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Topical issues of physical therapy for gunshot lesions of the diaphysis of the shoulder

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Purpose: *to consider the features of physical therapy for gunshot lesions of the diaphysis of the shoulder.*

Material & Methods: *theoretical analysis and generalization of modern scientific and methodological literature data on the features of the use of rehabilitation equipment for gunshot shoulder injuries.*

Results: *the peculiarities of the application of physical therapy devices after gunshot lesions of the shoulder diaphysis are determined, the features of the application of kinesitherapy, therapeutic massage and physiotherapeutic treatment at different periods of the pathological process.*

Conclusion: *physical therapy is an integral part of the medical rehabilitation of the wounded with gunshot injuries of the shoulder and depends on the amount of damage to the muscular apparatus, the immobilization method, the severity of the general condition of the wounded and the period of the pathological process and rehabilitation measures.*

Keywords: *gunshot shoulder injury, physical therapy, rehabilitation measures.*

Introduction

The problem of rehabilitation of combatants is especially urgent today, when the antiterrorist operation (ATO) of the Ukrainian armed forces continues in the eastern regions. The scale of this phenomenon in Ukrainian society requires active study of the specifics of military operations and the structure of sanitary losses, and the creation of special centers throughout the country to provide social, psychological and medical assistance to participants in the antiterrorist operation, and especially those who received combat injuries that led to disability [1; 3].

It is assumed that during the war with the use of modern means of destroying all more or less serious injuries, the main place will be occupied by soft tissue injuries (44–46%). The proportion of injuries to the pelvic bones, upper and lower extremities (including damage to the vessels and nerves) will be up to 28%. About 8% of the wounded have injuries with damage to the internal organs and lumbar spine. 5% of the injury (equivalent gravity) will be divided between damage to the face (including the eyes) and the chest (including the thoracic spine). Traumas of the skull and brain account for 4%, and the neck and cervical spine – 1% [6].

The wounds of the extremities prevailed in all military conflicts, because this is one of the least protected anatomical sites. They averaged 64% of all damage. Among them, internal joint fractures are observed in 17,1% of the affected, damage to large blood vessels with gunshot injuries of large joints of the upper limbs reaches 3%, lower limbs – 4,5%. With respect to peripheral nerves, the more often they are damaged in injuries of large joints of the upper extremities, whose frequency is 11–13%.

At present, the frequency of severe damage to soft tissues and bones increases, which leads to a frequent development of infectious complications (32%) (gunshot gland 18%), a high percentage of slowed consolidation and false joints (12%) and the formation of common bone defects (up to 15%) [5].

The treatment and rehabilitation of servicemen and civilians who have received gunshot wounds to the limbs is one of the main problems of military field surgery, remains relevant, both for the military medical service of the armed forces and for the national health system. Armed conflicts on the territory of Ukraine, the activation of criminal structures and the associated increase in crime, the widespread use of firearms and explosive ordnance among civilians have led to numerous injuries in peacetime.

During the time that has passed since the end of the Second World War, there has been a significant evolution of firearms and ammunition. As a result, the scale and severity of tissue destruction increased dramatically, and the number of multiple and combined injuries increased at times. Traumatic illness, which develops in response to modern combat trauma, is usually characterized by a long and complex course with high rates of mortality or disability. These circumstances encourage the development of new approaches to the treatment and physical therapy of the wounded at the stages of medical evacuation and treatment [14].

Relationship of research with scientific programs, plans, themes. The work was carried out in accordance with the priority thematic area 76.35. "Medico-biological justification for the implementation of rehabilitation measures and the appointment of physical rehabilitation to young people of varying degrees of fitness." Number of state registration – 0116U004081.

Purpose of the study: to consider the features of physical therapy for gunshot lesions of the diaphysis of the shoulder.

Material and Methods of the research

Methods of research: theoretical analysis and generalization of modern scientific and methodological literature data on the

features of the use of rehabilitation equipment for gunshot limb injuries.

Results of the research and their discussion

Restorative treatment of the wounded with gunshot limbs injuries includes medical, social and professional rehabilitation. To be rehabilitated are those persons who, as a result of traumatic injury of limbs and surgical intervention, physiological functions and the ability for military professional activity have significantly decreased or temporarily lost. At the same time, the basic general principles of rehabilitation – consistency and consistency – are fully preserved in relation to particular types of pathology.

Medical rehabilitation combines surgical and medicament methods, balneotherapy and climatotherapy, physiotherapy exercises, physiotherapy, therapeutic massage [2; 12].

At the hospital stage, rehabilitation of patients after traumatic injury of the limbs is not autonomous, but in close interaction with the treatment process, supplementing the treatment and increasing its effectiveness. In turn, a full-fledged surgical treatment, including such measures as early diagnosis of the disease, adequate preoperative preparation, qualitatively and rationally performed surgical intervention, the correct use of medicines in the postoperative period, allows using rehabilitation methods already at the earliest stages of the treatment process. So, treatment and rehabilitation are closely related, mutually complementary and should not be contrasted, therefore, the development of methods for physical rehabilitation is carried out taking into account the content of postoperative treatment of patients, and the implementation of rehabilitation measures is an integral part of the entire treatment and recovery process. The tasks of the hospital stage of rehabilitation of patients with gunshot limb injuries are: development for each patient of an individual program of rehabilitation activities and ensuring its continuity at the following stages; the implementation of an adequate mode of motor activity with a consistent increase in load; sanation of chronic foci of infection and treatment of concomitant diseases; the formation of an optimal psychological response to the consequences of trauma, as well as the system of the following rehabilitation measures [8; 9].

When developing individual rehabilitation programs, systematic monitoring of the adequacy and effectiveness of interventions and, if necessary, appropriate correction of rehabilitation programs are needed. Common criteria for the adequacy of physical rehabilitation in the early postoperative period is the improvement of the patient's well-being, gradual normalization of the performance of the cardiovascular and respiratory systems. In the functional-training period, the effectiveness of rehabilitation is assessed by the results of functional tests individually for various injuries. The sanatorium stage of rehabilitation with gunshot traumatic injuries of limbs is conducted in general or specialized branches of sanatoriums of the Ministry of Defense of Ukraine or in specially organized rehabilitation centers. Servicemen are sent to this stage, which, after treatment, are subject to long-term rehabilitation using special methods. On an outpatient-polyclinic stage, dispensary supervision is carried out for servicemen who have suffered traumatic injury to the limbs; measures are being taken to maintain efficiency, increase nonspecific immunity, prevent secondary and late complications, and gradually enter military professional activities [10; 12].

The duration of medical rehabilitation of servicemen in the firearms of limbs varies from several weeks to several months and depends on the severity of the injury, the complications, concomitant diseases, the patient's age, and the quality of the treatment. Timeliness of rehabilitation largely depends on reducing the number of postoperative complications. Rehabilitation activities end when the patient is provided with comprehensive assistance in achieving maximum physical usefulness and ability for military professional activity [12].

Thus, the main *objectives and principles of rehabilitation:*

- fastest start of rehabilitation activities, prevention of persistent dysfunctions of the body;
- continuity of rehabilitation, complements therapeutic interventions, including surgical interventions;
- continuity of rehabilitation in functional recovery;
- comprehensive nature of rehabilitation activities under the guidance of an orthopedic traumatologist;
- individualization of the rehab program, depending on the specifics of the injured and the pathological process;
- application of rehabilitation in the wounded team to accelerate the restoration of functions;
- return of a rehab to socially useful work, restoration of labor and combat ability [13].

The effectiveness of rehabilitation measures depends to a large extent on the correctness of the determination of the indications, the period and the scheme of their use in the overall treatment process.

Groups of the wounded are identified with injuries of the upper or lower extremity that enter the rehabilitation center for stage or final rehabilitation. The course of the pathological process and rehabilitation measures for the wounded is divided into *5 periods*.

Up to the *1st period*, the phase of traumatic inflammation in the case of soft tissue injury and bone fractures lasting 10–15 days is included. The main objectives of the rehabilitation of the first period are anesthesia, elimination of edema, resorption of hemorrhages and hematomas, healing of wounds of soft tissues. Treatment is carried out in the hospital.

Second period is characterized by the transformation of soft-tissue scarring and the formation of primary bone callus in fractures, it lasts from the 15th to 30–60th day. The tasks of rehabilitation are anesthesia, stimulation of callus formation, prevention of functional disorders, muscular atrophy.

Third period is the formation of the callus, its term from the 30th to 90–120 days. Rehabilitation tasks: strengthening the processes of mineralization of the callus, improving the trophism of the tissues, preventing complications, movement disorders in the joints, muscular atrophy, anatomical and functional restoration of the affected limb.

4th period is the stage of residual phenomena, the consequences of injuries in the formation of bone callus at the site of fracture and significant functional disorders of the limbs. Rehabilitation activities in this period should be aimed at restoring the function of the muscular system, movements in the joints and improving the supporting function.

5th period is determined by the results of injuries – false joints, bone defects and other conditions requiring long-term specialized orthopedic and traumatological treatment. The objectives of rehabilitation in this period is to stimulate the general protective functions of the body, improve local microcirculation and lymph flow, prevent edema, muscle atrophy, contracture and osteoporosis, stimulate reparative processes in damaged tissues.

In the 1st period, rehabilitation measures are carried out with the immobilization of the damaged limb with non-removable gypsum dressings or external fixation devices. In the 2nd and 5th periods, removable immobilization means or external fixation devices are used. In the 3rd and 4th periods immobilization of the limbs is not used. This determines the volume and intensity of physical therapy [6; 12].

Medical rehabilitation is carried out on the basis of the rehabilitation department, deployed in a hospital or in a rehabilitation center. It is carried out by the forces and means of medical personnel under the direct supervision and control of doctors and heads of hospitals, hospitals, medical and rehabilitation centers [15].

Physical therapy after gunshot lesions of the diaphysis of the shoulder.

Gypsum dressing is the main method of immobilization with gunshot fractures of the diaphysis of the humerus without the displacement of bone fragments and the limited nature of soft tissue damage in 65-70% of the wounded. In case of damage in the upper third (above the site of attachment of the deltoid muscle) – on the branch line (with the curved elbow joint to 90° and the shoulder extension up to 40–45) in the middle and lower third – by the thoracobranchy bandage [7; 11].

When the fragments are displaced, especially with a large damage to the soft tissues, extra-osseous through bone osteosynthesis is used by G. A. Ilizarov's devices or by spinal-rod compression-distraction apparatuses [12].

Immobilization with splinter firing fractures of the diaphysis of the humerus and soft tissue damage lasts 2,5–3 months. [7; 11].

Therapeutic physical trainingtherapeutic physical training is assigned to a wounded person with a diaphyseal fracture of the humerus, taking into account the localization of the fracture, the degree of soft tissue damage, the treatment method, the severity of the patient's general condition for five periods of the pathological process and rehabilitation measures [4; 12].

In the first period – in the first 10–15 days (3–4 days after surgery and absence of complications), taking into account the presence of degenerative-inflammatory processes between the clastic space for the purpose of resorption of hemorrhages and hematomas, acceleration of healing of wounds of soft tissues, reduction of edema of tissues in the site of injury, activation of blood, lymph circulation and metabolic processes, it is recommended to use passive, active-passive and active finger movements during kinesitherapy – when using immobilization of gypsum viscous or passive, active-passive and active movement in the joints of the fingers of the affected limb and wrist joint – immobilization Ilizarov, a short-term (up to 3–5) isometric tension arm and shoulder muscles [7; 11].

During the day it is recommended to carry out "treatment by position": the damaged limb is added to the withdrawn and elevated position, which helps to reduce edema, pain and prevent stiffness in the shoulder joint. Exercises are performed from the initial "lying" and "sitting" positions at a slow pace, the number of repetitions and the amplitude of movements are determined individually depending on the severity of damage to bone and muscle tissues, until a painful sensation appears in the wound, on average 4–6 times.

The exercises include exercises for healthy limbs and trunk, corrective exercises for the spine, static and dynamic breathing exercises, therapeutic walking in the ward and the corridor. It is recommended to take classes in therapeutic gymnastics for 10–15 minutes and independently 2–3 times a day for 5–10 minutes.

During this period, the following physiotherapy procedures are used: for anesthesia – diadynamic therapy in the fracture region, to improve the trophism of damaged tissues use UHF, magnetotherapy [16].

In the 2nd period – from the 15th to the 30th and the 60th day, active movements of the injured upper limb with fingers are used to anesthetize, accelerate the transformation of soft tissue scar, stimulate the formation of the primary bone callus, prevent functional disorders and muscle atrophy – when using immobilization with a cast bandage or active movements in the joints of the fingers and the wrist joint of the affected limb – when immobilized with Ilizarov apparatus, the isometric tension of the shoulder muscles (up to 5–7 s), Ideomotor exercises for the affected limb. It seems advisable to continue "treatment by position". Physical exercises are performed from the initial positions "sitting" and "standing" at a slow and medium tempo, the number of repetitions and the amplitude of movements are determined individually – until a painful sensation occurs in the lesion, an average of 6–8 times.

The exercises include exercises for healthy limbs and trunk, corrective exercises for the spine, dynamic breathing exercises, therapeutic walking in the ward and the corridor. It is recommended that TG sessions be performed for 15–25 minutes and 3–4 times a day for 10–15 minutes [7; 11; 12].

In the third period – from the 60th to the 90th day, rehabilitation measures are used to accelerate the formation of bone callus, strengthen the processes of mineralization of the bone callus, improve trophism of tissues, prevent the prevention of muscular atrophy and functional recovery of the affected limb in gymnastics classes using active movement with the fingers of the injured upper limb – when using immobilization with a plaster cast or active movements in the joints of the fingers and the wrist joint of the affected limb – when immobilized by the Ilizarov apparatus, isometric tension of the shoulder muscles (up to 6–8 s), ideomotor exercises for the affected limb, "treatment by position". Physical exercises are

performed from the initial positions "sitting" and "standing" at an average pace, the number of repetitions is 8-10 times, the amplitude is complete. The exercises include exercises for healthy limbs and trunks, corrective exercises for the spine, dynamic breathing exercises, therapeutic walking along the corridor and the park area of the hospital or hospital. Occupations of TG are recommended to be carried out for 25–35 min and independently 4–5 times a day for 15–20 min.

In the second half of the third period after the removal of immobilization, it is recommended to expand the volume of special physical exercises for the affected limb. Apply active-passive (with the help of a healthy arm) and active exercises for all joints of the affected limb. Widely used flapping movements in the shoulder and elbow joints from the initial position "standing with the torso tilted forward," tapping and bringing the shoulder and movement in the elbow joint, supination and pronation, moving the brush in different planes, compressing, opposing the fingers. To facilitate the movements of the injured hand at the beginning of the period, it is recommended

Physical exercises recommended for gunshot injuries of the shoulder muscles in the 4th period

No. i/o	Name of the muscle	Action of muscle
	Anterior muscle group of the shoulder	
	Biceps muscle	*Bends the arm at the elbow joint and provides supination of the forearm involved in the recoil and bringing the arm*
		Physical exercises
1	B.p. – sitting on a chair, the injured arm is lowered down. Flexion-extension of the arm in the elbow joint	
2	B.p. – sitting on a chair, a damaged arm is lowered down, in the hand a dumbbell is 2–4 kg. Flexion-extension of the arm in the elbow joint	
3	B.p. – standing, arms lowered. Circular movements in the shoulder joint forward, then back. In the second half of the period – the same, in the hands of a dumbbell 2–4 kg	
4	B.p. – standing, arms lowered. Simultaneous lifting of straight arms through the sides to a 90 degree angle. In the second half of the period - the same thing, in the hands of a dumbbell 2–4 kg	
5	B.p. – standing, straight arms extended forward parallel to the floor. The cultivation of straight arms to the sides (at the beginning of the period – slowly, then – jerks). In the second half of the period – the same, in the hands of a dumbbell 2–4 kg	
6	B.p. – standing, feet shoulder width apart, the body tilted forward. Flight movements in the shoulder joint of a damaged limb in various directions. In the second half of the period – the same, in the hands of a dumbbell 2–4 kg	
7	B.p. – sitting on a chair, hands are extended forward. Pronation-supination of the forearm. In the second half of the period – the same, in the hands of a dumbbell 2–4 kg	
	Coracobrachialis muscle	*Raises an arm and leads to the midline*
		Physical exercises
1	B.p. – standing, arms lowered. Simultaneous rising of direct hands forward to a 90 degree angle. In the second half of the period – the same, in the hands of a dumbbell 2–4 kg	
2	B.p. – lying on the floor, straight arms are divorced to the sides. Simultaneous lifting of direct hands in front of you, making cotton with palms	
3	B.p. – lying on the floor, straight arms are divorced to the sides, in the hands of dumbbells 2–4 kg. Simultaneous lifting of hands in front of you	
4	B.p. – sitting on a chair, straight arms split into the sides. Circular movements with the hands forward and backwards	
	Brachial muscle	*Flexes the forearm*
		Physical exercises
1	B.p. – sitting on a chair, the injured arm is lowered down. Flexion-extension of the arm in the elbow joint. In the second half of the period – the same, in the hands of a dumbbell 2–4 kg	
2	B.p. – sitting on a chair, a damaged arm is lowered down, in the hand a dumbbell is 2–4 kg. Flexion-extension of the arm in the elbow joint In the second half of the period - the same, in the hands of a dumbbell 2–4 kg	
	Back muscle group of the shoulder	
	Triceps muscle	*Due to the long head, the hand moves backwards and brings the shoulder to the trunk; the whole muscle participates in the extension of the forearm*
		Physical exercises
1	B.p. – standing, arms bent at the elbow joints, are brought to the trunk, the hands – into a fist (boxer stand). Imitation of boxing – striking an imaginary opponent with his right and left hand. In the second half of the period – the same, in the hands of a dumbbell 2–4 kg	
2	B.p. – standing, feet shoulder width apart, the body tilted forward, arms lowered. The cultivation of straight arms in the sides. In the second half of the period – the same, in the hands of a dumbbell 2–4 kg	
3	B.p. – emphasis lying. “Push-ups” – unbending hands in the elbow joints, lifting the trunk above the floor, the back is straight	
4	B.p. – sitting on a chair, arms bent at the elbow joints are wound behind the back. Straightening your hands in the elbow joints, lift them up. In the second half of the period – the same, in the hands of a dumbbell 2–4 kg	
5	B.p. – standing, straight arms diluted to the side, in the hands of the end of the rubber band, the middle of the tape is fixed on the crossbar of the gymnastic wall. Bringing straight arms to the body	
	Ulnar muscle	*Extends the forearm in the elbow joint*
1	B.p. – sitting, arms bent at the elbow joints in front of him. Circular movements in the elbow joints	
2	B.p. – sitting on a chair, arms bent at the elbow joints are wound behind the back. Straightening your hands in the elbow joints, lift them up. In the second half of the period – the same, in the hands of a dumbbell 2–4 kg	
3	B.p. – standing, arms bent at the elbow joints, are brought to the trunk, the hands – into a fist (boxer stand). Imitation of boxing – striking an imaginary opponent with his right and left hand. In the second half of the period – the same, in the hands of a dumbbell 2–4 kg	
4	B.p. – emphasis lying. “Push-ups” – unbending hands in the elbow joints, lifting the trunk above the floor, the back is straight	

to use lightweight starting positions: sitting on a chair at a table with a smooth surface, forearm arms on the table. All exercises are performed with limited amplitude, at an average rate of 6–8 times [12].

In the 4th period – the stage of residual effects, the consequences of injuries in the formation of bone callus at the site of fracture and significant functional disorders of the limbs – from 90 to 120 days rehabilitation activities should be aimed at restoring the function of the muscular system, joint movements and improving the supporting function. In the exercises of therapeutic gymnastics, physical exercises for healthy extremities and trunks with full amplitude from the initial positions "standing" and "walking" are used, the number of repetitions of each exercise is 10–14 times. The emphasis is on exercises aimed at correcting posture, difficult-coordination exercises and therapeutic walking.

In order to restore mobility in the joints and the strength of the muscles of the injured limb, it is recommended to use special physical exercises for the injured limb. Active and active-passive (with the help of a healthy arm) exercises for all joints of the affected limb. Widely used flapping movements in the shoulder and elbow joints from the starting position "standing with the torso bending forward," rotational movements, retraction and reduction of the shoulder and movement in the elbow joint, supination and pronation of the forearm, movement of the hand in various planes, compression, opposition of the fingers. All exercises are performed with a full amplitude, at an average rate, 8-10-14 times (8–10 times at the beginning of the period) [7; 11].

Physical exercises are applied taking into account the amount of injury and the subsequent surgical treatment of the musculoskeletal system of the limb, as well as the physiological and biomechanical properties of the affected muscles (Table) [4; 17; 18].

The complex of therapeutic gymnastics necessarily includes exercises for the restoration of self-service. During the exercises you can use gymnastic sticks, balls, block devices, at the end of the period – rubber bands, simulators, dumbbells, expanders. Self-study is recommended up to 4–6 times a day. A good effect is given in the pool or in the bath, where the exercises are performed in warm water. Apply walking in the park zone hospital. The duration of TG increases to 30-40 min.

Gymnastic exercises necessarily alternate with breathing exercises and methods of relaxation of muscle groups involved in training.

In the second half of the fourth period, the number of forceful exercises increases (resistance exercises, weight training in the gym), exercises are introduced that require complex, precise coordination of movements. Often use elements of sports games, especially with the ball (throws, transfer, catching the ball, etc.). Applied hydrokinetic therapy in warm water with active movements of the affected limb, swimming. Great attention is paid to exercises that promote professional and household rehabilitation.

At this stage, massage the muscles of the shoulder girdle and upper limbs, first of all, the so-called suction massage above the injury site, while using the methods of stroking and squeezing. Then, the muscles of the affected limb are massaged, intermittent stroking is performed in the fracture region, when shock bone consolidation is slowed down, shock techniques are used [7; 11].

For physical therapy, which were used in the first three periods, added electrical stimulation of weakened muscles, electrophoresis, phonophoresis, salt baths and microwave therapy [12].

In the presence of the fifth period of the course of the pathological process, which is determined by the complications of trauma – false joints, bone defects, local microcirculation and lymphatic drainage, the presence of edema, muscular atrophy, contracture and osteoporosis, requiring long-term specialized orthopedic and traumatic treatment, physical therapy is prescribed using appropriate means during the entire period of rehabilitation.

Conclusions

1. The treatment and rehabilitation of servicemen and civilians who received gunshot wounds to the limbs is one of the main problems of military field surgery, remain relevant, both for the military medical service of the armed forces and for the national health system.
2. Restorative treatment of the wounded with gunshot limb injuries includes medical, social and professional rehabilitation; medical rehabilitation combines surgical and medicament methods, balneotherapy and climatotherapy, physiotherapy exercises, physiotherapy, therapeutic massage.
3. The objectives of the hospital stage of rehabilitation of patients with gunshot limb injuries are: development for each patient of an individual program of rehabilitation activities and ensuring its continuity in the following stages; the implementation of an adequate mode of motor activity with a consistent increase in load; sanation of chronic foci of infection and treatment of concomitant diseases; the formation of an optimal psychological response to the consequences of trauma, as well as the system of the following rehabilitation measures.
4. Physical therapy is an integral part of the medical rehabilitation of the wounded with gunshot injuries of the shoulder and depends on the amount of damage to the muscular apparatus, the immobilization method, the severity of the general condition of the wounded and the period of the pathological process and rehabilitation measures.

The prospect of further research is the study of the features of physical therapy after gunshot lesions of the lower limb at the stages of medical rehabilitation.

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