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Ankle Sprain Rehabilitation in Acute and Subacute Phase

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Abstract: Ankle sprains are a common musculoskeletal injury that not only occurs in athletes but also affects the public across different age groups and activities. These injuries are mainly lateral ankle sprains (LAS), a large part of which are caused by people exercising and overstretching or tearing ligaments. Accurate diagnosis through physical examination and advanced imaging techniques is essential for effective treatment. There are three levels of ankle sprain severity, each of which requires a tailored rehabilitation strategy to minimize recurrence risk. This review explores ankle anatomy, risk factors for sprains, and evidence-based rehabilitation techniques such as proprioceptive training, cryotherapy, and assistive devices (such as tape). The effectiveness of combination therapies such as cryotherapy and ultrasound for accelerating recovery was highlighted, as was the importance of functional rehabilitation, including balance and strength training, for preventing chronic ankle instability (CAI). The importance of rational treatment modalities to achieve optimal rehabilitation and long-term joint health.

Keywords: Ankle sprains, Functional rehabilitation, Ligament damage, Recovery phases, Rehabilitation techniques.

1. Introduction

Ankle sprains are one of the most common musculoskeletal injuries, not just in athletes, but in the general population of all ages. Ankle sprains are generally characterized by excessive stretching or tearing of the ligaments supporting the ankle, usually caused by sudden twisting or excessive force during physical activity and waling on the uneven surfaces. Research by McKeon and Hoch have shown that ankle sprains account for a significant portion of sports-related injuries -- about 23,000 people in the United States each day. Lateral ankle sprains (LASs) are the most common type of ankle sprains, nearly 1.5 to 2.0 million people in the United States experience lateral ankle sprains each. These injuries mainly involve the lateral ligament complex, which consists of the anterior talofibular, calcaneofibular, and posterior talofibular ligaments [1]. Although ankle sprains are common, the consequences of inadequate and prompt treatment highlight the importance of rehabilitation after ankle sprain injuries. There are three levels of injury during an ankle sprain, ranging from mild ligament overstretching to severe rupture. Each level requires a tailored rehabilitation approach that addresses not only immediate recovery but also long-term joint function and stability issues, helping patients regain mobility, strength and balance through proprioceptive training, cryotherapy and more.

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2. Overview of ankle sprain

To better understand ankle sprain rehabilitation, the anatomy of the ankle is important because it is fundamental of ankle stability. The ankle is a complex joint made up of bones, ligaments, tendons, muscles, and nerves that work together to provide movement and stability. The tibia in the lower leg carries most of the weight of the body, and the talus forms a joint with the tibia and fibula. The calcaneus provides the foundation for the ankle, while other bones in the foot, such as the scaphoid, cuboid, and cuneiform bones, aid overall stability. The medial talocalcaneal joint and the subtalar joint are important in the ankle, because the former controls the dorsiflexion and plantar flexion which lift or straighten the foot, and the latter controls the inversion or eversion of the foot [1]. For the ligament, the lateral ligaments on the outside of the ankle (anterior talofibular, calcaneofibular, and posterior talofibular ligaments) and the medial deltoid ligaments provide stability and limit excessive movement. The anterior talofibular ligament can limit talus advancement and plantar flexion of the ankle joint. The calcaneofibular ligament plays an important role in providing stability to the subtalar joint. Talofibular toughness has a multi-bundle structure, so it is not only inserted into a specific area [2].

Due to the complexity of the ankle, the severity of ligament damage is different for each person. Understanding different ankle sprain grades can have better rehabilitation. Grade 1 which is a mild ankle sprain where the ligament is overstretched but not torn. People's symptoms are usually mild, with mild swelling and tenderness, but do not affect ankle stability or function, and loss of range of motion is minimal. A Grade 1 injury usually takes a few days to a week to recover, requiring rest and basic rehabilitation exercises. Grade 2 is a moderate sprain, which is characterized by a partial tear of the ligament that causes moderate swelling, bruising, and pain. People with injured feet experience some loss of function and may have difficulty bearing weight. Sprains at this level require more intensive treatment, such as physical therapy and the use of braces or crutches to aid recovery. Grade 3 is the most severe sprain involving a complete tear or rupture of the ligament. These injuries can cause severe pain, severe swelling, bruising, and ankle instability, often resulting in an inability to walk or hold weight on the foot. In Grade 3, people sometimes need surgery to help them recover [3].

Although the severity of an ankle sprain determines the treatments for patients, identifying the risk factors that make an individual vulnerable to these injuries is also important for prevention and management of their ankle health. The article by Delahunt et al. explains the internal and external risk factors of lateral ankle sprains (LAS) and chronic ankle instability (CAI). Intrinsic risk factors are internal characteristics that increase the likelihood of injury [4]. In the general population, young people under the age of 24 are more likely to suffer ankle sprains, with adolescents having the highest incidence. Another major risk factor is a history of ankle sprains. People who have a history of sprains are twice as likely to get another sprain. In addition, people with a larger body weight and BMI have a higher risk of injury, especially in sports that require physical confrontation, such as football. Muscle strength is also often overlooked. Muscle weakness in the ankle and hip muscles can lead to a centrifugal imbalance in the ankle that increases the risk of non-contact sprains. External risk factors are external factors related to the environment or activities. Court sports such as basketball and volleyball, as well as sports such as football, tend to increase the risk of LAS. Because these movements involve frequent changes of direction, jumps, and cuts. These movements cause rapid pronation and pronation of the foot and ankle joints, which is a key mechanical factor leading to injury. In addition, there are environmental factors such as uneven playing fields or inappropriate shoes, as this can cause people to lose their balance when they land [4].

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3. Diagnoses of ankle sprain

Once an ankle sprain happens, an accurate diagnosis is essential for the subsequent treatment process. The diagnosis of ankle sprains is known as physical examinations and Arthrography. In physical examinations, there are different ways to help doctors make decisions about low ankle sprains and high ankle sprains. For low ankle sprains, the anterior drawer test (ADT) and talar tilt test are commonly used (TTT). Both tests require the patient to sit in a high position with knees bent and feet dangling freely. The ADT evaluated ATFL stability by assessing the translation of the talus, with movement greater than 5 mm being a positive result, in addition to the formation of visible furrows at the ATFL level in the torn state. TTT examines the ATFL and calcaneofibular ligaments (CFL) and applies the posterior foot varus force to detect joint instability. For high ankle sprains, the squeeze test, Cotton test and so on are good diagnostic methods. The compression test involves squeezing the tibia and fibula of the middle leg to cause pain in the distal tibia and fibula to determine whether it is a high sprain. The Cotton test evaluates tibiotalar joint stability by applying lateral translation to the talus, with pain perceived as positive [5].

Since physical examinations are better suited to examining an injury when positive rather than examining an injury when negative, arthrography is needed to help judge. MR arthrography is a highly advanced imaging technique that enhances the diagnostic capabilities of traditional magnetic resonance imaging by using intra-articular angiography. For ligament injuries, the technique visualizes the lateral collateral ligament (LCL) complex, associative, and triangular ligaments, identifies partial and complete tears, and distinguishes between chronic and acute injuries. In addition, MRI arthrography is particularly effective in assessing ankle impingement syndromes, which is a chronic painful condition caused by repeated rubbing of joint tissue. This test can be used to diagnose bone and soft tissue abnormalities [6].

4. Phases of Ankle Sprain Rehabilitation

In the acute lateral ankle sprain stage, a central debate is whether to choose surgical or non-surgical treatment. Surgical interventions, especially ligament reconstruction, have been shown to reduce ankle instability and prevent injury recurrence. But surgery has its drawbacks. Longer recovery time after surgery, increased risk of ankle stiffness, and potential long-term complications such as postoperative osteoarthritis were noted in the study. Therefore, surgical repair may be required when people are in severely unstable conditions or when conservative treatment does not yield satisfactory results. Non-surgical treatments are highly effective for people with Grade 1 and 2 injuries, such as the use of semi-rigid ankle braces, physical therapy, and functional rehabilitation, which help reduce symptoms and restore mobility without invasive surgery. The method has a shorter recovery time and fewer complications [7]

In the subacute phase, which occurs between 5 and 14 days after the injury when the acute inflammation subsides, and the tissue begins to heal. But people still experience pain, reduced range of motion, and limited function. In the research, the authors highlight the need for patients with Grade I and II sub-acute ankle sprains to target interventions during this critical recovery phase. The Mobilization with Movement (MWM) technique is an excellent means of recovery from subacute injuries by allowing the therapist to apply sustained painless mobility to the affected area while simultaneously allowing the patient to perform active movements in directions of pain and movement limitation. In the study, patients with acute postures underwent prolonged non-weight training including ankle and subtalar joint range of motion. Once they were able to stand unassisted, weight training progressed from forward lunges and bilateral squats to unilateral squats, and finally to balance training. In the experiment, functional dorsiflexion and Y-balance tests of patients showed significant improvement in 2 weeks, 1 month, and 6 months after intervention [8].

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There are different rehabilitation techniques and modalities to better recover after injury. Proprioceptive training plays an important role in preventing ankle sprains and recurrent ankle sprains. Rivera et al. analyzed the effect of proprioceptive training programs on reducing ankle sprain rates through 3726 participants, including athletes of different sports [9]. Proprioceptive training programs vary in duration, frequency, and design, ranging from 5 to 30 minutes per session, and duration from four weeks to an entire season. Participants balanced activities by balancing on one leg, using tools such as a rocking board, and multi-tasking. The results showed that proprioceptive training reduced the risk by 43% in people who had not sprained their ankles, and by 36% in people with a history of sprains.

Building on the importance of effective rehabilitation strategies, Cain et al. evaluated the effects of three rehabilitation interventions on balance in adolescent athletes with chronic ankle instability (CAI) [10]. Forty-three teenagers were divided into four groups: resistance-band exercises, Biomechanical Ankle Platform System (BAPS) exercises, a combination of both, and a control group that did not have any exercises. They trained three times a week for four weeks, assessing their results through clinical balance tests, functional performance assessments, and patient-reported outcomes. The fact that participants were able to maintain their balance for longer periods of time during the balance Test, and the reduction in the number of compensatory Foot lifts during the foot-lift test, meant that the exercise improved the adolescents' neuromuscular control and center of gravity retention. However, the results did not indicate which single intervention was better, meaning that either a single task or a combination of regiments could improve balance and function in a short period of time. This method is very helpful for people to solve CAI.

Auley's research about the function of ice therapy mentioned how efficient cryotherapy is in acute soft tissue injuries [11]. Cryotherapy has long been a cornerstone of injury management, primarily because of its ability to reduce tissue temperature and inflammation. The most effective method is to use wet ice across a wet cloth barrier, repeated every 10 minutes, with the goal of reducing tissue temperature by 10-15°C. This method minimizes the risk of burns or nerve damage while keeping deep tissue cool even after the epidermis is rewarmed. The mechanism of cryotherapy lies in its ability to reduce cell metabolism and induce vasoconstriction, thereby limiting edema and secondary hypoxic damage. In addition, one can enhance the cooling effect by applying pressure to improve contact and reduce blood flow. However, this methodological study involved resting and uninjured individuals, which may not be fully applicable to active athletes or seriously injured individuals.

In addition, the combination of cryotherapy and ultrasound therapy is very helpful for acute lateral ankle sprains. According to the study of Ammendolia et al., combined cryotherapy and ultrasound therapy can be more effective than traditional rehabilitation methods [12]. The study included 25 semi-professional male soccer players with Grade I or II lateral ankle sprains. Participants were randomly assigned to an experimental group (receiving cryotherapy and regular rehabilitation) or a control group (receiving sham cryotherapy and the same routine regimen). The experimental group received a combination of temporal therapeutic ultrasound and cryotherapy through Cryosound, while the control group simulated cryotherapy but did not provide cryotherapy, and the rest remained consistent. By recording the results of follow-up at different time periods, the researchers found that the experimental group had better pain reduction and functional improvement than the control group, but these differences decreased over time. Physiologically, this therapy uses cryotherapy to shrink and dilate blood vessels to reduce inflammation and ultrasound therapy to raise pain thresholds, increase collagen flexibility, reduce edema, and relieve stiffness to promote athlete's ankle sprains recovery.

The assistive devices are also helpful for rehabilitation and prevention of ankle sprain. Taping, for example, significantly alters Ankle motion in patients with Chronic Ankle Instability (CAI), making the joint position more stable during walking and jogging. The study assessed the physical condition

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of 15 participants (8 men and 7 women) with a history of multiple ankle sprains with an average of 5.3 sprains after taping. The researchers used a pre-test and post-test crossover design using a standard prophylactic banding approach to study ankle and knee movements during walking and jogging without banding and in banding conditions. After taping, the taped participants showed less inverted from 51% to 61% and increment less plantar flexes lasted from 64% to 81% in their gait cycle, and reduced dorsiflexion was also observed during jogging. These changes help put the ankle in a more neutral alignment and avoid overpronation and plantarflexion, especially when people are at high risk of lifting their feet off the ground or landing [13].

5. Conclusion

Ankle sprain rehabilitation is important because it can help people recover better and prevent future recurrence and other complications. For people with varying degrees of injury, rehabilitation can be tailored to them. For example, treatment in the acute phase, such as cryotherapy, ultrasound therapy, and the use of assistive devices such as tape, can help relieve pain and inflammation in the early stages of injury. During the subacute phase, patients can use MWM and lightweight training to help restore some of their original function and range of motion. In addition, proper body training and balance training can help people reduce the risk of injury in the future and help people recover better. Overall, adopting a structured approach to rehabilitation and prevention is critical to achieving optimal outcomes in ankle sprain management. Future research should focus on personalized rehabilitation programs and innovative approaches to improve outcomes. This comprehensive approach emphasizes the value of combining evidence-based practice with emerging technologies to optimize ankle sprain recovery and long-term health.

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