the experiment and 20.0 m/s after the experiment in the lower left limb. The indications of the number of mobile entities in the lower limbs on the right and on the left at the beginning of the experiment were 117.9 and 115.9 respectively, while at the end of the experiment were changed to 275.5 on the right and 269.8 on the left. Positive changes in the functional state of

the neuromotor system provide for delaying pathological motion stereotypes can be explained by the neurophysiological impact of the exercises, whose mechanism is about the amplification of the influx of neural impulses via canals and activation of upper parts of the motion analyzer. It favoured the restoration of neural connections, and formation of compensatory mechanisms and caused the correction of the psychoemotional sphere of the patients.

4. The comparative analysis of depression levels of the patients before and after the execution of the classes, according to our elaborated experimental program displayed the qualified change of agitation level of the patients - the subdepressive state was changed to a "depressionless" state. On the course of personal communication, over 2 weeks of kinesitherapy classes, patients acquired positive emotions and the improvement of their mood, they started highlighting the demonstration of the sense of relief and pain killing.

Therefore, our elaborated experimental physical therapy program, providing the execution of kinesitherapy classes for patients aged from 14 to 20 years old, diagnosed with Charcot-Marie-Tooth nerval amyotrophia demonstrated its full validity. The prospects of further research can be formed in a way of creation of a more advanced type of physical therapy for patients with nerval amyotrophia via kinesitherapy treatment methods.

Our research does not contradict the opinion of the leading domestic and foreign researchers, concerning the urgent necessity for the elaboration of new theoretical concepts of physical therapy, and ergotherapy for patients, diagnosed with Charcot-Marie-Tooth nerval amyotrophia.

## Declarations

### Funding

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### Author contributions

Conceptualization, L.R., L.K., Y.V., A.H. and A.L.; Methodology, L.R., L.K., Y.V., A.H. and A.L.; Software, L.R., L.K., Y.V., A.H. and A.L.; Validation, L.R., L.K., Y.V., A.H. and A.L.; Formal Analysis, L.R., L.K., Y.V., A.H. and A.L.; Investigation, L.R., L.K., Y.V., A.H. and A.L.; Resources, L.R., L.K., Y.V., A.H. and A.L.; Data Curation, L.R., L.K., Y.V., A.H. and A.L.; Writing – Original Draft Preparation, L.R., L.K., Y.V., A.H. and A.L.; Writing – Review & Editing, L.R., L.K., Y.V., A.H., X.Ž., A.L., W.Z., R.M., M.H.-D., O.S. and V.K.; Visualization, L.R., L.K., Y.V., A.H., X.Ž., A.L., W.Z., R.M., M.H.-D., O.S. and V.K.; Supervision, L.R., L.K., Y.V., A.H., X.Ž., A.L., W.Z., R.M., M.H.-D., O.S. and V.K.; Project Administration, L.R., L.K., Y.V., A.H., X.Ž., A.L., W.Z., R.M., M.H.-D., O.S. and V.K.; Funding Acquisition, L.R., L.K., Y.V., A.H., X.Ž., A.L., W.Z., R.M., M.H.-D., O.S. and V.K.

### Conflicts of interest

The authors declare no competing interests and no conflict of interests.

### Data availability

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

### Ethics approval

This study was approved by Institute Ethics Committee, National University Yuri Kondratyuk Poltava Polytechnic, Poltava, Ukraine (Ref: NUYKPP/IEC/2022/123). We adhered to the principles of ethics thereafter throughout the study.

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