

METHODICS OF THE POSTTRAUMATIC BRACHIAL PLEXUS INJURIES REHABILITATION (CASE STUDY)

METODICA RECUPERĂRII LEZIUNILOR POSTTRAUMATICE ALE PLEXULUI BRAHIAL (STUDIU DE CAZ)

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Cuvinte cheie: plex brahial, traumatism, recuperare, metodică

Abstract. The posttraumatic sequelae of brachial plexus nerve injuries require a complex approach from a medical (surgical, orthopaedic, and orthotic – if applicable) and physical therapeutic perspective, for the functional rehabilitation necessary to the professional and social reintegration of the patient.

Rehabilitation of this type of injury is highly difficult, considering the complexity of consecutive dysfunctions, which can cause major invalidity. The most important points in the therapeutic approach are the initial clinical and functional diagnosis, the objectives per phase, and the selection of the most effective means and methods.

It is necessary to instruct the patient and to persuade him to collaborate for the rehabilitation process *per se*, considering that making progresses is related both to the quality of the treatment and application monitored and guided by specialist, and to the outside setting, such as the patient's domicile. The observance of the generally valid principles in physical therapy, the use of proper means and methods, within a logical and methodical sequence, and of the possibilities and demands per phase (reflected in the results of assessments) are indeed necessary and they ensure the progress is well carried out, leading to an improvement or to the cure of this type of traumatism.

Rezumat. Sechelele posttraumatice ale leziunii nervoase a plexului brahial necesită o abordare complexă din punct de vedere medical (chirurgical, ortopedic și ortotic – dacă este cazul) și kinetoterapeutic, în vederea unei recuperări funcționale necesară pentru reintegrarea social și profesională a pacientului.

Recuperarea acestui tip de afecțiune este foarte dificilă, luând în considerare complexitatea disfuncțiilor consecutive care pot produce invalidități majore. Punctele cheie ale abordării kinetoterapeutice sunt: diagnosticul inițial clinic și funcțional, stabilirea obiectivelor pe faze și selecția celor mai eficiente mijloace și metode.

Este necesar să instruiem pacientul și să îl convingem să colaboreze în procesul de recuperare, având în vedere că obținerea rezultatelor este strâns legată atât de calitatea tratamentului oferit de o persoană specializată și de munca pacientului la domiciliu.

Observarea primncipiilor valide ale aplicării kinetoterapiei, folosirea unor mijloace și metode adecvate în cadrul unor secvențe metodice logice, precum și respectarea cerințelor impuse de fiecare fază de recuperare (refectate din rezultatele evaluării), sunt întradevăr necesare și asigură progresul pozitiv al pacientului cu acest tip de traumatism.

Introduction

For the posttraumatic sequelae of brachial plexus nerve injuries a complete recovery from a medical, surgical, orthopaedic, orthotic, physical therapy perspective is required, with professional and social integration purposes.

The rehabilitation of this type of injury is highly difficult, considering the complexity of consecutive dysfunctions related to nervous structure and functionality. The drawbacks for both patient and therapist include the uneven nerve rehabilitation of the damaged nerves (impossible

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to control individually), the manifestations of the disease, anaesthesias, trophic disorders, major invalidity, effects on the patient's psyche, and long-term treatment.

Brachial plexus is made up by the anastomosis of the anterior branches of the last four cervical nerves (C5–C8) and of the first dorsal rachidian nerve (T1). It is also irregularly supplied by the C4 and D2 anterior branches. The brachial plexus comprises the upper trunk made by the C5–C6 anterior branches, the middle trunk C7, and the lower trunk C8–D1. Each of the trunks subdivides into anterior and posterior branches. The superior anterior and middle branches of the trunks make up the lateral fascicle, the posterior ones – the posterior fascicle, while the anterior branch of the lower trunk makes up the medial fascicle. The brachial plexus has a supraclavicular side (the trunks) and an infraclavicular side (the fascicles). Fig. 1.

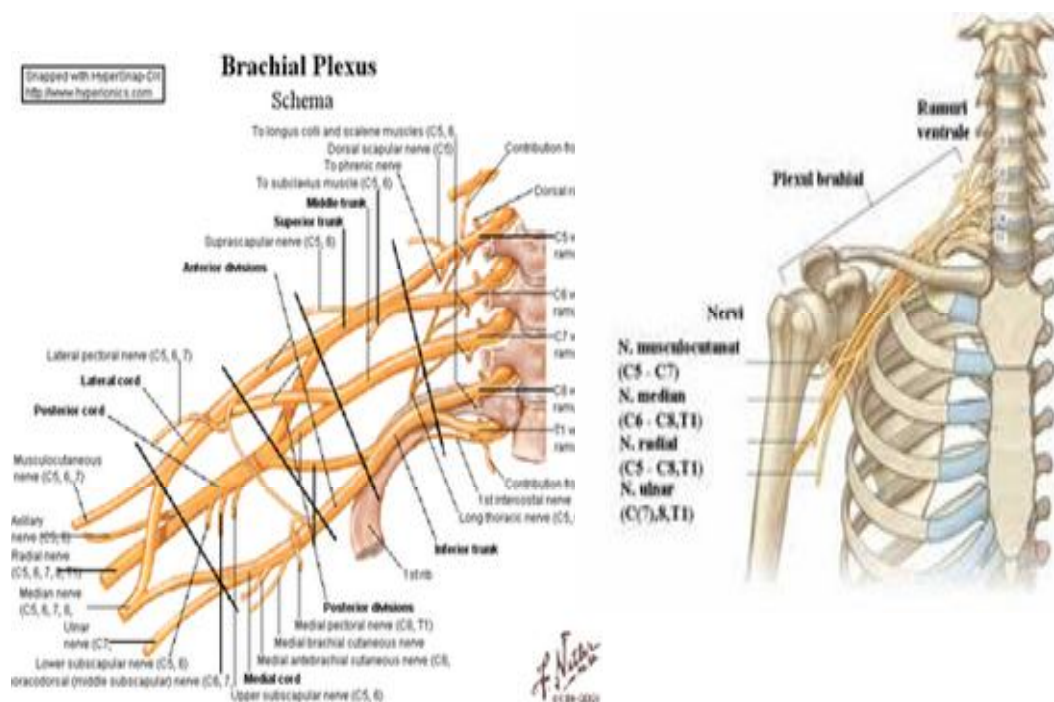


Figure 1. Brachial plexus [2]

The motor and sensitive roots of the brachial plexus for the muscles and teguments in the areas of the scapular belt and of the free extremity of the upper limb:

- C5 – for the abductors, external rotators, and forearm extensors;
- C6 – for the adductors, internal rotators, arm flexors, forearm extensors and pronators;
- C7 – for the wrist extensors and the long extensors of the fingers;
- C8 – for the wrist flexors the long flexor of the fingers;
- T1 – for the hand intrinsic muscles [1]

The signal-generating spinal motor neuron, functions by the “all or nothing” law. The function of unidirectional transportation of the elaborated signal belongs to the axon and it occurs discontinuously, with ups and downs. The information is received on the presynaptic level, while the decoding is postsynaptic; the effect resulted for the functioning of the entire system, is the contraction of muscle fibre.

The brachial plexus can be affected on various levels, from the roots of spinal nerves to the terminal branches [3]

There are various causes for the brachial plexus injuries. The traumatic agents can be mechanic, toxic, thermal, ischaemic; compression is the most common physical–mechanic traumatic factor [4].

In case of traumatism, nerve fibres may suffer various degrees of damage, which can be divided into three large categories:

- neurotmesis – complete cutting;

- axonotmesis – important injury, but the basal lamina of the Schwann cell remains intact;
- neuropraxia – short-term functional, sensory, and motor disorder.

Nerve injuries present a major interest considering that the functions of the damaged segments were altered; the recovery depends on the precision of the diagnostic, on the surgery performed, and on the rehabilitation treatment.

Nerve recovery depends on the level of the injury; the more proximal, the longer the recovery. Neurofibres generate differently: starting with the proximal segment, it occurs by 1.5 mm/day, in the injury area by 0.25 mm/day, and in the distal segment by 3–4 mm/day. [5]

Differential diagnosis of the posttraumatic injuries of the brachial plexus is apparent, taking into account the traumatic factor (compression, elongation, snatching) and the symptomatology: scapula–humeral luxation, head or neck of the humerus fracture.

The clinical examination, the X-rays, the electrodiagnosis methods – motor conduction velocity (MCV) and electromyography (EMG), CT-scan, can ensure the precision of the diagnosis. Peripheral nerve injuries determine three basic clinical syndromes: motor, sensory, and vasculotrophic.

Physical therapy is essential in ameliorating/treating them, and the intervention occurs on a long-term basis. [6,7,8]

Study objectives

The objectives set for the recovery of these complex injuries are as follows:

- preventing vicious attitudes, stiffness, and deformations;
- preventing muscle atrophies;
- re-educating reinnervated muscles;
- rehabilitating the kinaesthetic images of movement;
- rehabilitating sensitivity;
- preventing vasculotrophic disorders;
- re-educating movement and precision coordination;
- functional rehabilitation for professional activities [6]

Hypothesis

An early onset of the physical therapeutic treatment with the available means and methods: physical exercises, massage, electrotherapy, hydrothermal therapy, occupational therapy (OT) and ergotherapy (E) ensures the rehabilitation of the injured upper limb.

Subjects and methods

The study belongs to the following category: rehabilitation methodology – with practical applications – case study.

Research methods used – theoretical research, observation, anamnesis, exploration and assessment methods, kinesiotherapy-specific means and methods.

Period of the study: 19.10.2012–15.12.2012

The subject of this study – A.C. – is a female patient of the Clinical Recovery Hospital, Neurology and Neuromotor Recovery Clinic, aged 56. She had an accident at home (fall from height), which caused superior left-sided paralysis of the brachial plexus.

Functional clinical exam:

- kyphoscoliotic posture– functional (passive and voluntary recovery);
- motor deficit of the following muscles: deltoid, supraspinatus, infraspinatus, teres major, pectoralis major, and latissimus dorsi;
- functional deficit – alteration of the flexion, abduction, arm adduction, internal and external rotation;
- reduced bicipital and tricipital reflex;
- muscular hypotonia of the scapula–humeral belt and of the arm;
- sensitivity disorders – hypoesthesia on the external area of the arm and forearm.

Physical therapy programme

Phase I

Objectives:

1. Preventing joint stiffness and dysfunctional postures (preventing the humeral head subluxation).
2. Maintaining the trophicity of the paralyzed muscles.
3. Preventing vasculotropic disorders.
4. Re-educating the paralyzed muscles.
5. Regaining functionality and ability.
6. Re-educating the sensitivity.
7. Obtaining a favourable physical and mental state.

Means used (in variable proportions) were adjusted to the momentary situation of the patient.

After a 14-day hospitalization period, the patient came in for the outpatient treatment and she performed at home the recommended programme and activities specific to occupational therapy.

Rehabilitation programme

1. Posturing the left upper limb with the help of an orthotics for shoulder and elbow in functional position: shoulder (60° abduction, 45° flexion), elbow (90° flexion), forearm in slight pronation.
2. Toning massage for the entire left upper limb and for the back, with a focus on the shoulder area.
3. The use of heat – wrap treatments with paraffin for the left shoulder area.
4. Analytical passive mobilisations in all normal motion planes and axes.
5. Passive extension manoeuvres on the damaged muscles for the onset of the stretch reflex, followed by the execution of the voluntary movement *per se*.
6. Coordination exercises.
7. Electric stimulation of the muscles affected by paresis, with the active participation of the female patient, who voluntarily commands the movement.
8. Neuromuscular and proprioceptive facilitation techniques: “rhythmic initiation” (RI), “repeated contractions” (RC), “active movement with relaxation–opposition” (AMRO) for the damaged muscles.
9. Breathing exercises, associated with active mobilisations of the upper limbs and with gait exercises.
10. Correcting and maintaining the correct posture of the spine.
11. Active exercises comprising flexion, extension abduction, adduction, rotations, circumduction for: head, neck, trunk, lower limbs, executed in front of a mirror.
12. Exercises with objects: medicinal ball, skipping rope, circle, elastic bandage etc.
13. Exercises with apparatus: ergonomic device, stepper, treadmill.
14. Exercises for the re-educating sensitivity.
15. Longitudinal galvanisation – left upper limb.

Phase II

Objectives:

1. Improving the muscular force of the scapular belt and of the entire limb.
2. Maintaining joint mobility.
3. Regaining coordination and movement ability.
4. Re-educating sensitivity.
5. Maintaining the correct posture of the spine.
6. Improving the breathing.
7. Maintaining a favourable physical and mental state.

In the second phase, the advice is to increase the loading (intensity and volume of the effort), increasing the complexity of exercises and focusing on individual work (active movements with objects and high endurance).

Rehabilitation programme

1. Toning massage for the entire left upper limb and for the back.
2. Breathing exercises accompanied by active movements of the upper limbs.
3. Exercises for posture correction in front of a mirror.
4. Various types of gait, while maintaining the correct position of the spine, hands to the back of the head (of while holding a cane).
5. Exercises with objects: medicinal ball, cudgels, skipping rope.
6. Pulley therapy.
7. Kabat diagonals executed unilaterally and bilaterally, symmetrically and asymmetrically.
8. General gymnastics exercises involving all segments
9. Exercises with apparatus: treadmill, ergonomic device, stepper, ramer
10. Free breathing and gait exercises
11. Hydrotherapy
12. Exercises for the re-education of sensitivity

Results

Individual assessment had been made in the initial and final phase in relation to the evolution dynamics.

Result assessment at the end of *phase I* of the rehabilitation:

1. The force of the muscles innervated by the branches of the upper brachial plexus increased from F_2 to F_3 , as illustrated in Table I.
2. An improvement in the tone of the damaged muscle.
3. An improvement of the motor control on the level of the damaged muscles.
4. Maintaining the correct posture of the entire body.
5. The patient uses the left upper limb for household activities.

Final assessment

1. An increase in the force of the damaged muscles from F_4 to F_5 .
2. Regaining coordination and movement ability.
3. Sensitivity testing underlines that things are back to normal.
4. An improvement of the incorrect posture of the spine.
5. An improvement in the patient's physical and mental state.

By improving the tone, force, and mobility, and by reducing the hypoesthesia areas, the female patient is presently capable of training her left upper limb with complete exercises.

For the patient, occupational therapy (knitting and sewing) has represented an additional helping method in the recovery of the normal functions of the left upper limb. The global assessment of the upper limbs denotes that the patient can resume her household duties.

Table I. Muscular force assessment (of the left upper limb)

Muscle	Force		
	19.10.2012	12.11.2012	15.12.2012
Deltoid	2	3	4
Supraspinatus	2	3	4
Infraspinatus	2	3	4
Teres major	2	3	4
Pectoralis major	3	4	5
Latissimus dorsi	2	2+	3
Forearm flexors	4+	5	5
Forearm extensors	4+	5	5
Supinators	4+	5	5

Pronators	4+	5	5
Wrist flexors	4+	5	5
Wrist extensors	4	5	5
Flexors of the fingers	4+	5	5
Extensors of the fingers	4+	5	5
Adductors of the fingers	4	5	5
Abductors of the fingers	4+	5	5

Table II. Global motor assessment, for both upper limbs

Action	Right upper limb	Left upper limb		
		19.10.2012	12.11.2012	15.12.2012
1. Taking the hand to the mouth	5	2	3	4
2. Taking the hand to the clavicle on the same side	5	1	2	3
3. Taking the hand to the opposite knee	5	4	4	5
4. Arm abduction below the horizontal	5	1	3	4
5. Arm abduction above the horizontal	5	0	1	2
6. Taking the hand to the back	5	0	1	2
7. Forearm pronation and supination	5	5	5	5
8. Compete closing and opening of the hand	5	5	5	5
9. Grabbing and letting go of an object	5	5	5	5
10. Cylindrical prehension	5	5	5	5
11. Hand – opposite shoulder	5	1	2	3
12. Hand – back of the head	5	0	1	2
13. Distance between fingers and C ₇ apophysis	5	0	0.5	1
Total score	65	29	32.5	46

Table III. Testing the tactile, thermal, and pain sensitivity in the cutaneous areas corresponding to the C₄-D₁ roots

Innervation	Right upper limb	Left upper limb		
		19.10.2012	12.11.2012	15.12.2012
C ₄	2	2	2	2
C ₅	2	1	1	2
C ₆	2	1	1	2
C ₇	2	2	2	2
C ₈	2	2	2	2
D ₁	2	2	2	2

(0= absent, 1= reduced, hypoesthesia, 2= normal)

Discussions

The main objective in the first rehabilitation phase was an increase in the muscular force (from F₂ to F₃) of the most damaged muscles – deltoid and supraspinatus, but also of the other damaged muscles, thus leading to regaining a good level of movement execution, in terms of range of motion and complexity.

Following phase II of the rehabilitation, the final assessment indicated a significant improvement in the muscular force, thus regaining coordination and the possibility of performing the ADL with no difficulty.

Sensitivity testing has shown that things got back to normal; moreover, the clinical exam showed an improvement of the general body posture, as well as of the physical and mental state.

Conclusions

1. The correct clinical and functional diagnosis represents the premise of a correct therapeutic behaviour.
2. The physical therapy treatment with an early onset has good results in the case of brachial plexus paralysis.

3. It is necessary to set objectives for each rehabilitation phase, correlated with the progresses obtained after the clinical–functional exam.
4. The programme elaborated for functional rehabilitation of the damaged upper limb proved to be effective, and the assessment results confirm it.
5. It is necessary to instruct the patient at the beginning of the program in order for him/her to be cooperative and aware of his/her own contribution to the recovery.
6. Applying a complex treatment, by using kinesiotherapy-specific means combined with electrotherapy, thermal therapy, hydrotherapy, occupational therapy, the rehabilitation rhythm was accelerated, and it took the patient less time to resume her normal activity (statistics has shown that the posttraumatic recovery of the brachial plexus requires a longer period, depending on the gravity of the diagnosis).

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