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Measures and Follow-up Efficacy for Treating Anterior Tibiofibular Ligament Injury

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Abstract. With the improvement of sports technology and the increase in competition intensity, the complexity of sports injuries is becoming increasingly prominent, which puts higher demands on the accuracy of their diagnosis and treatment. This paper focuses on the special issue of ankle anterior talofibular ligament (ATFL) injury, and conducts a systematic study from three dimensions: diagnosis, treatment and subsequent efficacy, aiming to sort out and summarize effective treatment processes. The results of this paper indicate that arthroscopy remains the most accurate method in the diagnostic stage, while ultrasound examination can serve as an effective alternative, providing reliable evidence for clinical diagnosis. In terms of treatment, if conservative treatment is adopted, elastic bandaging is the preferred way to fix the ankle joint. In contrast, the combined reconstruction of the anterior talofibular ligament (ATFL) and calcaneofibular ligament (CFL) has more advantages - in the long run, this procedure can minimize the risk of patients developing chronic ankle instability, allowing athletes to almost 100% recover to pre-injury exercise levels. This paper analyzes the advantages and disadvantages of various diagnosis and treatment methods, constructs a comprehensive and systematic treatment process, and provides scientific reference for both doctors and patients to choose the most suitable rehabilitation plan. It helps to promote the standardization and personalization of sports injury diagnosis and treatment, and ultimately promotes the efficient rehabilitation of athletes.

Keywords: Ultrasound examination, ATFL-CFL reconstruction, CAI

1. Introduction

In recent years, different types of sports injuries have occurred frequently around the world with the increase in the intensity of the sports events. On the one hand, it is due to the overly tight time and competition schedule. On the other hand, the factor of increasing contact and confrontation plays a crucial role. However, ankle-related injuries are quite different from injuries on other parts of the body, being overlooked by patients for their importance and thus not receiving treatment on time. In the long term, ankle stability and sports performance will dramatically decrease, making athletes more prone to injury. Therefore, efficient and accurate detection of ankle injuries and proper adoption of the treatments that enable patients to return to sports rapidly have a positive influence on subsequent sports activities. Nowadays, there are only a certain number of research papers focusing

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on ankle injuries, especially on the injury of the anterior talofibular ligament. The research usually covers the detection methods in the early stage of the injury, therapy methods, and subsequent rehabilitation exercises on the anterior talofibular ligaments. Until now, various papers have recommended 3 distinct methods for injury detection: arthroscopy, MRI, and ultrasound examination. Among them, the use of arthroscopy is nearly the widest, not only for the detection of ankle-related injuries but also for the treatment and therapy. MRI and ultrasound examination have their own merits and demerits. To be specific, ultrasound detection is advantageous in the of cost and dynamic examination capabilities in comparison with MRI tests, but it is easy to be interfered with by specific artifacts [1]. For the therapy process, it can be divided into two different conservative and surgical treatment. Doctors usually recommend that patients take the former first, and then receive an operation to reconstruct the anterior talofibular ligament if it is useless and has no significant effects on rehabilitation. When reconstructing the ligament, doctors also should consider whether it is necessary to reconstruct other ligament like CFL to increase the ankle stability, and help patients return to the field in a shorter period. For the recovery stage, the degree of the ligament injury can be determined by ligament residual images taken by arthroscopy and MRI tests and the treatment methods chosen [2-4]. Generally, the reconstruction of multiple ligaments receives better results and feedback, but the forward shift of the ankle joint in position and lowering stability are inevitable [5]. For this field, what is lacking currently is a complete and detailed process and framework for the curing process. The research on anterior talofibular ligament injuries is chaotic and scattered in various stages without a systematic summary. This article aims to design a complete and systematic treatment plan for anterior talofibular ligament injuries. This article analyzes the advantages and disadvantages of existing methods and treatment mechanisms and can select and summarize more suitable and effective treatment methods.

2. Diagnostic method: comparison of accuracy and clinical applicability

2.1. Arthroscopy: the gold standard for diagnosis

The accurate diagnosis of ATFL injury is the basis for developing treatment plans. The patient received ankle arthroscopic detection with the lumbar anesthesia, and was placed in a supine position on the detection bed. Currently, commonly used clinical diagnostic techniques include arthroscopy, ultrasound, MRI, etc., each with its advantages and limitations. Arthroscopy is regarded as the "gold standard" for the diagnosis of ATFL injuries, as it can not only directly observe lesions such as ligament tears and laxity, but also simultaneously handle accompanying injuries within the joint (such as cartilage injuries and synovial lesions). Research has shown that, based on arthroscopic results, the diagnostic accuracy of ATFL injuries is close to 100%, and the injury grading (partial tear/complete rupture) can be clearly defined [1]. However, this method is invasive and costly, and it is recommended to evaluate within 48 hours after injury (to avoid acute swelling affecting the field of view) [6]. It is often used as a diagnostic tool for complex cases in clinical applications. One of the advantages is that for patients who suffered from ankle fractures, high-energy mechanical injuries, and synchronous ligament injuries, ankle arthroscopy can more accurately detect the ligament injuries, correctly assess fracture reduction, and have the vital importance on treating intra-articular lesions. Moreover, when there is possibly an occult intra-articular injury, ankle arthroscopy is recommended because, with the help of it, doctors can directly observe and assess the integrity of the ligament structure and determine the mechanical strength [1].

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2.2. Ultrasound: an efficient and economical preferred screening tool

Ultrasound has become the preferred screening method for ATFL injuries due to its non-invasive, low-cost, convenient, and capable of conducting dynamic observation capabilities in the diagnosis of lateral collateral ligament injury of the ankle joint. Research has shown that ultrasound has a sensitivity of 100% in diagnosing ATFL injuries, with high consistency with arthroscopic results, and can dynamically observe changes in ligament tension in different positions [1]. In contrast, ultrasound has a lower diagnostic sensitivity (86.7%) for ATiFL-DF (ankle anterior medial ligament dorsiflexion position), indicating its limitations in the diagnosis of complex ligament structures. However, considering both cost and accuracy, ultrasound is more suitable for primary healthcare institutions and rapid assessment in the acute phase. During the process of diagnosis, the patients were sitting or lying on the detection bed. The injured ankle joint was placed flat on the bed to detect the ankle joint cavity, ligaments, and tendons. The probe was scanned the long and short axes of ATiFL-DF and ATFL to explore the shape, thickness, continuity, echo intensity, and bone cortex attachment of the ligaments and compare them with the other side. The anterior drawer test would be performed if it was needed. However, the results may be affected because the anisotropic artifacts specific to musculoskeletal ultrasound interfere, the ligament show reduced or even no tissue echoes, and can lead to the incomplete ligament structure of the diagnosis [1].

2.3. Other techniques: MRI and biomechanical simulation

MRI can display the morphology of ligaments and the surrounding soft tissue, and the diagnostic accuracy for ankle joint ligament injuries is relatively high, but it is expensive and requires high equipment and reading experience; The combination of 3D CT reconstruction and biomechanical simulation platform (established through healthy volunteer data) can assist in evaluating joint stability after injury, but it is currently mostly used for research and has not yet been widely used in clinical practice [7]. When there is an injury at the attachment site of the ATFL to the fibula or talus, the false-negative diagnosis taken by MRI increases, and the static MRI examination is limited at the same time [1].

3. Treatment strategy: choice between conservative treatment and surgical treatment

3.1. Conservative treatment: suitable for mild to moderate injuries

The treatment of ATFL injuries requires personalized plans based on the degree of injury (partial tearing/complete rupture), the patient's exercise needs, and comorbidities, mainly divided into conservative treatment and surgical treatment. For patients with partial tears or low exercise needs, conservative treatment is the preferred option. The study compared the effects of elastic bandages and plaster fixation: among 41 patients, the elastic bandage group had significantly lower VAS pain scores (less pain), higher AOFAS and Karlsson functional scores, and both groups of patients recovered their walking and movement abilities without significant differences [8]. This suggests that elastic bandages are superior to plaster fixation in relieving pain and promoting functional recovery, which may be related to early moderate activity reducing joint stiffness. In addition, conservative treatment also includes early proprioceptive training, brace protection, etc. If symptoms do not improve after 6-12 weeks, surgery should be considered.

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3.2. Surgical treatment: comparison of reconstruction and repair effects

Surgical treatment is crucial for patients with complete rupture, chronic instability, or high demand for exercise. The current mainstream surgical methods include ATFL alone reconstruction and ATFL combined with CFL (calcaneofibular ligament) reconstruction, with significant differences in their effectiveness. In the combined reconstruction (ATFL+CFL), 93 patients were followed up for an average of 3-4 years after surgery. More than 90% returned to exercise, 70% recovered to preoperative levels or better, and the complication rate was less than 10% [9]. Another study involving 44 patients showed a significant improvement in Karlsson score 2 years after combined reconstruction surgery, with 100% of patients recovering preoperative function and only 9% experiencing minor complications [2]. Its advantage lies in simultaneously restoring the stability of ankle internal and external rotation, especially for patients with combined CFL injuries. Individual reconstruction (ATFL) and joint reconstruction have similar effects on motion dynamics indicators, but joint reconstruction has a greater advantage in restoring subtalar joint function (such as joint surface integrity) (67% vs 33%) [3]. On the controversy of adjuvant surgery, although ATiFL-DF transfer combined with ATFL repair can improve stability, it may damage the original function of ATiFL, and clinical application should be cautious [7]. In terms of surgical treatment, the combined reconstruction of the anterior talofibular ligament and the calcaneofibular ligament (also known as joint reconstruction) has more advantages in terms of motor performance than single reconstruction. The joint range of motion recovery rate of joint reconstruction is 33%, which is the same as the single reconstruction method. It is worth noting that the joint surface recovery rate of combined treatment is 67%, while that of individual treatment is only 33% [3]. In the subsequent impact of the third step, the anterior talofibular ligament is the most commonly injured ligament in lateral ankle sprains. Therefore, 40% of patients with their first lateral ankle sprain may develop chronic ankle instability. Even worse, if the sprain is severe enough, the calcaneofibular ligament may also be damaged at the same time. Excessive inversion and sprain of the ankle joint can lead to ligament relaxation or even rupture, limiting the range of motion of the ankle joint [10]. In addition, in a stable ankle joint, the anterior talofibular ligament is in normal condition, which is quite common. However, in chronic ankle instability, the state of the anterior talofibular ligament is abnormal. The forward displacement of the ankle joint in the chronic ankle instability group is greater than that in the normal group, but the degree of pain in chronic ankle instability is inconsistent with the forward displacement [11]. Ankle instability may be related to ligament relaxation or injury. In this study, patients with chronic ankle instability had higher vertical stability scores during forward and lateral jumps compared to the control group who had not experienced ankle sprains or related diseases [5].

4. Prognostic influencing factors and rehabilitation management

4.1. Key prognostic factors

Research has found that patients with high T2 signal intensity at the ATFL stump are more likely to experience ankle instability after surgery, indicating that preoperative assessment of stump quality is crucial for selecting surgical plans [12]. The postoperative return to exercise rate of high-level athletes is significantly higher than that of the general population, indicating that preoperative functional status is an important predictor of prognosis [9]. If CFL injuries are not repaired in a timely manner, the incidence of chronic instability is higher (up to 40%), and it can lead to talar displacement and decreased load-bearing capacity [5,10].

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4.2. The core role of rehabilitation training

Standardized rehabilitation is the key to achieving a high return to exercise rate. Studies have shown that even if postoperative structural stability is not fully restored, patients can almost 100% return to exercise through early activity, brace protection, and balance training (such as single leg landing balance tests) [2,10]. The focus of rehabilitation includes proprioceptive training within 6 months after surgery (to reduce the risk of re injury), progressive strength training between 6-12 months (to restore explosive power), and specialized simulation training in sports (such as jumping and changing direction) [6,8]. A highly effective and efficient method for detecting, treating, and rehabilitating injuries related to the anterior talofibular ligament has been discovered. Initially, the patients are supposed to take an ultrasonic testing because it is as accurate as arthroscopic inspection which is considered as the standard in the clinic and it is more affordable for patients compared with MRI and arthroscopy. Then, the patients are given the right to choose conservative treatment or operative treatment. If the patient prefers the former, an elastic bandage is a feasible and beneficial option instead of plaster immobilization. If the patient prefers the latter, joint reconstruction of ATFL and CFL is recommended. At last, even though the structural stability cannot reach the level before the injury, patients can return to sports almost 100% with proper rehabilitation. To be specific, in the clinical aspect, the best time to inspect is 48 hours after getting injured and the most suitable and valid therapy is arthroscopy [6]. The method of ultrasonic testing has the accuracy of arthroscopy and ultrasonic testing is also the most reliable way to assess the ankle rupture [1]. Turning to the treatment, it is suggested that ATiFL-DF transfer is also worthy of consideration, but it will affect and damage the effect of stability from ATiFL [7]. The combined reconstruction of ATFL and CFL has reached the minimum clinical divergence at 100% and patients can reach the sports performance before the injury [2]. Moreover, with the help of arthroscopy, the reconstruction of AFTL will achieve ideal function and high return-to-sports rates and the sports performance before the operation will also have an impact on the return-to-sports rates. Therefore, patients have to ask and plan their own treatment process [9]. Even if the isolated reconstruction of ATFL has the same effect as the joint surgery of ATFL and CFL on sports kinetics, the latter has more advantages for the articulations subtalar [3]. Additionally, the ATFL remnant quality may cause the instability of the ankle after the surgery, so the doctors and patients have to pay attention to the quality of the ligament [12]. For conservative therapy, elastic bandage treatment is more advantageous in eliminating pain than calf plaster cast fixation and the latter method has almost no outstanding points in ATFL repair [8]. It is also recommended to receive conservative treatments like early activities, brace protection, and proprioceptive training. If the method above has no significant effect, the patients have to consider taking an operation to repair or reconstruct ATFL [6]. For the long-term influence, the failure of ATFL will cause the minimum value of loading, the forward movement of astragalus, and the failure to withstand fast-accelerating power when a person is jumping forward [5]. Thus, the structure and function of ATFL will finally affect the stability and function of the ankle joint through multiple systems. It is important to focus on the precaution, diagnosis, and rehabilitation [10]. However, it is not proven that ATFL will directly cause chronic ankle instability. Instead, it has only a few impacts on CAI [11]. Noticeably, the low MRI signal intensity of ATFL before the operation is combined with better clinical outcomes, especially for the high return-to-sports rates.

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5. Conclusion

Ankle-related injuries tend to be ignored by patients. Without proper treatment, patients will possibly suffer from chronic ankle instability in the long term. Thus, appropriate and timely therapy is necessary for athletes, especially for those who wish to go back to the field. Summarized from the existing journals, ultrasound examination is a recommended option. The accuracy is almost the same as that of arthroscopy, and the price is lower compared with MRI tests and arthroscopy tests. Moreover, dynamic images are viewed in this sort of examination. Referring to the treating methods, adopting elastic bandages is better than plaster at the beginning. If the function cannot recover, applying ATFL and CFL combined reconstruction is a reasonable choice. The recovery rate for this operation is approximately 100%, and the forward displacement of this surgery is the least, which means there is the least possibility of causing CAI in the long term. The quality of lateral recovery is determined by the remnant quantity of the ATFL in the MRI image. Certainly, the drawbacks are inevitable. The anisotropic artifacts specific to musculoskeletal ultrasound will interfere with the results, and it may not reach the level before the injury for the recovery stage. For instance, patients are not able to withstand the rapid increase in force when landing after they jump forward. This essay aims to summarize an efficient, low-cost process, helping more athletes be free from the trouble of injuries. In the future, it is hoped to devise a portable ankle brace that has little influence on the sports performance so that many ankle injuries are prevented because the major reason is the twisting and spraining of the ankle during sports.

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