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# Physical treatment in ankle injures - review of the literature

# Postępowanie fizykalne w przypadku urazu stawu skokowego – przegląd piśmiennictwa

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**Słowa kluczowe:** uraz stawu skokowego; metody fizykalne.

**Key words:** ankle sprain; physical therapy.

## Streszczenie

Urazy stawu skokowego w skali całego układu kostno-stawowego człowieka występują najczęściej. Dotyczą one wszystkich grup wiekowych, jednakże z największą częstotliwością pojawiają się u osób młodych, amatorsko bądź też profesjonalnie uprawiających sport. Postępowanie lecznicze w przypadkach urazów stawu skokowego obejmuje unieruchomienie, farmakoterapię, metody kinezyterapeutyczne oraz fizykalne, wspomagane często zaopatrzeniem ortopedycznym, a w ostateczności leczeniem operacyjnym. Wśród metod fizykalnych, które można zastosować w przypadkach świeżych urazów na szczególną uwagę zasługuje krioterapia, magnetoterapia i laseroterapia. Po ustąpieniu stanu ostrego można zastosować zabiegi, które wywołują w tkankach efekt cieplny.

## Summary

Ankle sprain are very common among every age group. However, such injuries occur more often amidst young people due to sport activity. Treatment procedures for ankle sprain include pharmacotherapy, kinesiotherapy, physical therapy and orthotic support and in some cases surgical intervention. Cryotherapy, magnetic field therapy and lasertherapy are recommended for acute stage of injury. Thermotherapy is recommended for sub acute stage of injury.

## Introduction

Of all the joints in the body, none is as complex as the ankle. Its intricate structure of bones, tendons, and ligaments is under the control of an equally complex group of muscles. The variety of movements performed by the ankle subject it to forces of a magnitude far out of proportion to its size. It is little wonder that ankle injuries are the most common of all joint injuries

Treatment in case of ankle injures shall include pharmacology, kinesio- therapeutic methods and physical assistance with orthopedic equipment and finally with operational treatment. Treatment of serious injuries shall be performed on the basis of the formula RICE [2]:

**R** - est (rest),

**I** - ce (icing),

**C** - ompression (compression),

**E** - levation (elevation).

## Methods of physical treatment

The most important and worth mentioning physical method which can be used for fresh injuries shall be the following:

Cryotherapy which smoothens original consequences of the injury – relieves pain, stops internal bleeding and prevents fast increase of the swelling. Local and general cryostimulation shall mean elimination of warmth from the organism. Biological effects being the result of cooling of the given part of the body or the whole organism shall start a cascade of physiological processes which shall have an impact on the mechanisms of regeneration and mobilization of tissues. One of the processes fastening the process of recovery of the structure of the motor organs shall be the mechanism of vasodilation of blood vessels. In the initial phase of the procedure they are shrunk and then suddenly extended. In the result of the abovementioned the flexibility of ligaments, joints shall be increased and the muscle tension shall be decreased [3].

Magnetic therapy – a characteristic feature of the magnetic field shall be its transfer through all structure of the system. This feature differs the magnetic field form other forms of energy which

shall be consumed to certain depth within the area of tissues. The best known processes shall include stimulating impact of the field on the process of cellular breathing and tissue regeneration. Magnetic field shall have an impact on the improvement of oxidation processes and tissue breathing, the increase of angiogenesis and revascularization, the increase of the regeneration processes of soft tissues, fastening the processes of creating bone adhesions, anti-inflammatory, anti-swelling and analgesic activities [4].

Low-level laser therapy – shall also provide good therapeutic affects in treating the abovementioned problem. The observed changes occurring in soft tissues shall be specified as the so called secondary activities of laser radiation. Due to the abovementioned the following can be distinguished: the analgesic affect (due to hyperpolarisation of the membranes of nervous cells, creating endorfines), anti-inflammatory effect (due to extension of blood vessels, creating the lateral circulation, increasing the resorption of exudations) and the stimulating one (caused by the improvement of circulation, nutrition and regeneration of cells). In order to cause the bio-stimulating effect in the tissues the proper amount of energy has to be delivered to a particular area. According to the Arndt – Schultz law this means the best laser radiation with the surface density of the surface should amount from 2 to12 J/cm$^2$. While selecting the doses of energy we should take into consideration the following: age of the patient, type of the disease and current state (acute, chronic one), depth of the tissues changed due to the disease. In accordance to the Lambert-Beer law which shall present the relation of the depth of penetration of the tissue for a particular length of a wave of laser radiation the following lengths of waves shall be applied: in treating the surface changes caused by the disease or located on a shallow area the radiation with the length of the ways of 630/670 nm shall be used; in the therapy of the changes caused due to the disease located on deeper areas the ultra-red radiation with the length of ways at the level of 810 nm or 904 nm should be applied. In impulse work we adjust frequencies to the current state of the patient; in acute states we shall apply smaller frequencies which shall have analgesic effect and in more chronic ones we should apply the higher ones which shall have a regenerative and anti-inflammatory effects. The number of the procedures in a series and the frequency of their application depends on the type of the disease and reaction of the patient to the procedure [5]. Tissues ischemic, edema and injury have been shown to have a significantly higher response to laser therapy output power, wavelength and power density than normal tissue. The biological response includes DNA/ RNA synthesis, increased cAMP levels, protein and collagen synthesis and cellular proliferation. These reactions lead to rapid normalization, regeneration and healing of damaged tissue — the laser light modulates cellular metabolism [6].

After the end of the acute state:

High intensity laser therapy (HILT) – during the last 10 years we can observe a tendency to produce the devices generating a laser beam with a higher power which in many cases proved to be more

effective in laser therapy. As opposed to the low and middle – energetic therapies (to 500 mW) it shall be named the high-energetic one (HILT) – over 500mW. On the market in the USA lasers with the power to 7500 mW shall be available. The use of high power seems to be justified with the changes located deeper in the placed tissues. Power shall be a physical value which shall be characterized by the speed of the flow of energy, in this case the number of fetones delivered in a particular period of time. For the laser with a higher power in the surface tissues a big dose of optical radiation shall be absorbed (big surface density of power), in the result of the abovementioned the following thermal effects shall appear – a feeling of delicate warmth. The remaining part of the optical beam which shall be transferred to the tissues placed deeply, in connection with the decreasing together with the depth of the amount of the absorbed energy, does not cause thermal effects but only photo-bio-chemical effects which shall mean bio-stimulating processes [7].

Ultrasound therapy– the impact of the ultra-sound wave shall be a sum of warm, mechanical and physio-chemical effects. The created warmth extends the blood vessels in tissues, increases their blood flow through supplying greater amount of oxygen, nutrition substances and removing unwanted products of metabolism, increases local processes of metabolism and loosens the muscles. Apart from that we can observe the transmission of cellular membranes increases, including the ions of calcium, the changes of colloid state of proteins, increasing the synthesis of collagen, increasing the flexibility of collagen fibres, increasing the recovery of wounds, analgesic effect. The ultra-sonic waves allow to create new capillars in chronically ischemic tissues and release the increasing factors through macrophages. Under the impact of the ultra-sonic wave in the bone tissue the piezoelectric phenomenon occurs which may play a great therapeutic role. While selecting the doses the three following factors should be taken into consideration: the size of the surface being treated, the depth at which the changes appear and the stage of the changes. The parameters having an impact on the selection of the dose shall include: the way of work (constant or impulsive one), frequency (usually 1 or 3 MHz), intensity. The constant course shall lead to the creation of warmth in the tissues. In acute states the limitation of the warming effect shall be recommended. Therefore, it shall be suggested to use impulsive ultra-sonic wave with various ratios of filling. Dampening the ultra-sonic wave shall increase with the increase of frequency and that is why the waves reach deeper areas. Power which means the whole amount of energy supplied by the device per one second shall be measured in Watts. In acute and sub-acute states the intensity at the level of 0,1-0,5 $W/cm^2$ should be applied, and in chronic states 0,8-1,5 $W/cm^2$ [8]. The effectiveness of sleep therapy can be increased by the use of stimulating substance, analgesic or anti-inflammatory medicine in a form of gel [9].

Electro-magnetic fields of high frequency shall be used commonly in treating chronic disfunctions where the endogenic warmth shall constitute a preparatory factor for kinesiotherapy. Electric field

emitted by a short-wave diaterm can be also emitted in a form of impulses. The main aim of introducing impulsive electromagnetic waves of high frequency into the treatment was the need to decrease the warming effect. The tissues in this method shall undergo impulses of high peak power, separated from each other with long breaks in order to disperse the warmth. This method can be used in the diseases where heating the tissues is not recommended. Impulsive electro-magnetic field of high frequency shall have an impact of the increase of the number and activity of cells in a wound, the direction and the speed of collecting fibroblasts and collagen fibres, reduction of inflammation and swelling, absorption of hematomas and repairing process of nerves [8].

**Review of the literature**

van den Bekerom at al [10] analyzed data on outcomes (pain, swelling, ankle mobility or range of motion, return to sports, return to work, complications and patient satisfaction) and assessed the quality of included studies based on database MEDLINE, Cochrane Clinical Trial Register, CINAHL, and EMBASE. After deduction of the overlaps among the different databases, evaluation of the abstracts, and contact with some authors, 24 potentially eligible trials remained. The full texts of these articles were retrieved and thoroughly assessed as described. This resulted in the inclusion of 11 trials involving 868 patients. The main reason for exclusion was that the authors did not describe a well-defined control group without the intervention of interest.

Insufficient evidence is available from randomized controlled trials to determine the relative effectiveness of RICE therapy for acute ankle sprains in adults.

de Almeida at al. [11] conducted the study study in which the analyzed the effects of sodium diclofenac (topical application), cryotherapy, and LLLT on pro-inflammatory cytokine levels after a controlled model of muscle injury. The authors of this study performed a single trauma in tibialis anterior muscle of rats. After 1 h, animals were treated with sodium diclofenac (11.6 mg/g of solution), cryotherapy (20 min), or LLLT (904 nm; superpulsed; 700 Hz; 60 mW mean output power; 1.67 W/cm2; 1, 3, 6 or 9 J; 17, 50, 100 or 150 s). Assessment of interleukin-1β and interleukin-6 (IL-1β and IL-6) and tumor necrosis factor-alpha (TNF-α) levels was performed at 6 h after trauma employing enzyme-linked immunosorbent assay method. LLLT with 1 J dose significantly decreased ($p < 0.05$) IL-1β, IL-6, and TNF-α levels compared to non-treated injured group as well as diclofenac and cryotherapy groups. On the other hand, treatment with diclofenac and cryotherapy does not decrease pro-inflammatory cytokine levels compared to the non-treated injured group. Authors of the study conclude that 904 nm LLLT with 1 J dose has better effects than topical application of diclofenac or cryotherapy in acute inflammatory phase after muscle trauma.

Stergioulas [12] conducted the study aiming to whose objective was to compare three therapeutic protocols in treating edema in second degree ankle sprains that did not require immobilization with a splint, under placebo-controlled conditions. Forty-seven soccer players with second degree ankle

sprains, selected at random, were divided into the following groups: The first group (n = 16) was treated with the conventional initial treatment (RICE, rest, ice, compression, elevation), the second group (n = 16) was treated with the RICE method plus placebo laser, and the third group (n = 15) was treated with the RICE method plus an 820-nm GaA1As diode laser with a ra- diant power output of 40 mW at 16 Hz. Before the treatment, and 24, 48, and 72 h later, the volume of the edema was measured. A three by three repeated measures ANOVA with a follow up post hoc test re- vealed that the group treated with the RICE and an 820-nm GaA1As diode laser presented a statistically sig- nificant reduction in the volume of the edema after 24 h (40.3 ± 2.4 mL, $p < 0.01$), 48 h (56.4 ± 3.1 mL, $p< 0.002$), and 72 h (65.1 ± 4.4 mL, $p < 0.001$). Author of this study concludes LLLT combined with RICE can reduce edema in second-degree ankle sprains.

Boland at al. [13] claim to musculoskeletal injuries related to training and operational missions frequently affect military personnel. A common treatment for these injuries is the PRICE (protection, rest, ice, compression, and elevation) method, which is time consuming and impractical in the field. Therefore, the primary objective of this study was to determine the effectiveness of the cryotherapy wrap compared to a traditional treatment in the management of acute ankle sprains. A randomized controlled clinical trial was conducted in a university research laboratory with 13 subjects (9 males and 4 females). Participants were instructed to perform PRICE with a traditional ice pack and compression wrap (control group) and cryotherapy wrap (test group) for 48 hours following enrollment in the study. The Numeric Pain Scale, Foot and Ankle Ability Measure, and ankle/foot volumetric measurement were performed at initial presentation and 24-hour, 48-hour, and 7-day follow-up intervals. While the comparison of the Numeric Pain Scale scores, Foot and Ankle Ability Measure scores, and volumetric changes between groups revealed no statistically significant differences ($p > 0.01$), there was an 86% compliance rate for subjects in the cryotherapy wrap group compared to a 17% compliance rate of subjects in the control group. Authors of the study conclude that cryotherapy wraps performed comparably to ice therapy and therefore may be especially applicable to military personnel required to operate in austere and hostile environments where traditional therapies are unrealistic.

Many studies demonstrate the safety and efficacy of LLLT. A systematic review of 11 trials that included 565 patients demonstrated that LLLT used in a specific dose range significantly reduced pain in chronic joint disorders [6]. Another systematic review with metaanalysis of 18 randomized placebo controlled trials evaluating LLLT in elbow tendonopathy concluded that LLLT provided short term pain relief with less disability, when administered in optimal doses directly to the lateral elbow tendon insertions [14]. Another randomized placebo controlled trial treating activated Achilles tendonitis in seven patients demonstrated that LLLT suppresses inflammation, measured by reduction in the inflammatory marker PGE2. Further, LLLT improved clinical indices of pressure pain and sing hop function in these patients [15]. This therapeutic modality has become

well established in sports medicine and physical therapy as a safe and effective method to treat pain by decreasing inflammation.

Łukowicz at al. [16] presented the outcomes of treatment of few subjects with different musculoskeletal disorders with RAINBOW DROPS three probe laser (635 nm, 808nm, 960 nm). Authors of the study conclude that this therapy occurred to be effective in treatment of overload syndrome, trigger points, low back pain, degenerative disease, it is not recommended for treatment of acute lesions and superficial changes because of thermal effects of this therapy.

## Conclusions

In case of tarsal joint sprain the treatment shall depend on the degree of injury of the joint and the period from the time of the injury.

Physical methods shall shorten the recovery period and successfully decrease the lateral symptoms of the injury.

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