Секция 2. МЕТОДЫ ИССЛЕДОВАНИЙ И МЕТРОЛОГИЧЕСКОЕ ОБЕСПЕЧЕНИЕ ИЗМЕРЕНИЙ

УДК 615.8

THE USE OF SHOCK WAVE THERAPY IN SPORTS PRACTICE

Monich S., Liu Hang

Belarusian national technical university
Minsk, Republic of Belarus

Abstract. In this paper, planning and applying a variety of recovery tools is an integral part of the training process in the preparation of qualified basketball players. Effective recovery tools make it possible to reduce the negative effects of high-volume and intensity loads, and avoid the appearance of overtraining in athletes. The search for the optimal combination of training and restorative means is currently one of the urgent problems in the practice of sports training.
Key words: tape, glue, adhesive strength, device, test.

ПРИМЕНЕНИЕ УДАРНО-ВОЛНОВОЙ ТЕРАПИИ В СПОРТИВНОЙ ПРАКТИКЕ

Монич С. Г., Лю Хан

Белорусский национальный технический университет
Минск, Республика Беларусь

Аннотация. В данной работе рассматриваются планирование и применение разнообразных средств восстановления является неотъемлемой частью тренировочного процесса в подготовке квалифицированных баскетболистов. Эффективные средства восстановления позволяют снижать отрицательное воздействие больших по объему и интенсивности нагрузок, избегать появления состояния перетренированности у спортсменов. Поиск оптимального сочетания тренировочных и восстановительных средств на сегодняшний день является одной из актуальных проблем в практике спортивной подготовки.
Ключевые слова: ударно-волновая терапия, спорт, реабилитация, устройство, терапия

Адрес для переписки: Monich S., Prospekt Nezavisimosti, 65, Minsk 220113, Republic of Belarus
e-mail: sgmonich@bntu.by

Injuries that disrupt the functions of the musculoskeletal system (MSS) lie in wait for a person all his life at every step. According to statistics, ankle injuries are the most common among all limb injuries. The largest percentage of ankle injuries occurs from incorrect landings when jumping off high objects, landing on uneven surfaces, and falls. In these cases, dislocations and fractures are most characteristic. There may be injuries and diseases of the soft tissues of this area – calf muscles, Achilles tendon, sprains and inflammation of the ligamentous apparatus. This problem is especially relevant in sports. Modern training of high-class athletes requires strenuous training regimes and places high demands on the athlete's body, in particular on the development of overstrain and, as a result, increased injuries [1].

The intensification of the training and competitive processes in basketball requires athletes to demonstrate the maximum possible physical abilities, including performance. However, the adaptive processes occurring in the body of athletes under the influence of loads are caused by complex changes in organs and tissues. Insufficient attention to recovery can lead to the accumulation of fatigue and even the appearance of maladaptive changes, which can further cause frequent injuries and diseases. In this regard, the question arises of studying the means of recovery and their effect on the functional state and physical performance of athletes after intensive training.

The analysis of scientific and methodological literature devoted to the problem of athletes' recovery has revealed that in sports practice, rehabilitation measures are applied taking into account the specifics of the type of activity and may have a differentiated character depending on the load indicators, the duration of the preparatory period, the degree of fatigue, the functional state and qualifications of athletes [2].

Modern studies of sports training processes have shown that the recovery process after stress should be attributed to factors contributing to improving the effectiveness of training athletes of various qualifications. The intensification and increase in the intensity of training and competitive processes in basketball necessitated the systematization of recovery tools used in the process of training qualified basketball players in order to increase their performance, prevent injuries, as well as as a necessary condition for increasing the volume and intensity of training loads.

The mechanism of the impact of the shock wave on the motor apparatus, despite the appropriate equipment available to doctors for a long time, has not yet been clarified. All the previously assumed mechanisms of influence are nothing more than hypotheses.

Several theories are put forward to explain the analgesic effects of the shock wave [2]:

– the shell of the nociceptor cell in focus may be damaged, so that the source of pain can no longer arise.

– the principle of hyperstimulating analgesia: an unusually strong irritation transmitted through neurons to the brain can activate the descending inhibitory tracts of the nervous system, which block nociceptive information flowing in parallel to the spinal cord.

It is assumed that osteogenesis is exposed to a shock wave. In this case, microcracks occur and due to mechanical damage, fibroblasts transform into osteoblasts.

Under the influence of the shock wave, there is a local increase in blood flow, a change in the permeability of cell membranes, activation of metabolism and restoration of cellular ion exchange. This ensures intensive elimination of the end products of catabolism, stimulation of tissue repair processes, anti-inflammatory and decongestant effect [1, 6].

The method steadily reduces pain sensitivity, muscle spasm, loosens painful bone outgrowths, calcification sites, fibrous foci, followed by gradual resorption of their fragments, increases the elasticity of ligaments and tendons, improves local blood circulation, significantly reduces pain syndrome, restores the volume of movements in joints, increases the tolerance of physical exertion and, as a result, resumes professional or household activities.

Extracorporeal shockwave therapy is an alternative to surgical treatment of diseases of the musculoskeletal system. Clinical studies have shown [4, 5] that 75 % of patients who underwent UHT recovered. And only 25 % had surgery.

Prerequisites for the use of UVT in the treatment of degenerative diseases of the spine are a number of diseases of the spine, which are based on metabolic disorders and degenerative processes in tissues (osteochondrosis, scoliosis, spondylosis, intervertebral disc protrusion, etc.).

An electromagnetic shock wave generator is known [3] containing a hollow cylindrical inductor 1 consisting of a cylindrical spiral coil 2, a reverse current line 3 and a metal shell 4 separated from the inductor coil by an insulating layer (Figure 1). The inductor is fixed with the possibility of mounting in a dielectric flange 5, which is mounted on a reflector 6.

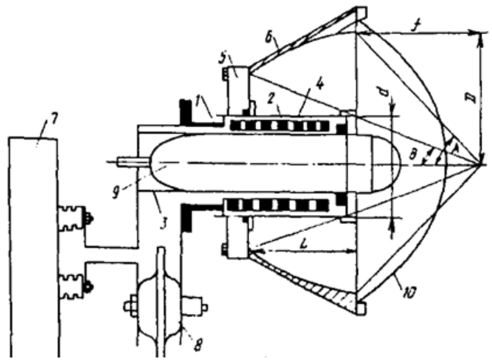

Figure 1 – An electromagnetic shock wave generator

The reverse current line is connected to one of the terminals of the capacitive accumulator 7, the second terminal of which is connected to one electrode of the arrester 8, and the output of the spiral coil of the inductor is connected to its other electrode. The device works as follows. The capacitor 7, charged to the operating voltage, when a starting pulse is applied to the arrester 8, is discharged through the coil 2 of the inductor 1. A current pulse through the inductor coil excites an eddy current in the metal shell 4. The force interaction of currents in the inductor coil with currents in the metal membrane causes shock acceleration of the metal shell.

The moving metal shell excites a diverging cylindrical shock wave pulse in the surrounding liquid, which, when reflected from the surface of the reflector 6, focuses in its focal zone.

The advantages of this design are high reliability and efficiency, stable operation of the arrester and its long service life, low negative pressure amplitude.

During the procedure, the response of the patient's body to the treatment is measured, presumably by measuring the parameters of acupuncture points associated with the place of therapeutic effect. The measurement information is analyzed by the control circuit for the presence of tissue damage by the shock wave. If necessary, the procedure parameters are automatically changed according to the program stored in the device's memory.

The device works as follows (Figure 2). A high-amplitude current pulse flows through the inductor, which leads to the appearance of a magnetic field around the conductor.

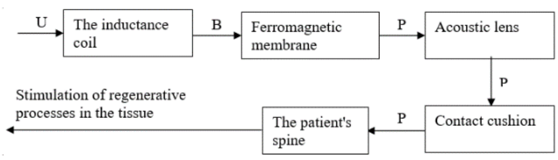

Figure 2 – Block diagram of the shock wave head

In this case, eddy currents are induced in the ferromagnetic membrane, which create their own magnetic field directed counter to the magnetic field of the coil. As a result of the interaction of these fields, the membrane is repelled from the coil, which leads to the appearance of a shock wave. An acoustic lens transforms a flat shock wave front into a spherical converging one. The contact pad is used to conduct acoustic energy into biological tissue.

Literature

1. Extracorporal Shock Waves Activate Migration, Proliferation and Inflammatory Pathways in Fibroblasts and Keratinocytes, and Improve Wound Healing in an Open-Label, Single-Arm Study in Patients with Therapy-Refractory Chronic Leg Ulcers. / I. Aschermann [et al.] // Cell Physiol Biochem. – 2017. – V. 41, № 3. – P. 890–906.

2. Berta L.Extracorporeal shock waves enhance normal broblast proliferation in vitro and activate mRNA expression for TGF-beta1 and for collagen types I and III / Berta L. [et al.] // Acta Orthop. – 2009. –V. 80, № 5. – P. 612–617.

3. Electromagnetic shock wave generator with a reflector: pat. RU 2122363, Y. V. Andrianov, O. N. Andrianova, K. G. Bagaudinov, B. A. Garilevich. – Publ. 11.27.98.
4. Shmagoy, V. L. The place of shock wave therapy in postoperative rehabilitation of patients with disorders of reparative osteogenesis after fractures of the shin bones / V. L. Shmagoy, R. G. Rodak, V. V. Karas // Medicine of transport in Ukraine. – 2014. – № 4. – P. 58–63.
5. Stimulation of peripheral nerve regeneration: current state, problems and prospects / I. N. Shchanitsyn [et al.] // Successes of physiological sciences. – 2017. – V. 48, № 3. – P. 92–112.
6. Shock wave therapy in the complex treatment and rehabilitation of patients with coronary artery disease with refractory angina pectoris / A. M. Shchegolkov [et al.] // Bulletin of Restorative Medicine. – 2014. – № 6. – P. 69–75.

УДК 621.382

ПРОЧНОСТНЫЕ СВОЙСТВА ПЛЕНОК ФОТОРЕЗИСТА AZ nLOF 5510

Абрамов С. А.[1], Бринкевич Д. И.[1], Просолович В. С.[1], Колос В. В.[2], Зубова О. А.[2], Черный В. В.[3], Вабищевич С. А.[4], Вабищевич Н. В.[4]

[1]Белорусский государственный университет
[2]ОАО «ИНТЕГРАЛ» – управляющая компания холдинга «ИНТЕГРАЛ»
[3]Белорусский национальный технический университет
Минск, Республика Беларусь
[4]Полоцкий государственный университет имени Евфросинии Полоцкой
Новополоцк, Республика Беларусь

Аннотация. Методом индентирования исследованы пленки негативного фоторезиста AZ nLOF 5510 толщиной 0,99 мкм, нанесенные на поверхность пластин кремния методом центрифугирования. Пленки AZ nLOF 5510 ведут себя как упругопластичные материалы, в которых присутствуют растягивающие упругие напряжения. После дополнительной сушки и ионного травления поведение пленок AZ nLOF 5510 при индентировании схоже с поведением твердых непластичных материалов. Такая обработка приводила также увеличению микротвердости структур фоторезист/кремний, что обусловлено сшиванием молекул фоторезиста, приводящим к утрате упругопластических свойств пленки. Показано, что образование при ионном травлении на поверхности фоторезистивной пленки тонкого углеродоподобного слоя препятствует растяжению пленки после снятия нагрузки с индентора.
Ключевые слова: негативный фоторезист, микроиндентирование, микротвердость, ионное травление.

STRENGTH PROPERTIES OF AZ nLOF 5510PHOTORESIST FILMS

Abramov S.[1], Brinkevich D.[1], Prosolovich V.[1], Kolos V.[2], Zubova O.[2], Chornyi V.[3], Vabishchvich S.[4], Vabishchvich N.[4]

[1]Belarusian State University,
[2]«INTEGRAL» Joint Stock Company
[3]Belarusian National Technical University
Minsk, Republic of Belarus
[4]Euphrosyne Polotskaya State University of Polotsk
Novo Polotsk, Republic of Belarus

Abstract. Films of AZ nLOF 5510 negative photoresist with a thickness of 0.99 microns deposited on the surface of silicon wafers by centrifugation were studied by the indentation method. AZ nLOF 5510 films be-have like elastoplastic materials in which tensile elastic stresses are present. After additional drying and ion etching, the behavior of AZ nLOF 5510 films during indentation is similar to that of solid non-plastic materials. Such treatment also led to an increase in the microhardness of the photore-sist/silicon structures, which is due to the crosslinking of photoresist molecules. It lead to a loss of the elastic-plastic properties of the film. It is shown that the formation of a thin carbon-like layer on the sur-face of a photoresistive film during ion etching pre-vents the film from stretching after the load is re-moved from the indenter.
Key words: negative photoresist, microindentation, microhardness, ion etching.

Адрес для переписки: Просолович В. С., пр. Независимости, 4, г. Минск 220030, Республика Беларусь
e-mail: prosolovich@bsu.by

Фоторезист AZ nLOF 5510 (производитель MicroChemicas Gmbh. Германия) широко используются в однослойных процессах обратной (lift-off) литографии микроэлектроники. Он предназначен для получения тонких пленок толщиной от 0,7 до 1,6 мкм. Так при скорости вращения центрифуги 3000 об/мин толщина фоторезистивной пленки AZ nLOF 5510 составляет 0,90 мкм. Фоторезист AZ nLOF 5510 разработан под *i*-линию (λ = 365 нм) дуговой лампы и применяется в процессах RIE травления и ионной имплантации. Фоторезист (ФР) чувствителен к электронному