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Efficacy of cryotherapy in recovery from muscle injuries: a systematic review

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In today's world of active lifestyles, muscle injuries have become a common problem that requires effective recovery methods. In addition to traditional methods, such as physiotherapy and pharmacotherapy, cryotherapy has proven to be an innovative and popular treatment. It reduces pain, inflammation and promotes muscle recovery. However, it is important to consider its mechanisms of action, possible limitations, and safety, especially in the context of whole-body cryotherapy.

A systematic review of scientific literature was conducted using the PRISMA methodology (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). To collect relevant publications, a search was conducted in leading scientific databases, including Google Scholar, PubMed, Web of Science, and Scopus. The review covered publications over the past 10 years (2015—2025) to ensure that the data is up-to-date and reflects current trends in the use of cryotherapy. The analysis included only peer-reviewed articles in a foreign language that belonged to the specified databases and were relevant to the use of cryotherapy for the treatment of muscle injuries and acceleration of recovery processes in the field of sports medicine and rehabilitation.

Cryotherapy is a common method in sports medicine and rehabilitation to reduce pain, inflammation, and accelerate recovery from muscle injuries and physical activity. This systematic review analyzed 50 peer-reviewed articles from 2015—2025, of which 35 were human studies. The results show that cryotherapy, in particular localized cold application and whole-body cryotherapy, helps to reduce pain and inflammatory markers, as well as accelerate muscle recovery after injury or intense exercise. For example, a meta-analysis of 11 randomized controlled trials confirmed that whole-body cryotherapy reduces serum levels of pro-inflammatory cytokines, improving regeneration. Another study on athletes showed that localized cryotherapy reduces pain and improves functional recovery after acute muscle injuries.

However, the effectiveness of cryotherapy depends on the duration, temperature, and frequency of sessions. Studies indicate the need for repeated sessions to achieve a stable effect, as a single application may not be sufficient. In terms of safety, cryotherapy can affect dynamic postural stability, reducing balance and altering movement kinematics after a session, which requires caution during vigorous exercise. In addition, prolonged application of cold carries the risk of frostbite and nerve damage, especially if used improperly. Thus, cryotherapy is a promising method, but requires an individual approach, careful monitoring of application parameters, and further research to clarify optimal protocols. Cryotherapy is an effective method for reducing pain and inflammation, as well as for accelerating recovery from injuries and physical activity. However, research on the effects on humans is still limited, and the effects require repeated sessions for a stable result. The use of cryotherapy can affect dynamic stability and carries a risk of nerve damage if used improperly.

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Impact of hyaluronic acid on healing of cold wounds

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The issue of treating cold wounds is still of high relevance. Tissue necrosis after local cold exposure occurs as a result of direct injuring effects of cold followed by primary necrosis and secondary necrosis due to vascular factors. Improving the methods for treating cold wounds requires the search for new therapeutic approaches, elucidation of mechanisms of action of various active substances and testing their biological activity *in vivo*. Hyaluronic acid (HA) is a well-known substance that is widely used in aesthetic medicine. However, the possibility of its application for treating cold wounds is still unclear.

The aim of the study was to investigate the HA effect on cold wound area in hairless rats.

In the study we have used a 1% solution of high molecular weight HA (>2,000 kDa) in saline. Cold wounds were simulated by pressing a cryoapplicator (8.0 mm diameter) with liquid nitrogen temperature to the lateral surface of femur for 30 sec. Immediately after cryoapplication, 0.8 ml of the studied solution was injected around the visible area of skin injury and partially under the affected skin from 6—8 points. The surface area of wounds was calculated at 1th and 7th days of observation using the «ImageJ» software.

The findings show that differences between the mean values of wound area in rats of the experimental group (application of HA) and the control group (healing without treatment) were revealed in 1 and 7 days after simulating cold wounds. Thus, the acceleration of wound healing was observed in the time interval corresponding to inflammatory phase of wound process, which is characterized by progressive development of tissue edema in injured area. These results are probably related to anti-inflammatory properties of HA. In our opinion, these data are primarily stipulated by anti-edematous effect of HA. It is known that high molecular weight HA is able to bind a significant amount of water. Therefore, we can assume that HA molecules bound the fluid of inflammatory exudate promoting a decrease in inflammation activity within injured tissues. The HA application reduced the effect of injuring vascular factors of cold impact by decreasing the edema intensity in tissues.

The introduction of high-molecular-weight HA contributed to a decrease in cold wound area. Our findings show the prospects of using high molecular weight fraction of HA in developing the novel approaches to cold wound therapy and improving the existing protocols.