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Overview of Achilles Tendon Injury Treatment

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Abstract. Achilles tendon rupture is a prevalent injury, particularly among middle-aged individuals who participate in high-demand athletics. This article reviews the anatomy, risk factors, diagnosis, and current treatment strategies for Achilles tendon rupture, with a focus on surgical and non-surgical approaches. The traditional open repair technique is still a widespread surgical approach that uses a large incision to reconnect the tendon directly. However, complications and infections may occur, so percutaneous or mini-open techniques can be changed depending on the patient's condition. Various suture techniques, such as Bunnell, Modified Kessler, and Tsuge, have been evaluated in clinical settings, with braided polyester sutures demonstrating superior biomechanical performance over monofilament polydioxanone sutures. Despite the effectiveness of surgical intervention, non-surgical treatment remains an option for specific patient populations, though it is associated with a slightly higher re-rupture rate. Postoperative rehabilitation is crucial for restoring function, with early weight-bearing and mechanical stimulation playing key roles in successful recovery.

Keywords: Achilles tendon, Diagnosis, treatment.

1. Introduction

The Achilles tendon (AT) is the largest, strongest, and thickest tendon in the human body, with a length of approximately 150 mm, a thickness of 5-7 mm, and a width of 20 mm. It is situated at the posterior aspect of the lower limb and is connected to the gastrocnemius muscle before attaching to the calcaneal tuberosity. The insertion of the tendon on the calcaneus is crescent-shaped, which is in alignment with the posterior calcaneal prominence. It is divided into several segments: the calcaneal insertion, pre-insertion site, intramuscular segment, and free tendinous region [1]. The heel fat pad (HFP) provides cushioning for the calcaneal insertion [2].

The AT transmits the force from the plantar flexor muscles, enabling efficient movement and stability. It can stretch up to 4% [3]. The elastic properties of the AT change with age, with younger individuals exhibiting lower stiffness and higher tensile stresses. Physical inactivity has been shown to negatively impact tendon characteristics [4]. The Achilles tendon is particularly susceptible to ruptures due to the substantial forces it is required to endure during a variety of activities.

There is a correlation between the expanding number of middle-aged men participating in high-demand sports and the increasing prevalence of Achilles tendon ruptures. In the United States, such ruptures commonly occur in basketball, while in Europe and Canada, they are more frequent in football [5].

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Histologically, tendons are composed of connective tissue, with Type I collagen making up over 90% of a healthy Achilles tendon [6]. In addition to Type III collagen, which supports tensile strength, Type VI collagen is distributed in the mid-tendon and fibrocartilage regions. Meanwhile, Type X collagen is primarily located in the mineralized sections of fibrocartilage and at the junction where the Achilles tendon connects to the calcaneus [7].

2. Symptoms and high-risk group/activity

Achilles tendon ruptures can be acute or chronic, with the latter being brought on by overuse injuries, inflammation, and degenerative changes in the tendon. Acute ruptures commonly affect physically active individuals, with 68% of such cases occurring in this group. These injuries often arise during sudden sprints or changes in direction during exercise. Prodromal symptoms, such as a 'pop' sensation or feeling as if being lifted, are frequently reported, particularly among elite athletes [8]. Patients may experience an inability to bear weight, weakness in ankle plantar flexion, bruising, and functional deficits [9].

Strong dorsiflexion forces applied to the ankle, combined with eccentric contractions of the gastrocnemius-soleus complex to plantarflex the ankle, usually cause the injury. Certain medications can also contribute to chronic Achilles tendon rupture. For instance, corticosteroid injections, while enhancing muscle mass and strength, may lead to vascular deformities and tendon degeneration, particularly when combined with intense training [10]. Additionally, conditions like gout, rheumatoid arthritis, ankylosing spondylitis, hyperthyroidism, renal failure, infections, and tumours can all lead to chronic tendon degeneration [5]. Inappropriate footwear, abrupt increases in exercise intensity, variations in training regimens, and changes in terrain or surfaces are other risk factors for Achilles tendon rupture [11].

3. Diagnosis

Physical examination can confirm Achilles tendon rupture and can be observed as increased dorsiflexion of the ankle, plantarflexion weakness, and significant defects in the area of the tear. Also, the Thompson test is performed by squeezing the posterior calf muscle and observing the foot's movement; a positive Thompson test is indicated when there is little or no plantar flexion of the foot relative to the contralateral leg. It should also be confirmed by history. As well as the knee flexion test is performed with the patient prone and the knee joint loose [12].

A further test is imaging. These include ultrasonography, magnetic resonance imaging (MRI) and X-rays. Ultrasonography is the most accurate way to diagnose a ruptured Achilles tendon. The location of the fracture can be accurately found to assist in preoperative planning [13]. MRI helps to visualise the problem of chronic tendon degeneration and distinguishing between partial or complete tears.

4. Treatment and prevention

Restoring the tendon's length and tension is the main objective of treatment for acute Achilles tendon rupture. Treatment options can be typically categorized into surgical and non-surgical approaches. The choice of regimen depends on the patient's age, health, doctor's preference and skills. Surgical treatment is being used more often. The tendon rupture probability after surgery is low, only 4% [14]. The heel elevation test is better to realize. Plantar flexion and endurance are particularly improved, and surgical repair is good [15]. However, there may be an increase in the rate of postoperative infection [16].

The traditional approach for treating Achilles tendon rupture typically involves an open surgical repair. A large incision is made along the posterior aspect of the lower leg to allow direct visualisation of the ruptured tendon and repair. The torn ends of the tendon are then meticulously reattached using sutures or other fixation methods to restore its structural integrity and strength, facilitating optimal healing and functional recovery. Patients typically experience a period of immobilisation after surgery, which is followed by a planned rehabilitation program designed to help them restore their strength and flexibility. Although this method is effective, it is associated with a longer recovery period and a higher risk of complications compared to minimally invasive techniques [17].

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There are many different approaches and material of setures to traditional open technologies, such as a bunnell, Kessler, and Krackow stitch, and their strength is similar [18]. Compared to normal Krackow sutures, alternative suture structures like the "gift box" or "three-bundle" approach have demonstrated better strength. The strength of the repaired tendon is closely related to the strength of the suture itself and the number of core strands [17].

The material of the sutures is also the focus of research, such as braided non-absorbable polyester (PE) and monofilament absorbable polydioxanone (PDS). In the experiment conducted by Dündar et al., two types of sutures were utilized to evaluate the surgical outcomes of three different suture techniques: Bunnell, Modified Kessler, and Tsuge. The findings indicated that, for the Tsuge and Modified Kessler techniques, braided polyester sutures demonstrated superior biomechanical performance compared to monofilament polydioxanone sutures [19]. Different suture methods have advantages and disadvantages, so choosing the technical solution according to the other patient conditions and the degree of Achilles tendon damage is necessary.

The standard technique that needs to be mentioned is the Bunnell suture, The conventional Bunnell technique is performed at the entry and exit points of the suture at 1.5 cm and 3 cm from the proximal tendon of the Achilles tendon rupture, and 2 cm from the distal ruptured Achilles tendon. Tension is applied after suture to close the gap, and the knot is tied to the distal Achilles tendon [19].

Jordan et al studied the Bunnell suture as well as its evolved suture, using cross-lock suture and suture pre-tensioning. Cross-lock Bunnell shows a good repair strength and proper pre-tension prevents the gap and Achilles tendon from lengthening. The results showed the effectiveness of this method over the conventional Bunnell suture [20].

The next two technologies belong minimally Invasive Surgery. The second technique is the mini-open technique, is widely utilized as it also reduces surgical complications and the risk of sural nerve injury. The Percutaneous Achilles Tendon Repair System (PARS) involves a small skin incision through which PARS instruments are introduced, using an external importer, the distal and proximal segments of the ruptured Achilles tendon are threaded laterally into three sutures and exited from the contralateral side. After that, remove the device and tying [17]. Maffulli et al. (2011) reported that elite athletes typically take about 4.8 months to fully recover from exercise post-PARS surgery [21].

The percutaneous technique is a minimally invasive procedure that minimises the morbidity and complications associated with open surgery and reduces infection and haematoma destruction in the injured area. However, it carries a higher risk of nerve injury, and in addition, the rate of tendon rupture in percutaneous repairs is higher than in open techniques. Percutaneous techniques use endoscopy and ultrasound to assist in surgery [22] (Pedowitz & Kirwan, 2013). Intraoperative ultrasonography is performed before repair to determine the course of the sural nerve, relying on the course of the saphenous vein, since the sural nerve is medial to the venule. Ultrasound is used to determine the inner and outer edges of the torn tendon. The ultrasound is repeated after the repair while the ankle is moved passively to see if the stump of the tendon is sufficiently contacted. These minimally invasive procedures can be used for patients with high demand and minimal adverse outcomes.

In 1977, Ma-Griffith's technique was first described for acute Achilles tendon rupture. This method is simple and can be done without special equipment, and it is known that it is still widely used today. Achilles tendon rupture repaired percutaneously has a minimal failure rate and minimal wound consequences [23].

Under local or general anaesthesia, the procedure is carried out while the patient is in a prone position. Once the site of the rupture is determined, a small puncture wound is created on the lateral and medial sides of the tendon using a 15-gauge blade in an area of about 2.54 cm proximal to the rupture site. Use a small, curved hemostat to insert through the wound and rotate 360 degrees to separate the skin and subcutaneous tissue from the tendon sheath. Adjust the free ends of both sides of the suture to equal lengths.

Use a straight needle and non-absorbable suture to transversely cross the maximum diameter of the Acta-less tendon from lateral to medial. The suture needle is then moved distally at a 45-degree angle through the tendon and exited from the opposite side of the rupture to form the medial and lateral

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foramen of the ankle. Before the needle is completely pulled out of the skin, use a hemostat and a 15-gauge blade to carefully enlarge the new puncture wound around the needle. Next, pull the end of the suture through the skin while applying traction to both suture ends to tighten the proximal portion of the suture.

Replace the straight needle with a curved needle before proceeding to the next step. In the lateral tendon, the curve cutting needle runs distally between the subcutaneous tissue and the tendon sheath through the lateral cutaneous foramen median. It then passes outward at the level of the middle of the distal segment of the ruptured tendon. Before the sutures are pulled across the skin, the subcutaneous tissue and tendon sheath are still separated using a curved hemostat. The sutures are then pulled out.

Replace The curve cutting needle with a straight needle on the lateral suture. The suture is then passed through the same enlarged lateral skin puncture hole and transversely through the tendon through the medial skin, with the transverse suture 1.25 cm from the distal end of the ruptured defect tendon. Before passing through the skin through the sutures, the area around the needle needs to be enlarged. Tighten the suture so that it fits the lateral aspect of the proximal and distal segments of the tendon.

The straight needle needs to be replaced with a curved needle again. Entering from the distal medial skin puncture hole and extending through the medial hole of the ankle, again requiring the use of hemostats and a 15-gauge blade to enlarge the surrounding space before the suture is extended. So far, both ends of the sutures are protruding from this skin puncture hole.

Pull the sutures at both ends in a criss-cross method so that the broken ends are close to the fit. Surgical knots are tied on the inside of the tendon to avoid damage to the sural nerve. Cut the excess sutures short and push the knot under the skin with a hemostat. A sterile dressing was used to cover the medial and lateral sides of the wound for a total of 6 small puncture wounds.

After the closure is completed, a non-weight-bearing cast is applied to the injured leg for 4 weeks, and the weight-bearing short leg cast is replaced for 4 weeks. This is followed by a toe raise and an Achilles tendon stretch for four weeks each [24].

Non-surgical treatment, while associated with a slightly higher re-rupture rate compared to surgical options, does not present risks of deep infection, scarring, or cranial nerve damage [25]. However, non-surgical treatment often results in calf atrophy and muscle weakness due to prolonged casting, extending the rehabilitation period, which can be particularly problematic for high-level athletes. A non-surgical approach is usually indicated for patients with systemic disease. It usually consists of using a non-weight-bearing cast or a controlled ankle motion (CAM) walking boot for six weeks, then transitioning to a weight-bearing cast or boot, with dorsiflexion gradually increasing.

Later rehabilitation is also important for tendon repair. After surgery, patients are first treated with a non-weight-bearing cast for six to eight weeks. But there is still a need for early restrictive movements. To accelerate functional recovery, four key principles should be established: mechanical stimulation of tendon fibers, early protected weight-bearing, functional support, and early limitation of range of motion. [22]. During the postoperative rehabilitation period, rehabilitation exercises are required to moderately exercise the muscles of the lower limbs. Helps with an early return to work and exercise, restoring normal muscle strength, functional levels and range of motion. After the wound has healed completely, the Achilles tendon needs to be massaged daily to avoid tendon adhesions.

From a preventive point of view, it is important to stretch well before exercising. Avoid strenuous exercise after a long period of inactivity, and gradually increase the intensity of exercise. Athletes need to avoid over-intensity training and set a recovery rest period. Wear appropriate and professional footwear when exercising. Athletes are advised to avoid Achilles tendon occlusion because long-term or frequent hormone occlusion therapy may cause thinning, degeneration, and increased risk of Achilles tendon rupture.

5. Conclusion

In conclusion, the treatment of Achilles tendon ruptures continues to progress, with both open and minimally invasive techniques showing specific advantages and limitations. The choice of the appropriate surgical approach should be tailored to the patient's clinical condition and activity level.

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Further studies are needed to refine these techniques and improve rehabilitation protocols, aiming to enhance functional recovery and reduce the recurrence risk.

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