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Treatment of Acute Lateral Collateral Ligament Injury of Athletes

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Abstract: Injury to the lateral collateral ligament of the ankle joint is common in athletes and it accounts for a large portion of cases of emergency sports trauma. Although the ankle ligament injury is not a very serious sports trauma, if it is not handled early, it will seriously affect the athlete's training and may cause severe after-effects. In view of the above problems, this article proposes the treatment of acute lateral ankle joint collateral ligament injury in athletes, in order to provide a reference for related treatment. In this study, 135 patients were admitted from March 2019 to August 2019. The 135 patients with acute lateral collateral ligament injury of the ankle were divided into three groups for comparison experiments. The three groups were conservative treatment group, direct surgical repair group and surgical ligament reconstruction group. The American Foot and Ankle Surgery Association (AOFAS) score was used to evaluate the function of the posterior foot, and the 3 groups of patients were observed for AOFAS scores, clinical effects, and complications before and 12 months after treatment. The results showed that, compared with before treatment, the AOFAS scores of the three groups were significantly improved after treatment ($P < 0.05$). The total AOFAS score and clinical efficacy of patients in the direct surgery repair group and the ligament reconstruction group were significantly better than those in the conservative treatment group ($P < 0.05$). However, the incidence of postoperative complications in the two groups of surgical treatment groups was higher than that of the conservative treatment group, and the difference was statistically significant ($P < 0.05$). There were no significant differences in the total AOFAS score, clinical efficacy, and complication rate between the direct surgery repair group and the ligament reconstruction group ($P > 0.05$). Therefore, it is believed that the effect of surgical treatment on the improvement of posterior foot function in patients with acute lateral ankle joint collateral ligament injury is more obvious than that of conservative treatment, but the safety is poor. The surgical effects of anchor repair and modified Elmslie are equivalent, so the treatment plan should be determined based on the comprehensive situation.

1. Introduction

Acute ankle sprain and contusion can occur at any age, but it is more common in young and middle-aged adults, especially athletes, who are usually caused by sudden excessive varus or valgus violence of the ankle [1]. The lateral collateral ligament starts from the lateral malleolus, including the anterior talofibular ligament that stops at the anterolateral side of the talus, the calcaneal ligament that ends at the lateral side of the calcaneus, and the talofibular ligament that ends at the posterolateral of the talus. The lateral collateral ligament is relatively weak and is most likely to be damaged during exercise [2]. Athlete injury is very common in athletes, and its incidence accounts for about 16% to 21% of all athlete injuries. Among them, lateral collateral ligament injury accounts for about 90% of ankle injury. Acute lateral collateral ligament injury of the ankle, if not treated in time, will result in chronic lateral ankle instability, which can cause repeated sprains and chronic bone and joint disease of varying degrees [3]. The injury of athletes is related to the development of their own careers. If they are not properly treated, it may greatly affect the performance of sports competitions and even interrupt their sports careers. Therefore, the treatment of athletes with acute lateral ankle joint collateral ligament injury has very important practical significance.

The treatment of lateral ankle joint collateral ligament injury has received extensive attention from experts and scholars, and many experts and scholars have conducted research. For the treatment of ankle injuries, it can be divided into conservative treatment (non-surgical treatment) and surgical treatment according to its severity [4]. Conservative treatment often uses gypsum fixation, acupuncture and pricking blood, massage and muscle management. Surgical treatment includes two major categories: lateral collateral ligament repair and ligament reconstruction. Active conservative treatment and surgical treatment are feasible. In [5], the authors point out that young patient with high-energy ankle fractures may experience complete avulsion of the superficial deltoid complex of the medial malleolus. In low-energy ankle fractures in the elderly, avulsion fractures of the tip of the medial malleolus may also cause partial injury of the deltoid ligament. The authors identify and repair superficial ligament injuries of the deltoid muscle in ankle fractures to restore the anatomic structure of the ankle collateral ligament and help improve clinical outcomes. In [6], the authors performed a retrospective analysis of all adult Weber Type C ankle patients treated with Arthrex TightRope fixation systems at four centers over a three-year period. All patients were followed up for an average of 14 months (range 12-26). Objectively use radiological measurements to assess the incidence of complications and revision rates. It was found that for Weber C ankle fracture with complex mandibular injuries, rope fixation is a safe alternative to screw fixation, proving that it has a lower incidence of complications and higher patient satisfaction. In [7], the authors used a classification system to divide the primary posterior ankle fracture fragments into 3 groups. Type 1 fractures are described as primary lithotripsy of the lateral hind ankle of the facet joint. Type 2 fractures consist of major fragments of the posterolateral tibial triangle (Volkmann area). Type 3 primary fractures are characterized by the entire posterior coronal fracture line. The value of this method is that by tracking the pathogenesis through the ankle, it can be shown that the kinetic energy path may disrupt other structures. Knowing how each category of injury is related, surgeons may be able to avoid some pitfalls in treating these injuries. The severity of this classification system is constantly increasing, pointing out the pathological mechanics that lead to fractures, so it can guide doctors on which method to use for which fixation. In [8], the authors reported the institution's experience in the diagnosis and treatment of chronic branch-ankle instability (CLAI) with ligament ligament (LB) injury. A total of 218 patients with CLAI who underwent continuous surgery from January 2012 to December 2015 were selected. The 218 patients underwent ipsilateral ligament tendon reconstruction. In 51.4% (112/218) of patients, CLAI

was associated with LB injury. 112 patients with LB injury also received this treatment. 36 cases underwent calcaneal anterior resection, 68 cases underwent LB repair, and 8 cases underwent LB reconstruction. Patients underwent clinical and radiological follow-up assessments within an average of 31 months (24-35 months) after surgery. Outcomes were assessed by comparing preoperative and postoperative American Orthopedic Foot and Ankle Society (AOFAS) scores, visual simulated pain scores, Carlson scores, and imaging assessments. In [9], the authors discussed the diagnosis and treatment of ankle fractures with acute triangular ligament injury. Misdiagnosis of ankle fractures with acute triangular ligament injury is common. Diagnosis is based on the patient's main complaint, symptoms and imaging, and even surgical exploration is required. Whether to repair deltoid ligament is still controversial. Treatment of different types of ankle fractures with acute triangular ligament injury should be standardized. In [10], the authors found that stable ankle fractures and severe ankle sprains can be successfully treated with the following knee plaster or air support braces and crutches. The results of the study showed that patients treated with air braces were statistically more patient-satisfied than patients treated with plaster models.

Aiming at the injuries caused by ankle ligament injury to athletes and other groups, this article proposes the treatment research of athletes with acute lateral ankle joint collateral ligament injury. This article selected 135 patients admitted from March 2019 to August 2019, and divided these 1235 patients into conservative treatment group, direct surgical repair group and surgical ligament reconstruction group. The AOFAS score was used to evaluate the function of the posterior foot. The AOFAS score, clinical efficacy, and complications of the three groups of patients were observed before and 12 months after treatment. The results showed that, compared with before treatment, the AOFAS scores of the three groups were significantly improved after treatment ($P < 0.05$). The total AOFAS score and clinical efficacy of patients in the direct surgery repair group and the ligament reconstruction group were significantly better than those in the conservative treatment group ($P < 0.05$). However, the incidence of postoperative complications in the two groups of surgical treatment groups was higher than that of the conservative treatment group, and the difference was statistically significant ($P < 0.05$). There were no significant differences in the total AOFAS score, clinical efficacy, and complication rate between the direct surgery repair group and the ligament reconstruction group ($P > 0.05$). Therefore, it is believed that the effect of surgical treatment on the improvement of posterior foot function in patients with acute lateral ankle joint collateral ligament injury is more obvious than that of conservative treatment, but the safety is poor. The surgical effects of anchor repair and modified Elmslie are equivalent, so the treatment plan should be determined based on the comprehensive situation.

2. Clinical data

2.1. Case Selection Criteria

2.1.1. Case Inclusion Criteria

1) The research group is a provincial sports team. The team has multiple national championships, and has won more than 3 gold medals in the last two national games.

2) Observation objects are balanced between men and women, and their sports performances are at or above the national level.

3) The first diagnosis of injury is in patients with acute stepping on the lateral ligament injury of the joint (see below for diagnostic criteria).

4) After the injury, X-ray examination was performed to rule out the absence of fractures and dislocations on the joints, and there was no clear surgical indication suitable for conservative treatment.

5) The patient had no other injuries that affected this study, and volunteered to cooperate with this study.

2.1.2. Case Exclusion Criteria

1) People who are allergic to drug use.
2) The patient had other injuries that affected the investigator. Those with chronic ankle sprains or cerebrovascular contractions, etc .; those with severe hypertension, heart, cerebrovascular, liver, kidney, and hematopoietic diseases.
3) Complicated with severe mental illness or severe alcoholism.
4) Patients are unwilling to participate in this treatment.

2.1.3. Case Withdrawal Criteria

1) The patient failed to follow the doctor's order for treatment on time.
2) Patients with drug allergies during treatment cannot continue to participate in this experiment.
3) The improvement is not obvious after treatment, and further MRI examination shows that the ligament is completely broken and requires surgery.

2.2. Diagnostic Criteria

Refer to the "Handbook of Practical Orthopedics" to formulate the diagnostic criteria for lateral ligament injury of this experiment.

① There is a clear history of stepping trauma, and patients with stepping lateral ligament injuries generally have a relatively clear history of excessive inversion injury of extension flexion.

② Pain, swelling, and subcutaneous fatigue spots on the injured site, accompanied by trekking, and the pain of the ligament on the lateral side of the joint is usually at the starting and stopping points from the anterior fat ligament and the fat ligament. Swelling and fatigue spots occur frequently on the anterior and lateral sides of the joint. The affected limb is afraid to touch the ground due to pain.

③ The patient resisted the foot varus test. When doing the foot varus, stepping on the front and bottom of the foot caused severe pain.

④ X-ray examination showed no fracture or dislocation.

⑤ The patient was not allergic to the use of drugs and did not affect other injuries in this study.

2.3. General Information

All cases were admitted patients from March 2019 to August 2019. There were 82 males and 53 females. The youngest was 15 years old and the oldest was 30 years old, with an average age of (21.15 ± 1.56) years. 135 cases were randomly divided into three groups: conservative treatment group, direct surgery repair group and surgical ligament reconstruction group. There were 45 cases in each group. The comparison of general information such as age distribution, gender, disease duration, injury cause, and injury location of the three groups was not statistically significant ($P > 0.05$), which increased comparability for subsequent studies. The clinical data of the three groups of patients are shown in Table 1.

Table 1. General information of patients in three groups

Group	Causes of injury (number)				Injury location	
	Sprain	Sports injury	Fall injury	Other reasons	Left	Right
Conservative treatment group	10	20	8	7	19	26
Direct surgery repair group	11	24	7	3	18	27
Surgical ligament reconstruction group	9	21	9	6	22	23

3. Treatment Plan, Observation Index and Statistical Processing

3.1. Treatment Plan

All patients were treated with local cold compresses immediately after the injury, and were treated with a plaster cast, and treated accordingly after diagnosis.

a) Conservative treatment group (gypsum fixation): According to the length of the patient's lateral middle and internal measurement to the sole of the foot, the plaster roll (appropriate width) is folded back 12 layers and lined with cotton pads. The U shape is attached to the outside of the lower leg, the inside of the lower leg and the sole of the foot, and the inside is lower than the outside. After the fixation (outer bandage), the ankle was valgus and the dorsal position was maintained for 4 weeks. In more severe cases, the fixation can be extended to 5 to 6 weeks, and ankle functional activities are performed after the end.

b) Surgical direct repair group (anchor repair): epidural anesthesia, ligament repair after fracture and dislocation of the foot and ankle. Cut the skin with an arc incision at the front and bottom of the lateral malleolus to remove the hematoma and expose the damaged ligaments. The inactivated ligament fibers were excised and the ankle was maintained with a slight valgus (90 degrees dorsiflexion). Screw the anchor in the distal fibula, and stitch the broken ligaments and tendons to the anchor line.

c) Surgical ligament reconstruction group (modified mslie method): epidural anesthesia, first make an arc incision (length 8-10cm) at the distal side of the lateral malleolus (2 ~ 3cm), explore the condition of the damaged ligament, and repair and clean the broken end. A longitudinal incision (3 cm) was made along the posterior edge of the fibula at the proximal end of the lateral malleolus (about 12 cm) to free the short peroneus tendon. Split along the midline (longitudinal), cut off the anterior half from the proximal end, and separate through the subcutaneous tunnel, and pull it into the arcuate incision to retain the distal end of the short peroneus tendon. Drill a fibula canal at the tip of the lateral malleolus (proximal 2.5 cm) (horizontal from front to back). A V-shaped bone tunnel was drilled at the talus of the anterior peroneal ligament and the calcaneal ligament. The tunnel diameter was approximately 4.5 mm and the hole spacing was 1.8 cm. Then pass through the calcaneus, lateral malleolus, and talus tunnel in sequence. Finally, the ligament that exits the exit of the talar tunnel is sutured and fixed on the periosteum of the fibula, and the joint capsule is repaired and sutured.

3.2. Observation indicators

1) According to the American Orthopaedic Foot & Ankle Society (AOFAS) scoring standard, the three groups of patients were evaluated for post-foot function before and 12 months after treatment, with a perfect score of 100 points. The higher the score, the better the ankle function.

2) At the 12-month follow-up after treatment, evaluate the curative effect with reference to relevant standards:

(A) Healed, the ankle joint pain and swelling disappeared, the varus stress test showed negative, the talus tilt angle was less than 50 degrees, and the activity was normal;

(B) Improved, ankle joint pain and swelling improved, varus stress test showed negative, and talar tilt angle was between 50 °and 90 °;

(C) Unhealed, ankle joint pain and swelling are not significantly improved and may be aggravated. The results of the varus stress test are positive, and the talar tilt angle is greater than 90 degrees.

3) Calculate the effective rate% (cure rate + improvement rate).

4) Record the occurrence of complications in patients.

3.3. Statistical processing

All data were analyzed and processed using SPSS 22.0, and the measurement data was expressed as ($x \pm s$). The t test was used for comparison between groups, and the one-way analysis of variance was used for comparison between multiple groups. Count data were analyzed by chi-square test, and $P < 0.05$ was considered statistically significant.

Since the t-test is more commonly used, it will not be described in detail here. The one-way ANOVA method is described in detail here to increase readability. The process of the one-way ANOVA method is as follows:

First, based on the results of the single factor test, the total variance V, the intra-group variance Vw, and the inter-group variance V B are obtained.

$$\begin{cases} V = \sum \left(X_{ij} - \bar{x} \right)^2 \\ V_w = \sum \left(X_{ij} - \overline{X}_i \right)^2 \\ V_B = b \sum \left(\overline{X}_i - \bar{x} \right)^2 \end{cases} \tag{1}$$

It can be seen from the formula that the total variance measures the degree of deviation of all observations X_{ij} from the total mean $\bar{x}$, and reflects the size of the sampling random error. The intra-group variance measures how far all observations X_{ij} deviate from the group mean $\overline{X}_i$. The inter-group variance measures the deviation of the group mean $\overline{X}_i$ from the total mean $\bar{x}$, reflecting the systematic error.

On this basis, the mean square error S_B between groups and the mean square error S_W between groups can also be obtained:

$$\begin{cases} S_B = \dfrac{V_B}{a-1} \\ S_W = \dfrac{V_w}{ab-a} \end{cases} \tag{2}$$

Under the assumption of equal variances, to test whether the mean of n populations are equal, the null hypothesis and alternative hypothesis must first be given.

The null hypothesis H 0: the mean is equal to $\mu_1 = \mu_2 =, \mathrm{L}\ , = \mu_n$.

Alternative hypothesis H1: Means are not completely unequal.

You can use the F statistic for the test of variance:

$$F = \frac{V_B / (a-1)}{V_w / (ab-b)} = \frac{S_B^{\ 2}}{S_W^{\ 2}} \tag{3}$$

This statistic obeys the F distribution with numerator degrees of freedom a-1 and denominator degrees of freedom ab-a.

Given the significance level a, if the value of the F statistic calculated from the sample is less than or equal to the critical value $F_\alpha(a-1, ab-a)$, the original hypothesis H 0 is not true, and the population mean is not completely equal, and the difference is not caused only by random factors.

4. Comparison of Treatment Results

4.1. Changes in Ankle Function

For changes in ankle function, the changes in AOFAS scores before and after treatment in the three groups of patients are mainly referred to, as shown in Table 2.

Table 2. Changes in AOFAS scores before and after treatment in the three groups of patients

Group	Total score before treatment	Total score after treatment	t value	P value
Conservative treatment group	45.93±3.50	85.31±2.87	55.167	0.000
Direct surgery repair group	46.86±2.67	96.12±2.46	89.469	0.000
Surgical ligament reconstruction group	45.77±3.12	94.26±2.48	76.592	0.000
F value	1.596	223.106		
P value	0.187	0.000		

As shown in Table 2, there was no significant difference in the total AOFAS scores between the three groups of patients before treatment (P> 0.05). The total AOFAS scores of the three groups of patients were significantly higher than those before treatment (P <0.05). The total score of AOFAS scores at 12 months after treatment was significantly different between the three groups (P <0.05). After a pairwise comparison, the total AOFAS scores of patients in the direct surgery repair group and the ligament reconstruction group were significantly different from those in the conservative treatment group (t = 20.103, P = 0.00; t = 16.693, P = 0.00). There was no significant difference in the total AOFAS score between the direct surgical repair group and the ligament reconstruction group (t = 1.801, P = 0.079).

4.2. Clinical Efficacy

The clinical effect is one of the important references to test the treatment results of the acute lateral ankle joint collateral ligament injury proposed by the athletes. The comparison of the clinical efficacy of the three groups of patients is shown in Figure 1.

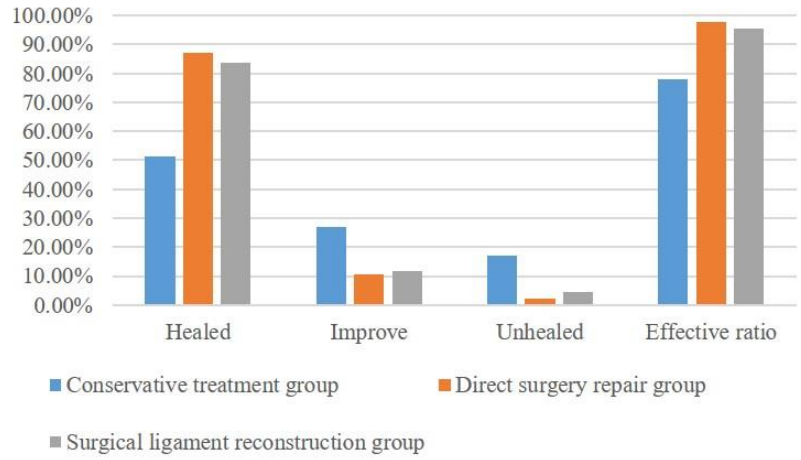

Figure 1. Comparison of clinical efficacy of three groups of patients

It can be seen from Figure 1 that after treatment, compared with the conservative treatment group, the clinical efficacy of the direct surgery repair group and the surgical ligament reconstruction group were significantly higher (χ^2 = 6.689, P = 0.010; χ^2 = 4.104, P = 0.043). There was no significant difference in clinical efficacy between the direct repair group and the surgical ligament reconstruction group (P> 0.05).

4.3. Complications

Athlete's acute lateral collateral ligament injury occurred, and complications occurred during subsequent treatment. Therefore, in this study, the incidence of complications was included in the study to more comprehensively track the acute lateral ankle joint collateral ligament injury. The occurrence of complications is shown in Table 3.

Table 3. Comparison of the incidence of complications among the three groups of patients

Group	Ankle rigidity	Feeling lost	Scar formation	Ankle dyskinesia	Deep vein thrombosis	Wound infection
Conservative treatment group	2.22%	2.22%	0	4.44%	2.22%	0
Direct surgery repair group	20%	20%	15.56%	4.44%	2.22%	0
Surgical ligament reconstruction group	17.78%	17.78%	13.33%	2.22%	4.44%	0

As can be seen from Table 3, the complication rate of patients in the conservative treatment group was compared with the direct surgery repair group and the surgical ligament reconstruction group, and the difference was statistically significant (P <0.05). There was no significant difference between the direct surgical repair group and the surgical ligament reconstruction group (P> 0.05). Among them, the incidence of ankle stiffness, loss of sensation, and scar formation at the injury site

was significantly lower in the conservative treatment group than in the direct surgery repair group and the ligament reconstruction group (P <0.05).

5. Discussion

The lateral ligament of the ankle joint includes anterior-talofilamental ligament, posterior-talofilamental ligament, and heel-fibula ligament. Most of the acute injuries are caused by dysfunction of ankle joint balance caused by sports sprain. Among them, the increased tension and avulsion of the lateral collateral ligament caused by excessive ankle inversion are the main causes of local tissue fluid leakage and bleeding. This can cause clinical symptoms such as ankle swelling, claudication, and pain. Failure to get it right in the early stages may cause chronic ankle instability, prone to repeated sprains, and ultimately increase the risk of diseases such as osteoarthritis. Clinically, conservative treatment (gypsum fixation or functional treatment) and surgical treatment are mainly used. There are about 80 reported surgical treatments for the lateral collateral ligament injury of the ankle joint. After summary, they can be divided into two major categories: direct ligament repair and ligament anatomic reconstruction. However, at present, domestic and foreign scholars have not reached a unified conclusion on the efficacy of different methods for the treatment of acute lateral ankle joint collateral ligament. Therefore, this article chooses the gypsum fixation method in conservative treatment. The suture anchor is used to repair the damaged ligament in the direct ligament repair, and the modified Elmslie method is used to reconstruct the lateral collateral ligament.

The application of plaster is the principle of fixed braking, which can effectively reduce the tension of the injured ligament and continue to avulse, creating favorable conditions for the repair of ligaments. It is mostly used for the treatment of l ~ Ⅱ degree ankle ligament injuries. However, it is reported that a longer braking time will result in a decrease in collagen synthesis and an increase in degradation, which will trigger tissue adhesion and affect the recovery of ankle function. Surgical treatment is mostly used in the treatment of severe ankle ligament injuries. The ankle joint stability can be reconstructed to the greatest extent after surgery, which promotes the daily life of patients and the recovery of their original occupation. The results of this study showed that the AOFAS score and efficacy of the two groups of patients treated by surgery were significantly higher than those of the conservative treatment group at 12 months after treatment (P <0.05). There were no significant differences in AOFAS scores and curative effects between the direct surgical repair group and the surgical ligament reconstruction group in this study (P> 0.05). It is suggested that for acute lateral ankle joint collateral ligament injury, surgical treatment is better than the conservative treatment group in restoring the function of the posterior foot of the ankle, and the effect is equivalent between different surgical methods.

The results of the complication rate study showed that the incidence of ankle stiffness, sensory loss, and scar formation at the injury site was significantly higher in the two groups of surgical treatment than in the conservative treatment group (P <0.05). The difference was not statistically significant (P> 0.05). The reasons for this may be: a) The patients in the surgical treatment group still need to be fixed with plaster for a period of time after surgery, which results in a longer total ankle joint fixation time compared with the conservative treatment group. The prolonged braking time and the extra trauma caused by surgery may lead to a higher incidence of ankle stiffness than the conservative treatment group. b) Surgical trauma may damage local cutaneous nerves and cause loss of sensation. c) Postoperative wound healing may increase the incidence of scarring in the surgical group compared with the conservative treatment group. Although the two surgical treatment methods used in this study have similar effects on the treatment of acute ankle collateral ligament injury. However, the complexity of the actual operation, the operation time, the increase in

the risk of fractures, and the economic benefits are not covered in this study, so it is necessary to further study.

In summary, the effect of surgical treatment on improving the function of the posterior foot of patients with acute lateral ankle joint collateral ligament injury is more obvious than that of conservative treatment, but the incidence of complications is higher. Therefore, surgical treatment is recommended for those with Ⅲ degree injury, athletes or heavy manual labor, but attention should be paid to prevention and treatment of postoperative complications. For most patients with ankle ligament injuries of degree Ⅰ to Ⅱ, scientific and reasonable conservative treatment is feasible, and rehabilitation training after treatment is emphasized to promote ankle joint function recovery after treatment. There are still some limitations in this study, and a comparison of long-term effects of different treatment methods should be added in subsequent studies so that it can be more comprehensively evaluated.

6. Conclusion

Injury of the lateral collateral ligament of the ankle is very common in athletes. Although the ankle ligament injury is not a very serious sports trauma, if it is not handled early, it will seriously affect the athlete's training and may cause severe after-effects. This article proposes the research on the treatment of athletes with acute lateral ankle joint collateral ligament injury, in order to reduce the further injury of athletes. Ankle sprain is a common injury that affects the training and competition of athletes. It has important significance for the prevention of ankle sprain. Ankle sprains often occur when you are tired from training and competition or when you are just starting to move without adequate preparation. In order to prevent ankle sprains, adequate preparatory activities must be performed before strenuous activities. Application of adhesive tape, elastic bandages and various ankle braces during training and competition can significantly reduce the incidence of ankle injuries. Among them, adhesive tape is most commonly used because of its light texture, convenient application, and very good results. Adhesive tape can prevent ankle sprains by limiting the extreme motion of the ankle joint. At the same time, it can strengthen the valgus muscle of the ankle and accelerate the response of the short peroneus. At present, various types of ankle braces have been greatly developed, and they can give ankle joints a great protection during exercise.

The shoes worn by athletes have a lot to do with ankle sprains. The design of training and competition shoes requires higher requirements. It does not affect the movement, but also effectively protects the ankle joint. At the same time, it can continuously adjust its tightness during the movement. When the human body is barefoot, the proprioception of the ankle joint is the most sensitive, and the proprioception of the foot is greatly reduced after wearing shoes. Therefore, the ankle joint is more likely to be damaged when wearing shoes than when it is barefoot. According to the ankle anatomy, biomechanics, and proprioception of the ankle under external force, high-top sneakers can effectively prevent ankle sprains. In addition, a low and wide heel can effectively prevent ankle sprains. The low heel can reduce the potential energy of the heel before the heel touches the ground when the hind foot is tilted sideways, and reduce the inversion force of the ground to the ankle joint. The wide heel can also increase the contact area of the hind foot with the ground and improve the stability of the hind foot in sports.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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