PHYSICAL REHABILITATION OF ATHLETES WITH POSTTRAUMATIC CONTRACTURES OF MASTICATORY MUSCLES USING A DEVICE FOR ACTIVE AND PASSIVE MECHANICAL THERAPY OF THE MANDIBLE

ФІЗИЧНА РЕАБІЛІТАЦІЯ СПОРТСМЕНІВ ІЗ ПОСТТРАВМАТИЧНИМИ КОНТРАКТУРАМИ ЖУВАЛЬНИХ М'ЯЗІВ ІЗ ЗАСТОСУВАННЯМ ПРИСТРОЮ ДЛЯ АКТИВНОЇ ТА ПАСИВНОЇ МЕХАНІЧНОЇ ТЕРАПІЇ НИЖНЬОЇ ЩЕЛЕПИ

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Анотації

The article analyzes the dependence of localization of head and face injuries on the type of sport. We have proposed a device for active and passive mechanical therapy of the mandible which is successfully used in the physical rehabilitation of athletes with injuries of the maxillofacial area. The study was conducted for 3 years and it was attended by 70 athletes with contractures of masticatory muscles, which were divided into 2 clinical groups, depending on the method of treatment. *The purpose* of the *study* is increasing of mouth opening amplitude to normal rates – 4.5–5 cm. The advantages of the device over the known: the device has removable plates of different size – suitable for children and adults, the plates are perforated − for people with partial absence of teeth, the bottom plate adapted to configuration and movements of lower jaw (not balances), the thickness of the plates provides their use even in patients with mouth open only to 5 mm easy to use, not requires great efforts, when patient presses on device handle, in the principles of action is programmed using not only passive, but active work of masticatory muscles. The most striking indicator of its effectiveness was the magnitude of the opening of mouth. In patients treated with the new method, the magnitude of the opening of mouth reached the norm for 14 days, at the same time, as in patients with control group, it was almost twice less.

Key words: physical rehabilitation, sports injuries, contracture, device for mechanical therapy of the mandible, masticatory muscles.

У статті проаналізовано залежність локалізації травм голови та обличчя від виду спорту. Ми запропонували прилад для активної та пасивної механічної терапії нижньої щелепи, який успішно застосовується у фізичній реабілітації спортсменів із травмами щелепно-лицьової зони. Дослідження проводилось протягом 3 років, у ньому взяли участь 70 спортсменів із контрактурою жувальних м'язів, які були розділені на 2 клінічні групи залежно від методу лікування. Мета дослідження – збільшення амплітуди відкривання рота до нормальних показників – 4,5–5 см. Переваги пристрою перед відомими: пристрій має знімні пластинки різного розміру – підходить для дітей та дорослих, пластини перфоровані – для людей з частковою відсутністю зубів, нижня пластина пристосована до конфігурації та рухів нижньої щелепи (не врівноваження), товщина пластин забезпечує їх використання навіть у пацієнтів з відкритим ротом лише на 5 мм, просте у використанні, не вимагає великих зусиль, коли пацієнт натискає на ручку пристрою, в принципах дії програмується з використанням не тільки пасивного, але і активна робота жувальних м'язів. Найяскравішим показником його ефективності була величина відкривання рота. У пацієнтів, які лікувалися новим методом, величина відкривання рота досягала норми за 14 днів, при цьому, як і у пацієнтів контрольної групи, вона була майже вдвічі меншою.

Ключові слова: фізична реабілітація, спортивні травми, контрактура, прилад для механічної терапії нижньої щелепи, жувальні м'язи.

В статье анализируется зависимость локализации травм головы и лица от вида спорта. Нами предложено устройство для активной и пассивной механической терапии нижней челюсти, которое успешно применяется при физической реабилитации спортсменов с повреждениями челюстно-лицевой области. Исследование проводилось в течение 3 лет, и в нем приняли участие 70 спортсменов с контрактурами жевательных мышц, которые были разделены на 2 клинические группы в зависимости от метода лечения. Цель исследования – увеличение амплитуды открывания рта до нормальных показателей – 4,5–5 см. Преимущества устройства перед известными: устройство имеет съемные пластины разного размера – подходит для детей и взрослых, пластины перфорированы – для людей с частичным отсутствием зубов, нижняя пластина адаптирована к конфигурации и движениям нижней челюсти (не весы), толщина пластин обеспечивает их использование даже у пациентов с открытым ртом всего до 5 мм, проста в использовании, не требует больших усилий, когда пациент нажимает на рукоятку устройства, в принципах действия программируется не только пассивное, но и активная работа жевательных мышц. Самым ярким показателем его эффективности была величина открытия рта. У пациентов, получавших новый метод, величина открытия рта достигла нормы за 14 дней, при этом, как и у пациентов контрольной группы, она была почти вдвое меньше.

Ключевые слова: физическая реабилитация, спортивные травмы, контрактура, аппарат для механической терапии нижней челюсти, жевательные мышцы.

Introduction. Unfortunately, the sport injury is an integral part of the existence of professional sports, and, in comparison with injuries of other origin (domestic, street, etc.), has a number of specific features. The risk of injury and their location mainly depends on the particular sport, fitness and athlete's role. According to our own clinical observations, which are quite similar to the results of statistical studies of other authors, it is determined that professional boxing and martial arts (60%) are in the first place in the head and face traumatic frequency. During fights sports, fractures of the lower jaw often occur in the area of the condyle, angle and symphysis, which in turn usually leads to the need for surgical treatment and long-term rehabilitation of athletes. A fairly large percentage of head, face, and neck injuries are reported in the hockey game, in which most often occur fractures of the crown of tooth, as well as fractures of the upper and lower jaws. The table below shows statistics for Ukraine that reflect the dependence of the localization of sports injuries in the area of the head and face of the sport (Tabl. 1).

Table 1

Localization of sports injuries in the area of head and face including the main sports (in percentage)

Sports	Head and face
Boxing	23,89
Wrestling	12,58
Hockey	18,84
Cycling	13,54
Skiing	11,79
Skating	9,02
Football	4,48

According to research, typical complications of facial injuries in sports like boxing, hockey, foot ball, handball and cycling are posttraumatic contractures of masticatory muscles [4, 5, 11–13]. Masticatory muscles contractures may develop after the bruising of the soft tissues in parotid-masticatory area, and after the fractures of the lower jawbone in the areas of condylar process and gonial angle.

The results of our retrospective analysis of patients' case histories showed that the frequency of posttraumatic contractures emergences in cases of lower jawbone condylar process fractures reached 23 %, and in cases of lower jawbone gonial angle fractures it reached 43 %, which is equal to the results of other studies [7, 9].

It was discovered that the reflex contracture of masticatory muscles has developed because of durable jaws immobilization due to orthopedic treatment of lower jawbone, soft tissues bruising in parotid-masticatory area. Cicatricial contractures mostly occurred after mechanical injuries of masticatory muscles during osteosynthesis surgery. The presence of a restriction on the opening of mouth in athletes leads to a deterioration of the function of chewing, a language that significantly reduces its general-somatic status and psycho-emotional state. Not isolated cases of alimentary dystrophy, aspirational asphyxiation by emesis in such patients, which are a direct threat of a lethal outcome [4, 6]. Also, the procedure for general anesthesia is significantly complicated due to the impossibility of intubating the trachea through the oral cavity. Therefore, in such cases, anesthetists carry tracheostomy [7]. All this makes this problem very actual today.

Materials and methods. According to the common clinical shows of posttraumatic masticatory muscles contractures and the peculiarities of medical tactics within certain stages of the disease, 70 athletes were divided into 2 equal clinical groups: the first control group included 35 patients with reflex and circatricial contractures who were treated with standard methods. The second main group included 35 patients with reflex and circatricial contractures who were treated by the new scheme.

We have developed a scheme for the physical rehabilitation of sick athletes with contractures of masticatory muscles, in which active-passive mechanical therapy of the mandible is the dominant element. In the context of advantages and disadvantages of existing devices we constructed a modern device for active and passive mechanical therapy of the mandible (patent for invention № 111394 UA, A61S 19/00) [10].

The main novelty of the device and its difference from the known is in the fact that the lower dental plate is fixed to the body of the device with the help of articulated joints. This ensures the adaptation to the lower jaw occlusal teeth surface in the process of the mechanical

therapy session and eliminates the danger of balancing on it.

The perforated surface of upper and lower plates is provided in the design of the device. This, with prior filling of the plates with some silicone, allows the usage of the device for athletes with orthodontic pathology and secondary edentia, which is impossible with other modern devices. The design of the device also provides a power supply of two batteries, which are placed in the supporting handle. This ensures ergonomics and compactness.

In order to expand the range of patients who can use this device, the design provides removable dental plates of different sizes according to patients age and constitution.

Doctor's effective control of mechanical therapy process is achieved with the help of the digital indications screen, which shows the gap between the jaws in cm, and the pressure on masticatory muscles in kg, which allows selecting of optimal treatment mode. Audible alarm of the pain fixation helps the patient to undergo the mechanical therapy session more effectively, which is not provided in any other known devices.

A significant advantage of the device over others is the ability to use it with the mouth opening amplitude less than 5mm due to a minimal thickness of dental plates. We have created a special computer program with the help of which it is possible to trace the tendencies of the course of different diseases in maxillofacial area.

Device mode action.

1. The patient, holding the handle of the device with one hand, and, if necessary, supporting the body of the device with the other hand, places the dental plates into the mouth cavity in the correct and comfortable position.

2. As shown in Figure 1, passive mechanical therapy is performed by squeezing the moving handle of the device with the patient's hand which, through the system of articulated joints, the lever and the lower dental plate, transmits the force of the patient's or the doctor's hand on the jaw.

Fig. 1. Passive dosed mechanical therapy – patient pressing hand on device handle parting jaw and mouth opens

3. With the pain growing, the patient decreases the pressure on the handle then the light and audio alarm located on the front part of the device go off. The performance data of the gap between the mouth (in mm) and the pressure on the masticatory muscles (in kg) remain unchanged on the digital indicator for some time up to 10 seconds.

4. As shown in Figure 2, active mechanical therapy is performed consciously by the patient with the deliberate clenching of dental plates due to masticatory muscles contractions and dosed retroaction, created by the patient's or doctor's pressure on the handle.

Fig. 2. Active dosed mechanical therapy – after feeling pain patient consciously grips jaw (hear audio signal) which lead plate of the device to its primary position – mouth closed

5. The programmable microcontroller was installed into the device for mathematical data processing from the sensors and in order to provide the indication and the signalization.

Diagnostics. In addition to general clinical examination of the patients, we performed ultrasonographic examination of masticatory muscles. The modified method of ultrasonographic examination was used for diagnosis of inflammatory masticatory muscles contractures.

The nature and the extent of the functional muscles disorder and their dynamics in the process of treatment was determined with the help of functional EMG. During the quantitative processing of electromyograms the following indicators were taken into account: the amplitude in the resting position and during straining the muscles on the damaged side and the opposite side, and the EMG amplitude asymmetry.

In order to evaluate the extent of local masticatory muscles damage the level of creatine phosphokinase in peripheral blood was determined.

Treatment. All patients from the control and main groups with reflex and circatricial masticatory muscles contractures underwent mechanical therapy, drug therapy and physiotherapy. The control group patients used the second group mechanical therapy devices every day during 14 days. They made the devices themselves or bought a simple dilator in the medical equipment stores. Also, during the 14 days the patients took «Dicloberl» underwent electrophoresis with lydazum in the parotid-masticatory area.

The main group members conducted the 14 days dosed course of passive and active mechanical therapy of the mandible in the hospital or at home. In total, the patient performed 6 rounds of 60 cycles of opening and closing the mouth daily.

Of course, the usage of mechanical therapy with muscle contracture changes is a rather painful procedure. That is why we have complemented the masticatory contractures treatment regimen with mandatory muscle relaxant and analgesic intake with the central action mechanism – «Katadolon Retard». The patient took 1 capsule in the morning after meals and before the first mechanical therapy round daily during 14 days. This drug has shown very good results in our practice, is well tolerated by the patients, however, it should be indicated, that it might cause drowsiness, which disappears after the patients stop taking the drug. Also, with the severe muscle scarring changes, we inject intramuscular solutions of «Longidaza».

We also perform magnetic laser therapy sessions during 14 days for the purpose of rapid edema removal and the increase of blood circulation in the masticatory muscles. These data complements each other and significantly speeds up the healing process of the patient. But, still, in our own experience, we have discovered that the role of mechanical therapy in masticatory muscles contractures is dominant. Redressment surgery-forced jaws opening, can be avoided with the help of it in many cases even with severe contractures.

The results. In the process of the study, it was found out that the most sensitive masticatory muscles alteration marker is creatine phosphokinase. The increase of the creatine phosphokinase level is ten times higher in comparison with the standard (up to 1788 units by litre) on the next day after the osteosynthesis.

One of the major clinical parameters in patients with contracture was the mouth opening amplitude dynamics. At the beginning of the treatment, all patients were diagnosed with a rapid mouth opening amplitude limitation from 20 to 5 mm. During the treatment this indicator was increasing wavily, especially in the evening. However, the amplitude of mouth opening reduced significantly (5 mm) in the morning, accompanied by the feeling of tightness in the masticatory muscles. The moment, when the morning and evening indicators were the same, proved the positive dynamics. As shown in Figure 3, at the end of the treatment the amplitude of the mouth opening in patients with reflex contracture of the control group was only 24 mm, which is significantly less than in patients in main groups, while the patients of the main group showed the results of 42 mm, which is close to a standard. The patients with the reflex contractures showed similar results.

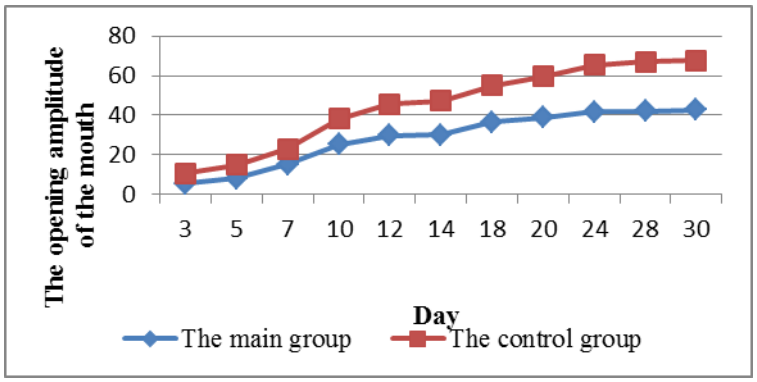

Fig. 3. Dynamics of changes in the opening amplitude of the mouth in patients with the main and control groups, depending on the type of treatment

The athletes with circatricial contractures showed the most significant deviation from the medium ultrasonographic standard the next day after the splint removal. It was 5 times lower than the standard – 5.77 %. However, the athletes with reflex contractures from the main group reached the standard ultrasonographic indicator in 14 days, while the athletes of the control group-only in 35 days.

At the end of the treatment the patients of the main group showed significantly higher EMG-amplitude indicators, and the difference of the EMG-amplitudes was significantly lower, than it was in control group athletes.

Discussion. At the current stage of modern dental care development, there exist different approaches to the posttraumatic masticatory muscles contracture treatment abroad. They are usually determined not by the type (reflex or cicatricial), but by clinical severity, which presupposes the usage of surgery, drug therapy and mechanical therapy [2–4, 6].

As a rule, doctors resort to redressement surgery with «old» contractures (after 10 weeks of their formation), when the thick intramuscular scar is formed [2, 8].

Our practical experience has shown that mechanical therapy is the most effective way of masticatory contractures treatment. In cases of masticatory muscles contractures local authors recommend the usage of well-known old-fashioned devices, which belong to the first group, namely those that act upon the entire dental arch and spread even pressure on the whole dentition applying dosed load. In particular, these are the Darsisak's device, spoons of Limberg, Mathesis's device, Yadrova's device. But, unfortunately, due to absence of these devices in hospitals and medical equipment stores, the patients have to use the devices of the second group – wooden clamps or wedge-shaped struts, which only apply pressure on particular parts of dental arch and have not dosed load [1].

The situation is quite different in Europe and the USA where there is a clear system of

standardized treatment protocols. For example, the world-known mechanical therapy system TheraBite® is used in Sweden. In the USA two known systems are used – the TheraPacer 3000, which makes continuous passive movements and is effective for the treatment of patients with temporomandibular joint (TMJ) diseases, and after the surgeries in the maxillofacial area, and a biomechanical DTS device, provided for continuous passive mechanical therapy- Dynasplint Trismus System ®. All of these devices can be used at home, they are commercially available [2, 3].

But, along with the advantages each model has its disadvantages, including: dental plates balancing for people with secondary edentia, large size. Some of the devices need to be plugged into a source of power. The design of all the devices includes the installation of dental plates in the oral cavity when mouth opening amplitude is no less than 5mm. They are quite expensive. In professional literature there are no reports on the creation of medical diagnostic device for mechanical therapy of the mandible that would allow tracing the dynamics and predicting the time of recovery with various pathologies.

Conclusions and recommendations for further research.

1. It has been determined that posttraumatic contractures of masticatory muscles are most often developed by athletes engaged in boxing and martial arts, hockey, football, handball and cycling.

2. Mechanic therapy is the dominant means in our proposed comprehensive treatment method for contractions of masticatory muscles.

3. The proposed method of treatment and rehabilitation of athletes with contractions of masticatory muscles is aimed at a significant reduction in the cost of the treatment process and also in many cases allows the abandonment of surgical methods of treatment of this pathology.

4. One of the main advantages of the device for mechanical therapy in comparison with other is the dramatic reduction of the terms of treatment. Even with contractures of severe degree in athletes after 14 days of treatment, in most cases, the desired effect is observed.

5. The cost of the device for mechanical therapy is moderate and makes it economically profitable.

6. Due to this method, the athlete becomes an active subject of the medical process, in particular treatment can be carried out both in the hospital and in outpatient settings.

The differentiated approach to the type of mechanical therapy is planned to be chosen in the working process depending on the disease. For example, it is recommended to use the passive mechanical therapy element with the temporomandibular joint diseases, while it is preferable to use both active and passive mechanical therapy elements with the masticatory muscles contractures.

The computer program aims at studying of the dynamics and the tendencies of the course of various maxillofacial area diseases, when there appears a limitation of mouth opening. It will be an algorithm for the choice of the most effective treatment regimen to help different pathologies, and can be valuable for drafting diagnostic and therapeutic algorithms of other nosological units (diseases).

The implementation of the methods of biomechanical bone and soft tissues structures study will make it possible to develop mathematical models. The programs of the simulation research of various kinds of mechanical therapy device operating modes will be constructed on the basis of these models. The mathematical models will form the basis of the other medical equipment products.

The single-use dental plates film-covers are to be used for hygienic purposes.

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