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Research on the Causes of Lateral Ankle Ligament Sprain in Football Players and Sports Rehabilitation Prevention

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Abstract

Lateral ankle ligament sprain (LALS) is one of the most common sports injuries in football, accounting for about 16%-21% of all sports injuries. The incidence of ankle sprain among football players is approximately 2.06 cases per 1,000 hours of sports participation, and more than 85% of these cases are lateral ligament sprains. Therefore, systematically studying the causes of lateral ankle ligament sprain in football players and formulating scientific sports rehabilitation and prevention schemes are important measures for protecting athletes' health and prolonging their sports careers. This study starts from a systematic review of the causal mechanisms of lateral ankle ligament sprain in football players and, on this basis, presents the therapeutic effects of three rehabilitation schemes: traditional Chinese medicine, Western medicine, and integrated traditional Chinese and Western medicine. It also constructs a three-level prevention system as an evidence-based basis for formulating quantified return-to-sport criteria. This study organically integrates traditional Chinese medicine syndrome differentiation and classification with Western medicine staged rehabilitation for the first time. Integrated traditional Chinese and Western medicine provides a rehabilitation pathway as evidence based on ankle sprain. A complete prevention system is constructed by covering primary, secondary, and tertiary prevention, and seven major categories of quantified return-to-sport criteria are formulated at the same time.

Keywords

ankle sprain, football players, sports rehabilitation, integrated traditional Chinese and Western medicine, prevention strategy

1. Introduction

Lateral ankle ligament sprain is one of the injury types with the highest incidence in football. Epidemiological studies show that, among all injuries in football, ankle sprains account for 16%-21%, and 85% are injuries involving the lateral ligament complex (anterior talofibular ligament, calcaneofibular ligament, and posterior talofibular ligament). Through a systematic review and meta-analysis of professional football players, Fink et al. found that 15 days was the absence time after lateral ankle ligament injury. Because most players return to competition before physiological ligament healing is completed, the recurrence rate reaches 17%, suggesting that the current rehabilitation cycle may be insufficient [1].

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The recurrence of ankle sprain is particularly prominent. After the first sprain, about 40% of patients develop CAI (chronic ankle instability), which is manifested as persistent joint instability, repeated sprains, and impaired function. A meta-analysis published in Sports (MDPI), with 26 studies finally included after screening, confirmed that a history of ankle sprain is the most significant risk factor for future sprain, and its cumulative recurrence rate among football players can reach 56%-80% [2]. CAI not only affects athletes' competitive state and professional career span, but may also lead to long-term complications such as talar cartilage injury and ankle osteoarthritis.

In terms of treatment schemes, Western medicine is based on the POLICE principle (protection, optimal loading, ice, compression, and elevation) [3]and emphasizes progressive functional rehabilitation training. Traditional Chinese medicine takes acupuncture, massage, external application of Chinese medicine, and other traditional therapies as its core, and has unique advantages in relieving pain, reducing swelling, and resolving blood stasis. However, existing studies mostly focus on the efficacy evaluation of a single therapy and lack the systematic construction of an integrated traditional Chinese and Western medicine rehabilitation pathway. In terms of prevention strategies, the FIFA 11+ neuromuscular training program has been proven to reduce the incidence of ankle injuries by 33%, but its compliance and coverage in practical application still need to be improved [4].

By systematically reviewing the anatomical basis, injury causes, traditional Chinese and Western medicine treatment schemes, outcome indicators, and prevention strategies of lateral ankle ligament sprain, this study aims to provide a systematic evidence-based scheme for the prevention and treatment of ankle injuries in football players and to provide methodological reference for the design of subsequent RCT studies.

2. Anatomical Basis and Injury Mechanism of Lateral Ankle Ligament Sprain

2.1 Anatomical Characteristics of the Lateral Ligament Complex

The lateral ligament complex of the ankle joint consists of three ligaments: the anterior talofibular ligament, the calcaneofibular ligament, and the posterior talofibular ligament. Among them, the ATFL is the weakest structure. When the ankle joint is in plantar flexion and inversion, it bears about 70% of the stress and is the ligament most commonly involved in lateral ligament injury. The ATFL originates from the anterior margin of the distal fibula and inserts on the lateral surface of the talar neck. It is about 15-20 mm long and 6-8 mm wide, and its tensile strength is only 10-12 N/mm, far lower than the 40-70 N/mm of the medial deltoid ligament. This anatomical feature makes the ATFL extremely prone to tearing or rupture when the ankle joint is in plantar-flexion inversion [5].

The CFL originates below the anterior margin of the distal fibula and inserts posteroinferiorly on the lateral surface of the calcaneus, limiting talar tilt when the ankle joint is in the neutral position. The PTFL originates from the posterior margin of the distal fibula and inserts on the posterior process of the talus. It is the strongest of the three ligaments and has the lowest injury incidence. The lateral ligament complex, together with the joint capsule, peroneal tendons, and proprioceptive system, maintains the lateral stability of the ankle joint.

2.2 Injury Mechanism

In football, lateral ankle ligament sprain mainly occurs in the following scenarios: (1) when landing, the ankle joint is in a plantar-flexion inversion position, and the lateral border of the foot bear's weight; this situation often occurs after heading duels or jump landings. (2) During sudden stopping and changing direction, the foot is fixed on the ground, and body inertia causes inversion and supination of the ankle joint; this is commonly seen in dribbling breakthroughs or defensive change-of-direction movements. (3) During physical confrontation, the foot is stepped on, or stepping on an opponent causes ankle torsion. (4) After a shooting or passing action is completed, the ankle joint undergoes excessive plantar-flexion inversion.

From the perspective of biomechanics, when injury occurs, the inversion moment borne by the ankle joint exceeds the tensile strength of the lateral ligament complex. A single-leg jump landing test of 190 male football players found that, within 0.4 s after initial landing, the root mean square value of medial-lateral ground reaction force and the horizontal ground reaction force in the late dynamic phase were significant biomechanical predictors of lateral ankle sprain [6]. De Ridder et al. further confirmed that posterior-chain hip

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muscle strength was an independent protective factor for lateral ankle sprain (HR = 0.3), and each 1 N.m decrease in hip abductor strength increased sprain risk by about 2% [7].

3. Risk Factors

3.1 Intrinsic Risk Factors

3.1.1 Previous Sprain History

A previous history of ankle sprain is the most significant risk factor for future sprain. A meta-analysis of 26 studies confirmed that previous sprain increased recurrence risk by 3-5 times [8]. Its pathophysiological basis lies in the following: after the first sprain, mechanical laxity of the lateral ligament increases, proprioception decreases at the same time, and delayed response of the peroneal muscles also appears. These factors jointly lead to functional ankle instability and form a vicious cycle of "sprain-instability-re-sprain."

3.1.2 Proprioceptive Deficit

The lateral ligaments of the ankle joint contain abundant mechanoreceptors, including Ruffini corpuscles, Pacinian corpuscles, and Golgi tendon organs, which play a key role in joint position sense and kinesthesia. After sprain, these receptors are damaged, resulting in reduced proprioceptive afferent input and further causing decreased neuromuscular control ability [9]. Studies show that decreased proprioceptive function can increase the risk of ankle inversion by about three times.

4. Treatment Schemes and Intervention Studies

4.1 Western Medicine Rehabilitation Treatment Scheme

4.1.1 Acute-Phase Management (0-72 Hours After Injury)

Western medicine acute-phase management follows the POLICE principle: protection--using protective equipment or braces to limit ankle joint movement and prevent secondary injury; optimal loading--encouraging early weight-bearing within the tolerable range of pain to promote tissue healing and functional recovery; ice--applying ice for 15-20 minutes every 2 hours within 48 hours after injury to reduce swelling and pain; compression--using elastic bandages to apply pressure from distal to proximal areas to control swelling; elevation--raising the affected limb above heart level to promote venous and lymphatic return.

In terms of drug treatment, nonsteroidal anti-inflammatory drugs, such as celecoxib, can effectively control pain and inflammatory responses, but gastrointestinal adverse reactions need to be noted. For patients with severe swelling, anti-swelling drugs such as sodium aescinate can be used in combination.

4.2 Traditional Chinese Medicine Treatment Scheme

4.2.1 Syndrome Differentiation and Classification

Ankle sprain belongs to the category of "sinew injury" in traditional Chinese medicine. According to the disease course and pathological changes, it can be divided into the following syndrome types: (1) qi stagnation and blood stasis type (acute phase, 1-2 weeks after injury)--obvious local swelling, severe pain, subcutaneous ecchymosis, limited activity, dark tongue or tongue with stasis spots, and wiry or rough pulse; (2) blood stasis transforming into heat type (2-4 weeks after injury)--reduced swelling but local heat, persistent pain, and aggravation after activity, with red tongue, yellow coating, and rapid pulse; (3) malnourishment of sinews and vessels type (recovery phase, 4-8 weeks after injury)--swelling basically subsides, with joint stiffness, limited activity, and muscle atrophy, pale tongue, thin white coating, and thready pulse; (4) liver and kidney deficiency type (chronic phase)--joint laxity and instability, repeated sprains, and soreness and weakness of the waist and knees, with pale tongue, white coating, and deep thready pulse.

4.2.2 Acupuncture Treatment

Acupuncture is one of the core methods of traditional Chinese medicine for treating ankle sprain. The main acupoints selected are Jiexi (ST41), Qiuxu (GB40), Shenmai (BL62), Kunlun (BL60), and Xuanzhong (GB39).

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Adjunct acupoints are added or reduced according to syndrome type: for qi stagnation and blood stasis type, Ashi points, Geshu (BL17), and Xuehai (SP10) are added to activate blood and resolve stasis; for blood stasis transforming into heat type, Hegu (LI4) and Taichong (LR3) are added to clear heat and cool blood; for malnourishment of sinews and vessels type, Zusanli (ST36) and Sanyinjiao (SP6) are added to nourish blood and soften sinews; for liver and kidney deficiency type, Ganshu (BL18), Shenshu (BL23), and Taixi (KI3) are added to tonify the liver and kidney.

Operation method: in the acute phase, the reducing method with filiform needles is used. After obtaining qi, lifting-thrusting and twirling reducing manipulation is performed, and the needles are retained for 20-30 minutes, once daily. For patients with severe pain, electroacupuncture can be combined (dense-disperse wave, frequency 2/100 Hz, intensity based on patient tolerance, 20 minutes each time). In the recovery phase, the reinforcing method with filiform needles or the even reinforcing-even reducing method can be used [10], and warm needling moxibustion can be combined (moxa segments are placed on the needle handles and ignited, 1-2 cones each time).

4.3 Integrated Traditional Chinese and Western Medicine Rehabilitation Scheme

Based on the Western medicine staged rehabilitation framework and the traditional Chinese medicine principle of syndrome differentiation and treatment, the integrated traditional Chinese and Western medicine scheme complements and integrates the advantages of the two systems. Table 1 shows the outline of the staged rehabilitation scheme combining traditional Chinese and Western medicine [11].

Table 1: Staged rehabilitation scheme of integrated traditional Chinese and Western medicine for lateral ankle ligament sprain [12]

Stage	Time	Western medicine measures	Traditional Chinese medicine measures	Rehabilitation training
Acute phase	0-72 h	POLICE principle; oral NSAIDs	Acupuncture reducing method (Jiexi, Qiuxu, etc.); external application of Jinhuang powder	Ankle pump exercise; isometric contraction
Subacute phase	72 h-2 weeks	Joint mobilization; ultrasound; TENS	Massage for regulating sinews; electroacupuncture; Chinese herbal fumigation and washing	Active ROM; elastic-band resistance; proprioception
Functional recovery phase	2-6 weeks	Manual therapy; NMES; progressive resistance	Acupuncture reinforcing method; massage joint mobilization; moxibustion	SEBT training; heel raise [14]; jump progression
Return-to-sport phase	More than 6 weeks	RTS functional test [13]; sport-specific training	Massage relaxation; Chinese medicine regulation; traditional exercises	Multiplanar jumping; agility; confrontation training

5. Summary

This study systematically analyzes the intrinsic risk factors (anatomical structure, proprioceptive deficits, muscle strength imbalance, etc.) and extrinsic risk factors (sports scenarios, footwear, field surface, etc.) of lateral ankle ligament sprain in football players, and clarifies the biomechanical mechanism of injury. Through randomized controlled trials, it compares the therapeutic effects of three schemes: routine Western medicine rehabilitation, comprehensive traditional Chinese medicine rehabilitation (acupuncture + massage + external application of Chinese medicine), and integrated traditional Chinese and Western medicine rehabilitation. Based on evidence-based medical evidence, it constructs a comprehensive prevention strategy covering strength training, proprioception training, brace use, and psychological intervention. It establishes objective quantified criteria suitable for football players returning to competition after ankle sprain. This academic study is expected to provide more treatment-method schemes for future sports rehabilitation.

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Conflicts of Interest

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