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Algorithm for the use of physical therapy in patients with compression-ischemic neuropathies of the upper limb

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Purpose: *to develop an algorithm of rehabilitation measures in people with compression-ischemic neuropathies of the upper limb.*

Material & Methods: *the study involved 67 patients with compression-ischemic neuropathy of the upper limb, among whom were 43 (64.2%) men and 24 (35.8%) women. The duration of the disease ranged from 3 to 18 months. The age of the examined varied from 18 to 67 years, on average 42,3±9,4 years. The study was conducted on the basis of the neurological department and the physiotherapy department of the Kiev city clinical hospital No. 4 of Kyiv in the period from 2017 to 2019. We used the following research methods: analysis and synthesis of literature data, content analysis of medical records, rehabilitation examination.*

Results: *an important condition for the treatment of tunnel neuropathies is an integrated approach, which should have the following components: a comprehensive rehabilitation examination to determine the main rehabilitation problems; statement of tasks with prediction of the final result; selection of appropriate individual and optimal physical therapy means for each patient. An algorithm of physiotherapeutic intervention has been developed, including the use of the following measures: kinesitherapy with neurodynamic mobilization, taping, stimulating massage, instrumental physiotherapy, mechanotherapy and hydrotherapy. The proposed algorithm of physical therapy measures differed from standard programs in that it allowed to formulate the goals of the rehabilitation process taking into account a differentiated approach to solving the problem of rehabilitation of patients with compression-ischemic neuropathies of the upper limb with varying severity of motor function disorders; had a comprehensive, multidisciplinary approach to solving the problems of patients with this pathology.*

Conclusions: *the development of an algorithm of physiotherapeutic intervention for people with compression-ischemic neuropathies of the upper limb is an urgent problem due to the fact that compression-ischemic neuropathies of the upper limb often lead to a decrease in the patient's quality of life and long-term disability. When developing an algorithm of rehabilitation measures, it is necessary to take into account: individual features of the functional state of patients with this pathology, the presence and severity of motor and sensory disturbances, which depend on which particular nerve of the arm is affected (median, ulnar or radiation), the nature of the lesion, age, professional activity and patient needs.*

Keywords: *neuropathy, upper limb, physical therapy, algorithm, conservative treatment.*

Introduction

Diseases of the peripheral nervous system is a major medical, economic and social problem for humanity. Statistics indicate not only an increase in neurological diseases, but also at their early onset [1; 4; 9]. In this regard, the role of neurological rehabilitation aimed at restoring a high quality of life, which was excited as a result of damage to the peripheral nervous system, is significantly increasing throughout the world.

The current stage of physical therapy can be defined as the stage of an integrated approach to recovery, the ultimate goal of which is the return of patients to society, to labor and social activity. The search for new methods of treatment and restoration of the functional state of the upper limb with peripheral neuropathies is carried out in different directions. One of them is the improvement of neurosurgical treatment methods [6; 13; 15], the introduction of orthopedic operations [3]. In order to stimulate regeneration, they use drugs (including medicines) that improve nerve microcirculation and conduction along the nerve trunk – long-term chronic electrical stimulation [15], a large arsenal of methods of apparatus physiotherapy [5; 7; 8].

However, the results of the treatment of injuries of the peripheral nerves of the upper limb in wide clinical practice are not always satisfactory due to the fact that the available opportunities for the rehabilitation of such victims are often not realized. These drugs are mainly aimed at restoring the structure and function of the damaged nerve of the upper limb, the activity and participation of patients in everyday life with this pathology are not always taken into account in the treatment process, contrary to the main provisions of the International Classification of Functioning, Disability and Health, which has been introduced for some time in the activities of medical, social and educational workers of the Ministry of Health of Ukraine.

It should be noted that work on this problem is of a single nature, a clear algorithm of rehabilitation measures for this pathology has not yet been developed. A comprehensive, scientifically based approach to solving the problem of rehabilitation of persons with peripheral neuropathy of the upper limb, taking into account the type of treatment (conservative or surgical), the course of the disease, the impact of rehabilitation measures on the quality of life of patients, is currently not found in the available literature.

Purpose of the study: to develop an algorithm of rehabilitation measures in individuals with compression-ischemic neuropathy of the upper limb.

Material and Methods of the research

The study involved 67 patients with compression-ischemic neuropathy of the upper limb, among them there were 43 (64,2%) men and 24 (35.8%) women. The duration of the disease ranged from 3 to 18 months. The age of the examined ranged from 18 to 57 years, an average of 39,4±10,7 years. The study was conducted on the basis of the neurological department and the physiotherapy department of the Kyiv City Clinical Hospital No. 4, Kyiv, from 2017 to 2019. We used the following research methods: analysis and synthesis of literature data, content analysis of medical records, rehabilitation examination.

Results of the research

Multidisciplinary rehabilitation today is a key approach in the application of medical and rehabilitation measures for various diseases. This approach is of fundamental importance in the restoration of motor functions, activity and participation of patients with compression-ischemic neuropathy of the upper limb. This holistic approach is supported by the World Health Organization's International Classification of Functioning, Disability and Health, which is the only basis for a multidisciplinary approach [2; 4].

It is known that an important condition for the treatment of tunnel neuropathies is an integrated approach, which should have the following components:

a) comprehensive rehabilitation examination to determine the main rehabilitation problems;
b) setting goals for predicting the final result;
c) selection of appropriate individual and optimal physical therapy means for each patient (Figure 1).

The basic principles of physical therapy for this pathology are:
- partnership between a doctor and a patient;
- versatility of efforts or complexity;
- unity of psychosocial and biological methods;
- continuity and individualization of therapeutic effects [14].

Rehabilitation examination included:

1. Interviewing the patient, determining the goals of physical therapy and patient requests.
2. Physical examination: examination of the patient; determination of the range of motion in the affected upper limb; sensitivity tests.
3. Motor examinations: manual-muscle testing; visual analogue pain scale; provocative tests: Falena, Tinelya.
4. Functional assessment: using the Boston DASH questionnaire, the main functional deviations were determined, and based on this, goals at the level of activity and participation in the SMART format with the ICF were related.

At the stage of planning the rehabilitation process and setting goals, we took into account the results of the patient examination and their needs. The goals of rehabilitation measures were determined depending on professional activities, everyday lifestyle and leisure.

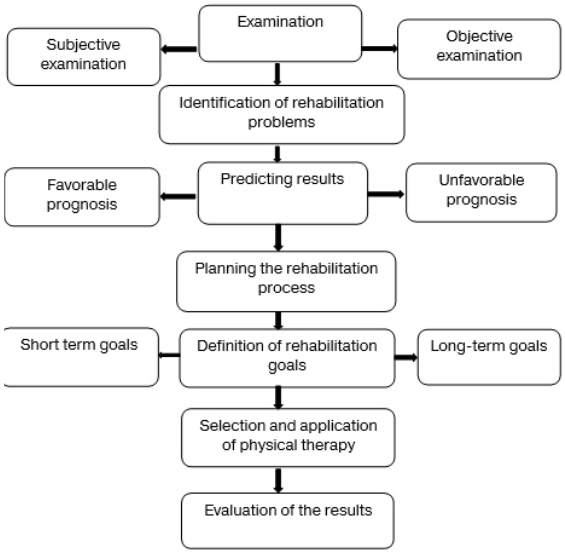

Fig. 1. Sequence of actions in the process of physical therapy with compression-ischemic neuropathy of the upper limb

The course of neuropathies of the peripheral nerves of the upper limb of the nerve has certain periods of the disease, each of which is characterized by a corresponding functional state of damage (acute, subacute, remission, recovery) and the use of physical therapy measures.

We started physiotherapeutic measures immediately after the diagnosis was established, since the further course of the recovery process depends on this in many respects.

The goals of physical therapy are:

1) maximum possible restoration of impaired functions of the wrist and hand;
2) improving the elastic properties of the joint-ligamentous apparatus;
3) restoration of muscle strength of the hand and affected upper limb;
4) improvement of sensory-motor control and proprioceptive sensitivity;
5) adaptation to domestic and professional loads;
6) restoration of overall performance based on the maximum restoration of the functionality of the upper limb.

The developed algorithm of physical therapy measures took into account:

- methodological approaches of the International Classification of Functioning in establishing the direction of the rehabilitation process;
- the basis for the formation of individual smart goals (smart tasks) for patients;
- individual needs of patients and lifestyle activity;
- motor and sensory disturbances and changes in the psycho-emotional state, affecting the prognosis of recovery.

The basis for the development of the algorithm of rehabilitation measures was the scientific, organizational, substantive and normative basis, the need for a differentiated approach taking into account motor and sensory disturbances, which depend on which particular nerve of the arm is affected (me-

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dian, ulnar or radiation), the nature of the lesion and individual characteristics functional state of patients.

The median nerve (carpal tunnel syndrome) and the ulnar nerve (cubital canal syndrome) are most often affected, and the radial nerve compression syndrome is less commonly observed. During the initial examination, carpal tunnel syndrome was diagnosed in 39 (58,2%) patients, cubital canal syndrome in 19 (28,4%) patients, and radial nerve compression syndrome ("spiral syndrome" in 9 (13,43%) patients). channel").

It is known that with carpal tunnel syndrome, the hand hangs down, extension of it and the main phalanges of the fingers is impossible, fingers hang down, and it is impossible to retract the thumb. Sensitive disorders are less pronounced, there is swelling of the hand.

If the median nerve is damaged, there is no flexion of 1, 2, and partially 3 fingers, it is impossible to rotate the hand, contrast and retract 1 finger, which is in the same plane with the other fingers ("monkey paw"). Decrease in all types of sensitivity on the palmar side of the hand and terminal phalanges of 2, 3, 4 fingers on the back side. Pain and pronounced autonomic manifestations are characteristic.

With compression damage to the ulnar nerve, flexion of 4, 5 fingers, adduction and dilution of all fingers leads to a violation; 5, 4 and partially 3 fingers extended in the main and bent in the middle phalanges ("clawed paw"). Severe atrophy of the interosseous muscles. Sensitivity is reduced on the ulnar half of the hand, V and half of the fourth finger [5; 12].

The algorithm of physiotherapeutic intervention provided for the use of the following measures: kinesitherapy with neurodynamic mobilization, taping, stimulating massage, apparatus physiotherapy, mechanotherapy and hydrorehabilitation (Figure 2). The proposed algorithm of physical therapy measures differed from standard programs in that it allowed to formulate the goals of the rehabilitation process taking into account a differentiated approach to solving the problem of rehabilitation of patients with compression-ischemic neuropathy of the upper limb with varying severity of motor function disorders; had a comprehensive, multidisciplinary approach to solving the problems of patients with this pathology. The use of physical therapy is designed for 30 days.

Kinesitherapy helps to restore the functional parameters of the wrist and hand, strengthen the muscles of the affected upper limb, increase the amplitude of movements, increase endurance. The basis of kinesitherapy are various forms of movement – therapeutic exercises [7; 8]. Therapeutic exercises allow you to implement most of the goals of rehabilitation with neuropathy of the upper limb. We selected exercises taking into account their facilitated implementation (starting position, sliding planes, etc.); damage localization; simplicity or complexity of movements (elementary, commonwealth, coordination, etc.) degrees of activity (passive, passively active, active) restoration or development of necessary motor skills. At the beginning of the rehabilitation course, we used passive, passively active, ideomotor exercises. When the patients' condition improved, the exercises were supplemented with isometric exercises - static alternating tension and muscle relaxation of the affected area. The tension grew gradually and reached maximum effort at 6–7 seconds. The rest period after each exercise is about 1,5–2 minutes.

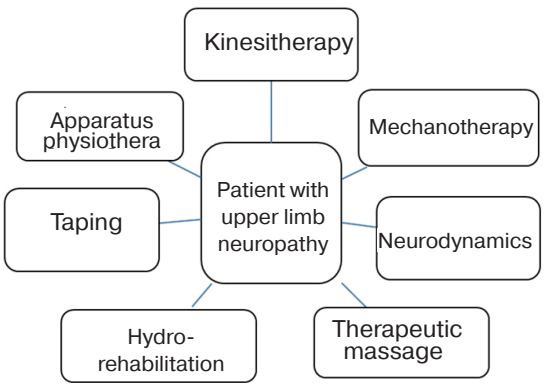

Fig. 2. Components of the algorithm of rehabilitation measures for compression-ischemic neuropathy

Static tension allows you to focus and continue the moment of maximum muscle tension, which allows you to selectively affect various muscle groups. The complex consisted of 4–6 exercises, which were performed from different initial positions - sitting, lying on your back, on your stomach, on your side and was carried out 2–3 times a day for 10–15 minutes. The restoration of muscle strength in the affected area was achieved with the help of strength exercises, resistance exercises, additional burdens (expanders, dumbbells). Used mainly therapeutic strength exercises.

Before the start of classes, indicators of active and passive movements performed by the patient were determined. The indicators of passive movements, as a rule, exceeded the indicators of active movements. The greater the difference between these indicators, the greater the reserve extensibility, and hence the possibility of increasing the amplitude of active movements.

To consolidate the achieved range of movements, positioning was used using special langets or orthosis. The minimum fixation time is 10 minutes with a gradual increase to 40–60 minutes. When conducting kinesitherapy classes, general developmental exercises, breathing exercises, corrective exercises, exercises with objects and relaxation were also used. Classes were held daily or every other day, the duration depended on the stage of the disease: 15–25 minutes, 25–40 minutes.

With neurodynamic techniques, we have applied neurodynamic testing and neuromobilization. The primary tasks of neuromobilization in compression-ischemic neuropathy of the upper limb include: elimination of pain; prevention of edema of the nerve and perineural tissues; stimulation of nerve conduction and regeneration of nerve fibers; improvement of local and general blood and lymph flow; prevention of scar formation at the site of damage; prevention or elimination of trophic disorders, stiffness in joints, contractures and changes that impede the restoration of movements of the upper limb; compensation for lost movements by the like (with a complete and stable reaction of degeneration) due to synergistic muscles that have retained innervation.

Before starting the diagnostic part, it is recommended that electroneuromyography is performed to determine the parameters of the impulse conduction along nerve fibers. Neurodynamic testing was performed according to strict algorithms

and consisted of movements of the upper limbs in certain directions and at a certain angle with the help of a physical therapist [19].

If, according to the results of neurodynamic and manual-muscle testing, there were no contraindications to the use of neuromobilization, we started neurodynamic exercises. The implementation of the techniques of non-mobilization is carried out through the phased application of flexion, extensor movements and rotation with the help of the hands of a physical therapist according to clearly defined guidelines [20; 21]. The mobilization of nerve movements up and down, sliding along the length of the channel, sometimes stretching to full recovery is carried out. Patients engaged in therapeutic exercises with elements of neuromobilization daily for 30–40 minutes.

An important place among rehabilitation measures for compression-ischemic neuropathy is kinesiotepuvannia [17; 18]. Kinesiotheipuvannia is used to eliminate pain, improve blood circulation, activate proprioceptive sensitivity, increase muscle tone, increase the range of active movements in the affected upper limb.

The kinesiological taip was applied according to a certain scheme, depending on the existing motor disorders. So, with carpal tunnel syndrome, teipuvannya of the hand, wrist joint and forearm were performed, various types of teipes were used – I-teip and Y-teip [17; 18]. In case of cubital channel syndrome, the application was performed using I-tape on the inner surface of the hand and forearm from the IV-V finger to the medial epicondyle of the humerus through the wrist joint, as well as on the outer surface of the hand and forearm in the direction of the lateral epicondyle of the humerus.

Therapeutic massage was carried out in order to stimulate the paretic muscles of the affected limb mainly in the diseased areas of the arm, sometimes on symmetrical limbs [8; 9]. In case of neuropathy of the ulnar nerve, the forearm, shoulder and elbow joint were massaged, in case of damage to the radial nerve – forearms, wrists, hands, and in case of neuropathy of the median nerve – wrists, hands and fingers. The following techniques were applied to massaging these areas: stroking, rubbing, kneading and shaking. Massage was carried out every other day for 20–30 minutes.

We used mechanotherapy to increase flexibility and amplitude of movements, improve coordination of movements, increase sensorimotor control and proprioceptive sensitivity, increase muscle strength [10; 11]. We used the ARTROMOT ®-F rehabilitation simulator, which has an extended range of movements in different planes. Exact adjustment of the range of motion in the joint allows the patient to practically not feel pain when performing exercises on the simulator. With each session, the range of motion gradually increased, if possible until the joint was fully restored. The technique of mechanotherapy for patients with compression-ischemic neuropathy of the arm was built taking into account the biological and physiological changes in the patient's body, the stage of the disease and the degree of damage, the time elapsed after the first clinical signs of the disease. Classes were held every other day, lasting 20–30 minutes.

To eliminate the stable limitation of the amplitude of movements in the joints of the hand and fingers, to reduce the strength of the muscles, resulting in a total loss of finger grip and disability, passive and active exercises in water (hydrorehabilitation) were used [7; 8]. Much attention was paid to the application of exercises for training the basic functions of the hand: delight, content, moving objects of various densities. Exercise to the delight of elastic objects in lightened conditions of the aquatic environment helps to correctly orient the direction of movements made by the fingers, thanks to the purposeful nature of the movements and easy opposition of the used object (sponge, rubber ball, etc.).

In connection with the fixed nature of motor disorders, passive exercises in water are performed according to general methodological rules (slow pace of movement, gradually increasing effort, a short delay in movement in the extreme position). To restore the working (cylindrical) finger grip by passively bending all fingers, a sufficient amplitude of bending in the metacarpophalangeal joints is achieved. Further accomplishment of free active movements in water and with self-help, as well as exercises in water to delight and compress the ball helps to consolidate the range of movements in the joints achieved by passive exercises. Classes were held every other day, the duration depended on the stage of the disease: 15–20 minutes, 25–40 minutes.

In patients with damage to the peripheral nerves of the hand, the most common symptoms that require the appointment of physiotherapeutic procedures are a decrease in muscle tone, pain, motor and trophic disorders [16]. For this purpose, we used: a constant magnetic field on the flexor muscles of the arms and extensors of the legs, 20–30 mT, 15–20 minutes, every other day, 7–10 procedures; acupressure with an exciting technique, every day or every other day;

Stimulating services (indicated for motor and trophic disorders): electrostimulation of weak muscles with sinusoidal modulated currents in the rectified mode with "send-pause" modulations at a frequency of 100 Hz, a depth of 75–100%, the ratio of the duration of the current and pause as 1:2, 2–3 minutes per field, the total duration of the procedure is 8–10 minutes, 15–20 procedures, daily. It is advisable to use a bipolar technique with the location of the same area electrodes at both ends of trained antagonists of hypotonic muscles. For the purpose of electrical stimulation, multichannel stimulation devices of the Myotonia type can be used. The correct selection of stimulation parameters is important to avoid overfatigue of the hypotonic muscle.

Conclusions / Discussion

The development of an algorithm for physiotherapeutic intervention for persons with compression-ischemic neuropathy of the upper limb is an urgent problem in view of the fact that compression-ischemic neuropathy of the upper limb often leads to a decrease in the quality of human life and long-term disability.

When developing an algorithm of rehabilitation measures, it is necessary to take into account the individual characteristics of the functional state of patients, the presence and severity of motor and sensory disturbances, which depend on which particular nerve of the arm is affected (median, ulnar, or radiation), the nature of the lesion, age, professional activity, and patient needs. The main rehabilitation measures for this pathology are: kinesitherapy with neurodynamic mobilization,

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teipuvannya, therapeutic massage, apparatus physiotherapy, mechanotherapy and hydrorehabilitation.

Prospects for further research are to determine the effectiveness of the developed algorithm of rehabilitation measures for this pathology and to develop recommendations for home rehabilitation.

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