Preventive Strategies for Soft Tissue Injuries of the Ankle

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Abstract: Soft tissue injury of the ankle joint is a condition that has an acute onset and is prone to recurrence. According to relevant statistical data, chronic instability of the ankle joint is the most common complication, severely affecting quality of life and reducing life experience. This article summarizes previous research evidence, synthesizes relevant guidelines, and analyzes expert consensus to extract effective measures to reduce the incidence of soft tissue injuries of the ankle joint and decrease recurrences. Based on existing data, it is found that the treatment involves multiple stages and various treatment methods. Therefore, this article integrates and summarizes different treatment strategies for different populations and stages of ankle joint soft tissue injuries, presenting them in the form of a three-level prevention strategy, aiming to provide procedural references for the treatment and prognosis of ankle joint soft tissue injuries and further promote the standardization of prevention and treatment.

1 INTRODUCTION

Soft tissue injuries of the ankle, particularly lateral ankle ligament injuries, are among the most common musculoskeletal injuries. They account for approximately 10% of all emergency department visits and 30% of all sports-related injuries (Swiontkowski, M.F.,2004). Individuals engaged in activities such as jumping, running, and rapid direction changes face a higher risk. Among 200 high-level competitive aerobics athletes from China, ankle injuries accounted for about 45% of all risks (Ma,X. ,2024).Additionally, a gender difference has been observed, with female athletes being approximately 25% more likely to sustain soft tissue injuries to the ankle compared to male athletes (Marín Fermín, T., 2023).The increasing popularity of ball sports has further contributed to the rise in the incidence of these injuries, significantly impacting patients' daily lives and imposing substantial medical costs for initial and follow-up treatments.

Although soft tissue injuries of the ankle joint have a high incidence in various populations, the treatment methods following such injuries are still under discussion. While rehabilitation is the cornerstone of conservative treatment, the extent and severity of the injury are often not clearly defined at the time of diagnosis, leading to poor timeliness in the formulation and implementation of rehabilitation strategies. This may result in adverse outcomes, including high recurrence rates, persistent symptoms, reduced levels of physical activity, functional impairment, and decreased quality of life. Research indicates that approximately 70% of patients with initial ankle sprains will experience recurrence or progress to chronic ankle instability and osteoarthritis (Marín Fermín, T., 2023). However, the epidemiology of chronic ankle instability remains unknown, and the long-term outcomes of post-traumatic osteoarthritis are poor; therefore, preventing soft tissue injuries to the ankle is crucial. By adopting a three-tiered prevention approach to prevent the occurrence, progression, and recurrence of ankle injuries, primary prevention targets individuals whose ankles have not yet been injured; secondary prevention focuses on patients in the acute phase of injury; and tertiary prevention primarily aims to prevent the recurrence and adverse sequelae of ankle injuries. Tertiary prevention plays an important role in improving the cure rate of soft tissue injuries in the ankle, reducing incidence and recurrence rates. At the same time, it effectively optimizes resource utilization, ultimately lowering the risk of re-injury and improving long-term prognosis.

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2 PRIMARY PREVENTION

The causative factors for soft tissue injuries of the ankle are varied, and a large body of literature points to the development of injuries in relation to self-associated internal risk factors as well as many potential external risk factors. The aim of primary prevention is to modify the external environment and internal risks in order to effectively avoid them and to improve one's own fitness, thereby reducing the risk of first-time injuries in the healthy population.

2.1 Risk Factors in the External Environment and the Prevention

In addition to occurring during exercise, soft tissue injuries to the ankle are also prone to occur on slippery or uneven surfaces and can even be dangerous due to oversized shoes or insufficient upper support. For older adults, the risk is also higher in dimly lit scenes and when walking up and down stairs. In private environments, environmental modifications can be made with the knowledge of a rehabilitation professional, such as increasing the brightness of the environment, reducing floor clutter, and preventing slippery floors. In public places, the risk rate can be reduced by wearing non-slip shoes with hard uppers, paying attention to uneven slippery surfaces underfoot, and carrying crutches for the elderly.

2.2 Internal Risk Factors and Their Prevention

2.2.1 Body Mass Index (BMI)

Research has indicated a substantial correlation between ankle soft tissue injuries and body mass index. Ankle soft tissue injuries are generally more likely to occur in those with a higher body mass index. Ankle and foot soft tissue injuries had a significant association with higher BMI, according to the results of Mendelian randomized analysis investigating the causal relationship between BMI and joint injuries (Bi, W., 2023). Therefore, it may be possible to lower the risk of ankle soft tissue injuries by keeping body mass index within the population mean range of 26.5-31.2 kg/m².

2.2.2 Muscle Strength

The difference in eccentric isometric strength of the ankle flexors between sides is a risk factor for ankle sprains.Specifically, soccer players with asymmetrical centrifugal ankle strength had an 9-fold increased risk of sprains due to ankle sprains. It has been shown that increasing muscle strength in the pyriformis muscle is effective in avoiding lateral ankle ligament injuries, and training in all four directions using elastic bands may also increase muscle strength around the ankle joint, thereby decreasing the risk of ankle soft tissue injuries (Ge, Q., 2025).

2.2.3 Exercise Habits

Proper warm-up before exercise is usually effective in avoiding the risk of soft tissue injuries in the ankle joint. A study showed that among young athletes, participants in balance training programs had significantly fewer ankle injuries compared to the control group ($p < 0.05$) (Nováková, T., 2021) .Therefore, by maintaining the muscles at an appropriate temperature, enhancing muscle elasticity and extensibility to levels suitable for exercise, and promoting proprioceptive neuromuscular training and control of body awareness and kinesthesia, In addition to sufficient basic warm-up activities, incorporating high-intensity exercises, such as sprints and other explosive training, during the warm-up period effectively prevents the occurrence of soft tissue injuries in the ankle joint (Pieters, D.,2022).

3 SECONDARY PREVENTION

Ankle soft tissue injury tends to occur suddenly and to varying degrees, and the treatment methods used vary with the different periods following the injury. Attention should be paid to the treatment methods used in the acute phase, which tend to have a greater impact on the prognosis and the patient's satisfaction with the treatment, as well as on the prognosis of the short-term treatment and the recovery period.

3.1 Cold Therapy

Reports have shown that the use of ice in the acute phase of ankle sprains provides better pain relief than the use of analgesics. But cryotherapy is less effective during the recovery phase after injury; therefore, cryotherapy should only be used in the acute phase of injury to alleviate pain and reduce swelling at the injury site.

3.2 External or Functional Support

Many studies have shown that after pain relief from acute ankle soft tissue injuries, it is crucial to immobilize the affected area using external or functional support devices. This not only prevents secondary injuries through the immobilization of the relevant area but also protects it from further external harm. Currently, commonly used bandages or pressure fixation devices are employed for emergency immobilization, and patients use wheelchairs or crutches to prevent weight-bearing on the injured area, which can reduce pain and promote recovery.

3.3 Non-Viral Anti-Inflammatory Drugs (NSAIDs)

NSAIDs have anti-inflammatory and analgesic effects, and their use during the acute phase of soft tissue injury in the ankle can effectively alleviate patient discomfort, making them a recommended treatment option. However, long-term use can significantly increase the likelihood of complications such as renal dysfunction and nonunion of bones. Therefore, it is advised to use NSAIDs only for a short term during the acute postoperative phase.

3.4 Manual Therapy

The application of physical therapy can effectively improve treatment outcomes in the acute phase. It can flexibly adjust techniques and intervention levels based on different injury conditions, demonstrating strong adaptability. Furthermore, based on scientific analysis and relevant treatment methods, it can reduce patients' rehabilitation time and enhance rehabilitation efficiency. In addition, improvements in various assessment scales now enable physical therapists to provide timely treatment after patients' soft tissue injuries to the ankle joint.

4 TERTIARY PREVENTION

Tertiary prevention can play an important role in reducing recurrence rates and complications by aggressively treating common symptoms after ankle soft tissue injuries. Studies have pointed out that the most common complication after initial ankle soft tissue injury is chronic ankle joint instability (CAJ), which is why most people are prone to re-injury after initial ankle injury. Therefore, systematic rehabilitation and prognostic protection play an important role in preventing re-injury to the soft tissues of the ankle.

4.1 Systematic Rehabilitation Training

4.1.1 Strengthening of Muscle

Improvement of muscle strength is recognized as an important means of enhancing joint stability and preventing re-injury to the soft tissues of the ankle. Muscle strength building has been used in a variety of rehabilitation methods for ankle injuries and is considered a primary measure in the early stages of injury. In an analysis of 200 aerobic athletes, it was found that the incidence of ankle injuries was inversely related to the level of exercise, and that for professional athletes, the differences in physical fitness were greater than the differences in skill, with which muscular strength is usually associated. After the control group was treated with acoustic waves while the experimental group was treated by strengthening the muscles around the ankle joint, it was found that the total effective rate of treatment in the experimental group was higher than that of the control group ($p < 0.05$) (Li, X.,2022).And it was not easy to recur, so it can be concluded that the strengthening of the muscles in the relevant areas can effectively prevent the occurrence of soft tissue injuries of the ankle joint.

4.1.2 Enhanced Proprioception

The control of proprioception is closely related to neuromuscular, for the enhancement of proprioception training is often not the only way, mainly through the enhancement of neuromuscular regulation of integration, so that the individual for their own postural judgment, the perception of movement and the activation of motor units more agile. The cause of recurrent sprains is also related to impaired proprioceptors after the first injury to the ankle ligaments. Therefore, strengthening proprioception, primarily through balance training, is also effective in reducing the risk of ankle soft tissue injuries.

4.1.3 Conventional Intervention Plan

In a study involving 43 patients with CAI, a 4-week intervention with resistance bands and a biomechanical ankle platform system was conducted three times a week. Using the foot lift test, balance test, and 8-shaped jump test, it was found that each

intervention group showed improvement compared to the control group that did not engage in related exercises ($p < 0.05$)(Cain, M. S., 2020).This was primarily achieved through a set of 10 repetitions, repeated 3 times, of ankle eversion, inversion, dorsiflexion, and plantarflexion exercises using resistance bands, and exercises on the biomechanical ankle platform system that involved changing the rotation direction clockwise or counterclockwise every 10 seconds during a 40-second activity, which can effectively improve CAI.

4.2 Sports Protection

Following an ankle injury, exercise is often recommended to facilitate recovery and adaptation to normal life. To prevent re-injury during exercise, a systematic evaluation incorporating rue therapy has shown that the use of a kinesio tape application to assess kinesio tape (KT) is effective in improving functional gait stability and ankle stability during exercise. This effectively reduces the risk of ankle re-injury (Liu, Q., 2024).

5 CONCLUSION

Primary prevention involves improving and controlling external environmental risks, as well as managing one's BMI, muscle strength, and exercise habits to prevent soft tissue injuries of the ankle joint, providing preventive measures for individuals with uninjured ankles. In secondary prevention, cold therapy or short-term use of NSAIDs is applied to patients with acute ankle soft tissue injuries to alleviate initial discomfort, while external functional support and manual therapy are used to enhance short-term treatment and provide support for prognosis and recovery. For patients with rehabilitated ankle soft tissue injuries, tertiary prevention involves systematic rehabilitation training and protective measures in physical activities to avoid recurrence, while enhancing proprioception and muscle strength through traditional interventions can also improve ankle stability and effectively prevent the occurrence of related complications.

In addition, long-term patient education and adherence to maintenance plans play a crucial role in maintaining ankle joint health. As research continues to advance, the integration of innovative rehabilitation techniques and personalized treatment approaches will further improve tertiary prevention strategies. The correlation between different risk factors and incidence will also be analyzed more accurately through scale analysis. With the development of artificial intelligence, prevention measures at all levels will also incorporate individual differences for more detailed analysis and provide prioritized treatment methods, offering guidance for clinical and public treatment.

By prioritizing comprehensive rehabilitation, external support measures, and long-term injury management, clinicians and patients can work together to reduce the burden of soft tissue injuries in the ankle and improve overall functional outcomes.

At the same time, the current literature generally suffers from issues such as small sample sizes, significant age differences among samples, limited discussion of gender differences, and non-standardized rehabilitation methods at various levels. Through technological breakthroughs and the integration of multidimensional strategies, it is possible to significantly reduce the incidence of injuries, improve prognosis, and enhance the quality of life for patients. Furthermore, progress in this field relies not only on technological innovation but also on the integration of social resources and the enhancement of public health awareness. It is hoped that more research outcomes will contribute to the supplementation and improvement of this field in the future.

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