Diagnosis and Treatment of Achilles Tendon Injury

Rongbin Wang
Guangzhou Foreign Language School, Guangzhou, China

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Abstract: The Achilles tendon is the thickest and strongest tendon in the human body, and due to its unique anatomical location and physiological function, it is also one of the most prone tendons to rupture. With the development of biomechanics research in recent years, more biomechanical concepts and research methods have been incorporated into the etiology analysis of Achilles tendon injuries, especially Achilles tendon ruptures. This study suggests that Achilles tendon injury has become a potential threat for athletes in track and field as well as ball sports during running and jumping. The probability of Achilles tendon injury varies depending on the sports they participate in and their grade level. Senior college students engaged in jumping and competitive sports have a higher probability of developing Achilles tendon injury. Achilles tendon injury is one of the most common symptoms in orthopedic clinical practice, and there are many causes of Achilles tendon injury, with the highest number of cases of accidental injury to the Achilles tendon due to improper exercise. The treatment of chronic Achilles tendinitis in Achilles tendon injury is relatively simple, and the treatment methods are also relatively single. The treatment of Achilles tendon rupture is mainly divided into conservative and surgical methods, including surgical treatment, conservative treatment, rehabilitation treatment, and cytokine action.

1 INTRODUCTION

The Achilles tendon is the most powerful and thickest tendon in a human body, located behind the ankle joint. Its starting point is one-third of the lower back of the calf, and its endpoint is the calcaneal tuberosity. Therefore, it can transfer strength to the feet by pulling the muscles of the posterior calf muscle group, and its main physiological function is to help the plantar flexion of the foot and ankle joint. Common Achilles tendon injuries are mainly divided into acute and chronic injuries, and diseases mainly include Achilles tendon rupture and Achilles tendinitis. The Achilles tendon is one of the most easily breakable tendons in the human body, mainly due to its unique physiological function and anatomical location. Once Achilles tendon injury occurs, the quality of life of patients will be greatly affected.

The blood supply of Achilles tendon is mainly provided by branches of the posterior tibial artery, followed by branches of the fibular artery. The vascular distribution is relatively sparse 2-6 cm above the insertion point, which is prone to ischemic degeneration of the tendon structure. Tearing and rupture of the Achilles tendon often occur in this segment. The microvessels and capillaries in the upper, middle, and lower segments of the Achilles tendon are not evenly distributed, with significantly fewer in the middle segment than in the upper and lower segments. This may be the pathological anatomical basis for the frequent occurrence of Achilles tendon rupture in the middle segment. According to the epidemiology, in recent years, with the progress of people's living standards and lifestyles, the awareness of sports has gradually increased, and the incidence rate of acute has also gradually increased. The incidence rate of male patients is higher than that of female patients, mainly aged 35-39 years (Lantto et al.,2015).

2 DIAGNOSIS

The known risk factors for Achilles tendon injury include previous intratendinopathy, history of fluoroquinolone use, history of steroid injection, and history of inflammatory arthritis (Haapasalo et al., 2018). With the development of biomechanics research in recent years, more biomechanical concepts and research methods have been incorporated into the etiology analysis of Achilles

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tendon injury, especially Achilles tendon rupture. Which is subjected to dynamic loads at or near failure during movement, and fatigue induced damage may be a factor leading to its ultimate fatigue and failure (Noback et al., 2018).

The diagnostic method for Achilles tendon injury is supported by clinical manifestations and imaging and ultrasound examination results. Imaging mainly relies on X-rays and MRI. In recent years, progress in the diagnosis of Achilles tendon injury has mainly been made through the update of imaging and ultrasound equipment, as well as new research and exploration by doctors based on new diagnostic equipment. A clinical trial has shown that high-frequency ultrasound has high diagnostic sensitivity and specificity for Achilles tendon. Elastic ultrasound imaging technology can accurately reflect muscle tension and assess muscle strength in patients with acute Achilles tendon injury. At the same time, there is a linear correlation between the longitudinal tensile force borne by the tendon and the elastic modulus value measured by elastic ultrasound imaging technology, which can reflect the elasticity of the Achilles tendon and achieve effective diagnosis of the patient's disease.

MRI has the characteristics of multi plane imaging and high soft tissue resolution, which can well display the morphology and signal changes of Achilles tendon, determine the location and degree of tear, and also display the changes in surrounding soft tissue structure. It can comprehensively and accurately evaluate Achilles tendon tear and is the preferred imaging examination method for acute Achilles tendon tear. The normal Achilles tendon shows low signal shadows on both T1WI and T2WI sequences, and there may be strip like high signal shadows inside. The strip like high signal shadows are parallel to Achilles tendon and have a width of less than 1.5mm. When the magic angle phenomenon occurs (the main magnetic field forms a 55 ° angle with the normal tendon diameter), the phenomenon in the magic angle rarely occurs in the conventional position. If the ruptured tendon bends, the effect of magic angle may occur, which needs to be analyzed comprehensively (Peh and Chan, 1998).

The MRI manifestations of complete Achilles tendon tear include retraction of the rupture end, and the width of the rupture crack reflects the degree of retraction of both ends. The ruptured fibrous bundles interlock and overlap with each other in a "brush" shape, and the ruptured fibrous bundles retract in a "oak" shape. When the torn tendon retracts significantly, it can appear wavy. MRI manifestations of incomplete Achilles tendon tear: Partial Achilles tendon tear, with a stripe like, patchy, and focal high signal shadow at the tear site compared to normal Achilles tendon. Incomplete Achilles tendon tear shows continuity on at least one level. Partial incomplete tearing occurs on the basis of certain lesions, as shown in Figures 1 (Xiao et al., 2014).

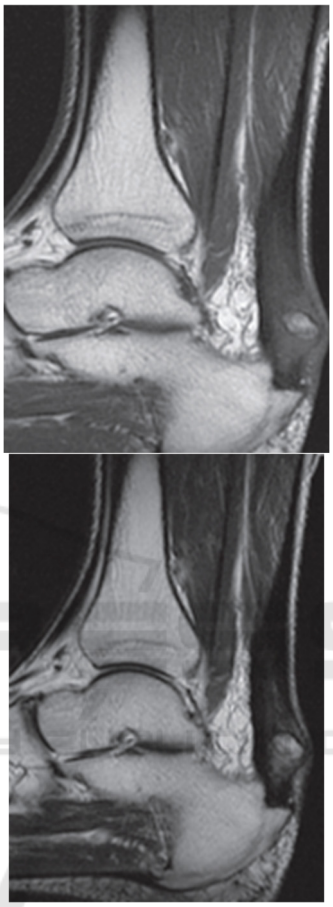

Figure 1: MRI manifestations of incomplete Achilles tendon tear.

3 ACHILLES TENDON INJURY AND MOTOR FUNCTION

Achilles tendon injury has become a potential threat for athletes in athletics and ball sports during running and jumping. Previous literature studies have reported that runners should be aware of the overuse injuries which is on the tendon, and athletes engaged in athletics and ball sports should pay attention to Achilles tendinopathy. Epidemiological data shows that in the past few decades, the incidence that about the Achilles tendon rupture has increased from 11/100000 to 37/100000, and the incidence is still on

the rise. More than 60% of tendon ruptures are related to participating during in the sports. Therefore, in the field of sports medicine, sports researchers should pay special attention to and attach importance to the issue of Achilles tendon injuries in athletes engaged in athletics and ball sports during training and competition.

The probability of Achilles tendon injury varies depending on the sports program and grade level. Senior college students who engage in jumping and competitive sports have a higher probability of Achilles tendon injury. In relevant research literature, Leppilahti et al.(1996) believe that continuous jump movements, strides, and single foot landing movements in basketball, as well as forward strides, large forward strides, light jump forward strides, and light jump backward movements in badminton, are more likely to cause Achilles tendon injury, even tearing (or rupture), compared to other sports. Numerous studies have shown that there are significant differences between conservative treatment and surgical treatment in terms of recovery time, treatment efficacy, and recurrence rate. It can be seen that conservative treatment can achieve good therapeutic effects in patients with chronic Achilles tendon injury and partial tear injury under certain circumstances. However, compared with surgical treatment, there are still disadvantages such as difficult healing and high recurrence rate in some patients.

The Achilles tendon in the human body shows the largest tendon group, and its importance to the body is self-evident. Its proximal end refers to the muscle belly of the soleus muscles, and its distal end extends to the calcaneal tuberosity. Its main function is to maintain the stability of the ankle joint when standing, prevent the body from tilting forward, and assist in completing movements such as walking, jumping, and running, playing a key role in the body's load-bearing capacity. Under normal circumstances, the force on the tendon bone complex in the human body is uniform and consistent. However, during intense exercise, the position of force on the entire foot changes significantly, resulting in a decrease in the contraction and coordination ability of the active muscles, which in turn leads to an imbalance in the weight-bearing capacity of the tendon bone complex, causing damage to the weak area of the Achilles tendon or increasing its risk of injury. The injury is one of the most common symptoms in orthopedic clinical practice, and there are many causes of Achilles tendon injury, with the highest number of cases of accidental injury to the Achilles tendon due to improper exercise.

In real life, there are two mechanisms that may cause injury to patients. One is due to long-term long-distance jumping exercise, which can lead to degenerative changes in the tendon and ultimately trigger Achilles tendon injury. The injury caused by this reason is closed and the surface skin of the affected area is not affected; Another type of injury is caused by sharp cutting or direct impact, and in severe cases, it can even lead to Achilles tendon rupture, which belongs to open type. Patients with closed Achilles tendon injuries often suffer from injuries caused by the inability to bear weight at the moment when the limb suddenly jumps and the toe is close to the ground. It is necessary to treat the affected limb with congestion, swelling elimination, and pain management to prevent infection. At the same time, patients should be guided to undergo proper rehabilitation training to ensure a speedy recovery.

4 TREATMENT

The treatment in Achilles tendon injury is relatively simple, and the treatment methods are also relatively single. The treatment is mainly divided into two treatment methods: conservative and surgical. There is no unified understanding in medicine regarding the choice of the two treatment methods, but surgical treatment is still the main means for orthopedic surgeons to treat Achilles tendon rupture or defect. In recent years, the development of surgical methods has mainly focused on minimally invasive techniques and the improvement and research of existing technologies. This also requires clinicians and family members to consider comprehensively and make accurate judgments when choosing treatment methods. The basis for accurate judgment is not only the patient's symptoms and examination results, but also the patient's prognosis and the acceptance of the prognosis by the patient and family members. Therefore, patients should be fully informed of the advantages and disadvantages of the two treatment methods before treatment, and the final decision between surgical or non-surgical treatment should be based on the joint decision-making and specific factors from the patient.

4.1 Surgical Treatment

The surgical treatment in the injury about Achilles tendon mainly involves the treatment in the rupture or defect. Currently, there are two main methods: open and minimally invasive surgery. Minimally invasive treatment is currently the preferred choice to

avoid postoperative complications as much as possible. For example, arthroscopic percutaneous anastomosis technology and Achilles tendon anastomosis devices are used in the treatment, but they have a clear range of applications and are more suitable for patients with clear preoperative examination results and small Achilles tendon rupture or defect area. In the study of postoperative infection incidence, a meta-analysis including 5 RCTs and 4 cohort studies showed that the deep infection rate of minimally invasive treatment was significantly lower than that of open treatment (Yang et al., 2017).

Open surgery is a relatively traditional surgical method, including V-Y tendon reconstruction, gastrocnemius fascia flap, tendon transplantation, allogeneic transplantation reconstruction, autograft reconstruction, artificial transplantation enhancement, and biomaterial enhancement. In recent years, there have been many studies on clinical doctors using open surgery for Achilles tendon repair. V-Y tendon reconstruction is an effective and economical method in classic surgery, suitable for large and medium-sized (2 cm or more) defects. A mid - to long-term follow-up study on the reconstruction using V-Y tenoplasty showed that it can produce satisfactory functional outcomes and lower incidence of complications, without the need for expensive synthetic implants (Lin et al., 2019).

4.2 Conservative Treatment

In terms of conservative treatment, traditional conservative treatment requires 6-8 weeks of plaster fixation. Within the first 4 weeks, place the ankle in a cast which in a plantar flexion position, and then place it in a neutral position for the next 2-4 weeks. The cast provides protection for the tendon during the maximum treatment in healing, but fixation may increase the risk of calf muscle atrophy, gait abnormalities, and thrombosis (Healy et al., 2010). In recent years, functional braces have been involved in conservative treatment of Achilles tendon injuries. The calf in a patient is placed in a removable walking boot that includes wedges for lifting the heel. Compared with surgical treatment, a long-term research showed that patients who use functional braces have longer underground time and healing cycle than those who use surgical sutures, making them more suitable for patients with severe comorbidities and less lifestyle exercise.

4.3 Rehabilitation Treatment

After long-term follow-up studies at multiple centers, it has been found that rehabilitation therapy, whether surgical or conservative, has a significant impact on the prognosis of patients by helping to strengthen muscle strength and improve ankle joint mobility (Westin et al., 2018). The first is to prevent complications. The highest incidence rate of complications after Achilles tendon surgery is deep vein thrombosis. The latest research found that deep vein thrombosis will affect the prognosis of patients with Achilles tendon injury through their subjective and functional factors (Svedman et al., 2020). Intermittent pneumatic compression during the rehabilitation period of Achilles tendon injury and leg fixation has been shown to reduce the risk. At the same time, studies have shown that intermittent initiation of compression may promote the growth of Achilles tendon ends by upregulating the synthesis of type I collagen. Secondly, it can promote functional recovery. A prospective cohort study found that immediate weight-bearing and early functional activity of the ankle joint during the early healing period after surgery can better restore patients' function and muscle strength compared to fixation in a plaster model for the first 2 weeks (Aufwerber et al., 2020).

4.4 Cytokine Effects

There are two mechanisms of healing after Achilles tendon injury, one is endogenous healing and the other is exogenous healing. The Exogenous healing mainly relies on fibrous connective's growth, which is tissued into the Achilles tendon, accompanied by fibrous adhesions. Endogenous healing refers to the division and proliferation of fibroblasts, including in the tendon itself, blood vessels during the healing process, or outer membrane of the tendon. The normal tendon collagen fibers are formed through self-cell proliferation and participate in the repair process. Therefore, the increasing of the endogenous healing can reduce the occurrence of adhesions (Boyer et al., 2005). How to increase endogenous healing of tendons, reduce exogenous healing of tendons, and thereby reduce tendon adhesion and the regulatory mechanism of endogenous healing of tendons has been a hot topic in scientific research in recent years.

5 CONCLUSION

As the thickest and most powerful tendon in the human body, the Achilles tendon located behind the ankle joint is one of the most prone tendons to rupture. Once Achilles tendon injury occurs, it will have a huge impact on the patient's quality of life. In the analysis of the etiology of Achilles tendon injury, especially Achilles tendon rupture, it is necessary to incorporate the concept and research methods of biomechanics. The conclusion of this study is that the diagnosis of Achilles tendon injury is mainly based on the update of imaging and ultrasound equipment, as well as new research and exploration conducted by doctors on the basis of new diagnostic equipment. The probability of Achilles tendon injury is related to the sports they engage in and different grades. Senior college students who engage in jumping and competitive sports have a higher probability of Achilles tendon injury. There are many reasons that can cause Achilles tendon injury, and improper exercise has the highest number of cases of accidental injury to the Achilles tendon. In real life, there are two mechanisms that can cause injury to patients: one is due to long-term long-distance running and jumping exercise, which leads to degenerative changes in the Achilles tendon, and the other is due to injury caused by sharp cutting or direct impact. The treatment of Achilles tendon rupture is mainly divided into two methods: conservative and surgical. Before treatment, patients should be fully informed of the advantages and disadvantages of both treatment methods, and the final decision should be based on the patient's specific factors and joint decision-making. In short, in the field of sports medicine, special attention and importance should be paid to the issue of Achilles tendon injuries in athletes engaged in athletics and ball sports during training and competition, and continuous research and improvement of treatment methods and effects for Achilles tendon injuries should be carried out.

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