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Analysis of the Application of Sports Medicine Ultrasound in the Rehabilitation of Anterior Talofibular Ligament Injury

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Abstract: *Objective:* To explore the application effect of sports medicine ultrasound in the rehabilitation treatment of anterior talofibular ligament injury. *Methods:* 36 patients who visited our hospital from January 2020 to September 2023 were selected as research subjects and randomly divided into the study group (18 cases) and the control group (18 cases). The control group adopted routine examination and rehabilitation training, and the study group adopted sports medicine ultrasound and rehabilitation training. The ankle function scores and daily living ability of the two groups were compared before treatment and 9 weeks after treatment. *Results:* There was no statistically significant difference between the study group and the control group in terms of ankle function scores and ability to perform activities of daily living before treatment ($P > 0.05$), but the difference was statistically significant after treatment ($P < 0.05$). *Conclusion:* Ultrasound can be used as a supplement to magnetic resonance imaging (MRI) of the ankle joint for diagnosing anterior talofibular ligament injury; ultrasound can show the location, distance, and degree of tear of the anterior talofibular ligament rupture and accurately predict muscle atrophy around the ankle joint; ultrasound combined with computed tomography (CT) can better determine the type of intra-articular fracture of the talar subtalar joint, and guide the choice of surgical timing. In addition, ultrasound can be used to determine the severity of peroneal muscle atrophy, assess the progress of early postoperative functional exercise, and guide personalized rehabilitation programs.

Keywords: Sports medicine ultrasound; Anterior talofibular ligament injury; Rehabilitation

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1. Introduction

The anterior talofibular ligament (ATFL) is an important structure connecting the tibiofibular bone and the ankle joint, and assists in maintaining the stability of the knee joint by pulling the anterolateral ligament of the knee joint. It has been found that when the foot strikes the ground, 35%–60% of patients will have an injury to the anterior talofibular ligament. It is commonly believed that it is mainly composed of tendons and surrounding soft tissues, and is prone to a variety of secondary injuries after injury, including subtalar osteoarthritis, subtalar osteophyte formation, peroneal muscle atrophy, and ankle valgus deformity, which leads to a long and costly

rehabilitation time for patients [1]. Magnetic resonance imaging (MRI) is commonly used in clinical practice to diagnose anterior talofibular ligament injuries, but the imaging results are not intuitive enough and do not provide three-dimensional information, resulting in limitations in the assessment of treatment prognosis. In recent years, sports medicine ultrasound technology has been widely used for its noninvasive, efficient, and reproducible characteristics, especially in the field of sports medicine, and has gradually become a routine diagnostic and therapeutic means. Sports medicine ultrasound has good clinical value as it detects the elastic mechanical changes of target tissues through high-frequency sound waves. Studies have shown that ultrasound can not only assist in determining the site of injury, but can also be used to observe other structures, such as tendon sheath cysts, synovial effusion, subchondral calcification, neurovascular bundle abnormalities, etc.; in addition, ultrasound can also measure the thickness of the soft tissues and ligament tension to assist in determining the degree of ligament damage. In addition, ultrasound can also be used to assess the degree of muscle atrophy, determine the effectiveness of surgery, and guide the development of rehabilitation therapy programs. In addition, ultrasound can be used to assess the degree of muscle atrophy, determine the effect of surgery, and guide the development of rehabilitation programs.

2. General information and methods

2.1. General information

36 patients who visited our hospital from January 2020 to September 2023 were selected as study subjects, all of whom met the diagnostic criteria for anterior talofibular ligament injury. They were randomly divided into the study group (18 cases) and the control group (18 cases), and the differences in baseline data such as age, gender, and disease duration of patients in each group were not statistically significant, $P > 0.05$, as shown in **Table 1**.

Inclusion criteria included patients were between 18 and 45 years old; patients had a history of at least one ankle sprain or plantar fasciitis; patients had no previous history of joint or ankle fracture of the lower extremity; patients had no acute infectious diseases; patients had not received other treatments and had not used steroid hormones.

Exclusion criteria were patients with ankle fracture and anterior talofibular ligament injury, fracture combined with soft tissue injury, ankle joint infection or inflammation; the presence of serious psychological problems; and resistance to this examination.

Table 1. Comparison of general information

Information		Control group (n = 18)	Study group (n = 18)	χ^2/t	P
Gender	Male Female	8 10	9 9	0.112	> 0.05
Age		41.26 ± 1.24	41.35 ± 1.41	0.203	> 0.05
Duration of illness (days)		26.31 ± 2.54	25.87 ± 2.88	0.486	> 0.05

2.2. Methods

The control group adopted conventional examination as well as rehabilitation training, and the study group adopted sports medicine ultrasound and rehabilitation training, as follows.

(1) Patients adopted the supine position and externally rotated the injured foot lightly for better exposure and examination of the anterior talofibular ligament. The patients wore loose and comfortable clothes so that they could move the injured part freely during the ultrasound examination. At the same time, the examination process was explained to the patient to relieve his/her tension.

(2) The ultrasound equipment was turned on and warmed up to ensure proper functioning and the frequency, depth, and other parameters of the equipment were adjusted to obtain optimal image quality. A high-frequency probe was used to obtain more detailed images of the ligamentous structures.
(3) A probe suitable for examining the anterior talofibular ligament, usually a high-frequency wire-array probe, was selected and placed on the skin surface at the site of the injury and slid along the course of the anterior talofibular ligament to obtain a clear image of the ligament.
(4) Through ultrasonography, the morphology, structure, and continuity of the anterior talofibular ligament were observed, and the presence of abnormal echoes within the ligament was noted, such as interrupted echoes and uneven echoes, which may be indicative of ligament injury.
(5) It was also observed whether the ligament was continuous to determine whether there was a complete rupture or partial tear. The thickness of the ligament was measured and compared with the healthy side to assess whether the ligament was swollen or thinned.
(6) The joint cavity was observed for fluid or blood accumulation, which may be associated with ligamentous injury, and other surrounding structures were examined, such as bones, muscles, and nerves, to rule out other possible injuries.
(7) Observation in the ultrasound examination was recorded in detail, including ligament morphology, continuity, echogenicity, etc. Based on the examination results, a detailed ultrasound report was prepared for further diagnosis and treatment by the doctor.

Rehabilitation therapy was carried out as follows.

(1) In the early stage of injury, appropriate braking and rest are essential to reduce pain and prevent further injury. Patients should avoid excessive activity, try to keep the injured part of the body at rest, and use crutches or wheelchairs to assist in walking to reduce the burden on the injured limb.
(2) In the early stages of injury, cold compresses can help reduce swelling and pain. Patients can gently apply ice packs or cold compresses to the injured area for 15–20 minutes at a time, every 2–3 hours. After the swelling and pain are gradually reduced, hot compresses can be used to promote blood circulation and accelerate tissue repair.
(3) Medication plays an auxiliary role in the rehabilitation of anterior talofibular ligament injury. Patients can use over-the-counter medications such as non-steroidal anti-inflammatory drugs (NSAIDs) to reduce pain and inflammation under the doctor's supervision. If pain is severe, prescription medications such as local anesthetics or glucocorticoids may be considered. However, it should be noted that medication should follow medical advice to avoid abuse or overdose.
(4) Rehabilitation training is a key part of the recovery of anterior talofibular ligament injury. In the process of injury recovery, patients should carry out gradual rehabilitation training under the guidance of a professional rehabilitator. The purpose of rehabilitation training is to enhance the strength and flexibility of the muscles around the joints and to restore the normal mobility and function of the joints. The training may include joint mobility training, muscle strength training, balance training, and so on. The patient should follow the advice of the rehabilitator and carry out the training step by step to ensure the rehabilitation effect.
(5) Anterior talofibular ligament injury may lead to psychological problems such as anxiety and depression. Patients should actively communicate with healthcare professionals to understand the injury and the recovery process and build confidence. At the same time, they should seek the support of their family and friends to face the challenges in the recovery process together.
(6) Nutritional support is also important for the recovery of anterior talofibular ligament injury. Patients

should maintain a balanced diet with sufficient protein, vitamins, minerals, and other nutrients to promote tissue repair and restore health. During the rehabilitation process, if there are special nutritional needs, a dietitian is consulted for a personalized diet plan.

2.3. Observation indexes

The ankle joint function scores and daily living ability scores of the two groups of patients were compared before treatment and 9 weeks after treatment.

2.4. Statistical methods

The research results were imported into SPSS22.0 software to analyze the data. The count data were expressed as percentages, and the χ^2 test was used for comparison between groups. Measurement data were expressed as mean ± standard deviation (SD), and *t*-test was used for comparison between groups, and $P < 0.05$ was taken as a statistically significant difference.

3. Results

There was no statistically significant difference between the study group and the control group when comparing the ankle function score and daily living ability score before treatment ($P > 0.05$), and the difference was statistically significant after treatment ($P < 0.05$), as shown in **Table 2**.

Table 2. Ankle function score and daily living ability score

Groups	Ankle function score		Scoring of daily living ability	
	Pre-treatment	9 weeks after treatment	Pre-treatment	9 weeks after treatment
Control group (n = 18)	65.21 ± 2.41	71.36 ± 2.14	75.36 ± 2.47	81.36 ± 2.14
Study group (n = 18)	66.01 ± 2.49	76.24 ± 2.16	76.21 ± 2.84	86.01 ± 2.01
t	0.980	6.809	0.958	6.720
P	> 0.05	0.000	> 0.05	0.000

4. Discussion

Ultrasonographic findings of the anterior talofibular ligament are prone to misdiagnosis due to the lack of accurate morphological and histologic structural description of the ligament. Currently, two-dimensional planar ultrasound or three-dimensional ultrasound is mainly used to measure the thickness of the anterior talofibular ligament and surrounding tissues to assess the degree of injury. Two-dimensional planar ultrasound divides the ankle into four quadrants—lateral, medial, central, and anterior—and measures the length of the ligament in each quadrant. A study was conducted using 13 patients and by assessing the ligaments in a 40 mm x 40 mm cross-section, it was found that high strength tears were present in 25% of the cases [2]. A prospective study was conducted using eight athletes with anterior cruciate ligament (ACL) injuries, measuring ATFL thickness in all subjects using two-dimensional planar ultrasound. The results showed a significant increase in ATFL thickness in the severe and moderate tear groups compared to the control group [3].

Three-dimensional ultrasound can provide more accurate imaging of the ATFL, enabling measurement of the ATFL at different locations through sequential image acquisition. Weng *et al.* [4] used 3D ultrasound to assess the thickness of ATFLs in 16 patients with sports injuries and compared it with the results of MRI,

which showed significant differences in the thickness of ATFLs and that thinner ATFLs were more susceptible to injury. In the study by Li *et al.* [5], 69 patients with foot pain, including 25 patients with anterior talofibular ligament injuries, were examined using three-dimensional ultrasound, and they found that the thickness of ATFLs was positively correlated with the severity of tendon injuries, while it was not related to the joint space. However, two-dimensional planar ultrasound may no longer be sufficient for the diagnosis of patients with a first-time diagnosis of anterior talofibular ligament injury, and other imaging tools should be considered. For example, MRI can provide detailed information about the ATFL and subtalar joint structures, which can help to clarify the extent of the injury and the effectiveness of ligament repair.

Rehabilitation is an important part of the treatment of anterior talofibular ligament injuries and is aimed at improving the patient's lower extremity line of force and restoring ankle function. The ideal rehabilitation plan should be formulated after individualized preoperative assessment, including motion pattern analysis, ankle inversion angle measurement, foot pressure measurement, and electromyography. Among them, ultrasonography can quickly and effectively obtain mechanical information about the ankle plantar flexor and extensor muscle groups, so as to predict the early postoperative rehabilitation effect and guide the motor-functional exercise. For patients with symptomatic anterior talofibular ligament injuries with poor results of conservative treatment, most scholars believe that surgery is the only option, rather than total arthroscopic ligament reconstruction surgery or incision and repositioning + suture. Therefore, aggressive postoperative physical therapy is particularly important. It is generally recommended that patients begin functional exercises 3 weeks after surgery, but due to the large individual variability, it is difficult to accurately quantify the muscle strength of patients by traditional methods. Feng and Xie [6] found that 6 weeks after the rupture of the anterior talofibular ligament, the mean contractile force (mFb) of the gastrocnemius rectus femoris muscle on the affected side was 0.91 ± 0.24 N; after 12 weeks, the value was only 0.57 ± 0.22 N, which was significantly decreased compared with the preoperative period ($P < 0.01$), suggesting that there may be a phenomenon of secondary muscle atrophy. Zhang and Pang [7], using ultrasound dynamic monitoring, found that the degree of atrophy of gastrocnemius muscle in patients was -0.35 ± 0.19 mm, -0.38 ± 0.18 mm, -0.45 ± 0.21 mm, and -0.32 ± 0.16 mm on preoperative and postoperative days 1, 3, 7, and 14, respectively, and the difference between the two groups was not statistically significant ($P > 0.05$), suggesting that ultrasound dynamic monitoring helps to understand the postoperative muscle atrophy of patients in order to adjust the rehabilitation program. However, there have been no reports of preoperative ultrasound assessment of muscle strength changes around the ankle joint at home and abroad.

In this study, there is no statistical difference between the study group and the control group in terms of ankle function score and daily living ability score before treatment ($P > 0.05$), and the difference is statistically significant after treatment ($P < 0.05$), suggesting that sports medicine ultrasound can more accurately reflect the recovery of patients with anterior talofibular ligament injuries, which is conducive to the development of a scientific and reasonable rehabilitation treatment program and the promotion of patients' recovery process. Anterior talofibular ligament injury is a common sports injury, and its treatment is mainly based on surgery. Through the above research, it can be found that ultrasound technology can be used in the diagnosis of anterior talofibular ligament injury, early postoperative efficacy assessment, and postoperative functional exercise program development. In actual clinical work, ultrasonography is inexpensive and has no radiation effect, which has a better application value. Currently, Ye *et al.* [8] showed that sports medicine ultrasonography can be used to evaluate the recovery of patients with anterior talofibular ligament injury. Ultrasonography has the advantages of non-invasiveness, repeatability, high resolution, etc. It can effectively detect whether the ligament has obvious displacement, rotation, tear, swelling, and other changes, and also observe the length, thickness, width, and other structural changes of the gastrocnemius muscle [9]. In addition, ultrasound can also effectively

detect the muscle strength of the long head and the short head of the fibula, thus providing a basis for the development of personalized rehabilitation treatment plans [10].

5. Conclusion

In conclusion, sports medicine ultrasound can effectively monitor the recovery of patients with anterior talofibular ligament injuries and can guide the implementation of rehabilitation training and improve the clinical prognosis of patients. In the present study, neither the control group nor the study group dynamically monitored the recovery process of patients. In clinical practice, some patients may be reluctant to accept rehabilitation therapy or even refuse to cooperate with the doctor's treatment due to fear of pain or other reasons. If the rehabilitation effect is not achieved for a long time, patients may lose confidence and fail to actively participate in the rehabilitation training, thus reducing the rehabilitation effect.

Disclosure statement

The author declares no conflict of interest.

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