ABSTRACT

Aim: To analyze the effectiveness of nonoperative modern management in patients with ruptured tendo-Achilles when compared with operative management.

Background: Ruptured tendo-Achilles is a common pathology presenting to the orthopedic department. It mostly occurs during spontaneous activity in active male patients between the age of 30 and 40. Traditional nonoperative management consisted of a period of nonweight-bearing in an equinus cast for 6 weeks. When comparing this nonoperative management regime with operative repair of tendo-Achilles ruptures, many studies found that rerupture rates increased, and peak strength decreased in the nonoperative group. We look at the results of nonoperative management when the accelerated functional rehabilitation protocol is used compared to operative management.

Review results: In a patient with a ruptured tendo-Achilles, employing nonoperative management using the accelerated functional rehabilitation protocol was comparable with operative management. In multiple high-level studies, both groups showed no difference in rerupture rates, peak strength, return to work, return to sport, patient satisfaction, range of movement, and clinical and functional outcome. One study demonstrated improved exercise at high velocity in the operative group in the short-term; however, the clinical significance of this is yet to be analyzed.

Conclusion: Operative management of ruptured tendo-Achilles carries risks that are difficult to manage, in particular wound breakdown requiring subsequent revision surgery and tendon transfers. It was previously proven that operative management had decreased rerupture rates and improved strength. It has now been proven that when using the accelerated functional rehabilitation protocol, results are comparable to the operative group, without going through the risks of surgery.

Clinical significance: Our group recommends strong consideration toward employing nonoperative management of ruptured tendo-Achilles using the accelerated functional rehabilitation protocol over operative management. Exceptions to consider are open injuries from lacerations, avulsion from the calcaneal attachment, or strong wishes from the patient, such as an elite athlete.

Keywords: Accelerated functional rehabilitation, Achilles tendon rupture, Acute tendo-Achilles rupture, Nonoperative.

BACKGROUND

Rupture of the tendo-Achilles is a common pathology presenting to the foot and ankle clinic. Patients tend to be fit and active, and are most commonly male aged between 30 years and 40 years of age. There is an incidence of around 18 in 100,000 per year and tend to occur within patients carrying out spontaneous, rather than continuous, exercise regimes — the so-called “weekend warriors.”

They can prove to be a difficult clinical diagnosis in the acute primary setting. A common scenario seen is a patient sustaining an injury to their ankle, thinking it was a sprain, and not seek medical advice hoping it will shortly improve. When seen by a primary care physician who may not be used to regular acute trauma in their practice, they may also mistake the injury as a simple sprain and initiate a physiotherapy regime without the diagnosis of a tendo-Achilles rupture. This misdiagnosis may cause missed ruptures in up to 25% of patients.

The mechanism of rupture tends to occur during a sporting activity with ballistic movements of the ankle joints. The commonest mechanism tends to be sudden resistance on a foot during forced plantar flexion, such as suddenly running from the back to the front of the court in badminton to chase a shot. A sudden dorsiflexion force on a plantarflexed foot is the next commonest mechanism. In our practice, a typical scenario is a patient playing football who suddenly feels they have been kicked in the back of the leg by another player, but when they turn around, no one is there. This awkward force on a foot that has taken a wrong step during strenuous sport leads to a rupture of the tendo-Achilles.

Historically, the tendency was to have a discussion with the patient who has sustained a tendo-Achilles rupture as to the advantages and disadvantages of surgery. Younger, more active patients would tend to go down the path of reconstruction. Older and less active patients with higher comorbidities would tend to have nonoperative treatment. Other factors would also play a role, such as the length of rupture gap visualized on ultrasound scanning. Nonoperative treatment would be 6–8 weeks nonweight-bearing in an equinus cast. However, it was thought that rerupture rates were increased, and muscle strength was decreased. This was offset by the risks of surgery, in particular wound infection as the scar site is in a delicate area.
Since the integration of the accelerated functional rehabilitation protocol, this has revolutionized the way in which ruptured tendon-Achilles is managed in all patients. Our group has adopted this method, and in this article we look to explore the nonoperative management of tendon-Achilles rupture in all patient groups, along with their outcomes.

Anatomy and Examination
The Achilles tendon is the largest tendon in the body formed by the combination of the soleus tendon, along with the medial and lateral gastrocnemius tendons. There is also a contribution from the plantaris tendon. The structure of the terminal gastro-soleus complex results in internally rotated fibers as it traverses distally. Fibers from gastrocnemius therefore attach to the outer aspect of the calcaneus, while the soleus contribution is more toward the midline. The Achilles tendon receives its blood supply from the recurrent branch of the posterior tibial artery, along with a direct blood supply from surrounding muscles. The tendon is at its narrowest 4 cm proximal to the insertion on the middle of the posterior calcaneum, and it is at this hypovascular watershed zone where the Achilles tendon is most susceptible to rupture. During normal locomotion it receives stresses of up to four times the body weight, while running can produce forces of up to eight times the body weight. As a result, the Achilles tendon takes repetitive microtrauma on a daily basis, and relies on constant repair and remodeling to withhold its normal physiological strength.

The Achilles tendon is superficial being covered only by fascia and skin, leaving it exposed to direct trauma. The subtendon space is filled with the adipose tissue and a bursa. The short saphenous vein and the sural nerve course along its border, leaving these structures susceptible to damage during surgical reconstruction. The Achilles tendon also contains strong proprioceptive fibers.

Examination will reveal a history of sudden weakness in the ankle and pain around the retrocalcaneal area, or over the tendon itself. It often assists diagnostic assessment by examining the patient prone on the examination couch. A palpable gap may be felt in the area of rupture along with increased resting ankle dorsiflexion compared to the contralateral side. There will be a positive Thompson test, in which squeezing the calf muscle at rest would not produce plantarflexion of the ankle as expected. Our group finds active plantarflexion of the foot to be an unreliable test due to the recruitment of the long toe flexors which also cross the ankle joint, and in some instances may even be strong against resistance with a present Achilles rupture leading to a false-positive result.

Our group find it reliable to ascertain the diagnosis based on clinical examination. If uncertain, our imaging of choice is ultrasound guidance to ascertain the complete and partial tears. In more chronic cases with calf muscle atrophy, magnetic resonance imaging (MRI) may prove useful in diagnostic uncertainties.

Risk Factors
A snapping sound along with a sharp pain is felt in the tendon upon violent exertion. Patients tend to have had a prodrome of tendonitis symptoms on further questioning. Risk factors for rupturing of the Achilles tendon include intrinsic and extrinsic factors.

Intrinsic
Tendonitis, tight calf muscles, tibia varum, cavus foot, overpronation, inflammatory arthropathy, poor vasculature.

Extrinsic
Poor exercise technique, fluoroquinolone, steroids.

Treatment of Achilles Tendon Ruptures
In more modern management, the treatment of Achilles tendon ruptures has stimulated significant debates and controversy regarding operative vs nonoperative pathways. As mentioned, discussions were had with patients and those who were younger and more active were in favor of operative treatment, while those of increasing age and comorbidities were in favor of nonoperative management. Several studies have compared operative and nonoperative management of Achilles tendon ruptures. One of the most referenced literature articles by Cetti et al. carried out a prospective, randomized study comparing both treatments. It was found that rerupture rates in the nonoperative group was 13% compared to 5% in the operative group. They also concluded that the nonoperative group had weaker calf muscle strength, slower return to sport, and decreased functional outcomes compared to the operative group. More evidence based on similar methodology also reproduced similar results, favoring operative management in the above categories. This led to a fairly accurate conversation with patients toward the advantages and disadvantages of surgery, making the decision much easier for select patients on which route to take. As a result, a more robust evidence-based argument was in favor of surgery.

What we stress, however, is that in these studies, the nonoperative management consisted of nonweight-bearing in an equinus cast for 6–8 weeks. Once this period was complete, gentle physiotherapy would then start. However, when patients were operated on, rehabilitation began quicker. This prolonged period of immobilization would logically result in calf muscle atrophy and difficulty in stimulating tendon healing, thus resulting in poor functional outcomes.

The advent of the accelerated functional rehabilitation protocol in patients with Achilles tendon ruptures has revolutionized the way rupture of the Achilles tendons are managed. The functional rehabilitation protocol focuses on stimulating tendon healing early in the treatment pathway of nonoperative patients (Table 1).

Extrinsic
Poor exercise technique, fluoroquinolone, steroids.

Intrinsic
Tendonitis, tight calf muscles, tibia varum, cavus foot, overpronation, inflammatory arthropathy, poor vasculature.

Table 1: Timeline showing standardized accelerated functional rehabilitation protocol used for ruptured tendon-Achilles

| Accelerated functional rehabilitation protocol | 0–2 weeks | 2–6 weeks | 6–8 weeks | 8–12 weeks | >12 weeks |
|-----------------------------------------------|-----------|-----------|-----------|------------|----------|
| 0–2 weeks | Nonweight-bear in equinus cast | Aircast boot with five wedges (2 cm heel lift) | Remove one wedge per week | Weight-bear as tolerated with crutches | Active plantar and dorsiflexion to neutral |
| 2–6 weeks | Gradual, slow stretches | Proprionception training | Weight-bear in aircast boot with no wedges (ankle at 90°) | Gradual, slow stretches | Proprionception training |
| 6–8 weeks | Gradual, slow stretches | Proprionception training | Weight-bear out of boot | Physiotherapy to increase range of movement, strength, and propriocception | Continue physiotherapy training |
| 8–12 weeks | Continue physiotherapy training | Begin resistance training | Physiotherapy to increase range of movement, strength, and propriocception | Sport-specific retraining | Continue physiotherapy training |
Willits et al. carried out a randomized control study analyzing 144 patients with acute Achilles tendon ruptures. A total of 72 patients were randomized to surgical reconstruction, and 72 were randomized to nonoperative treatment using the accelerated functional rehabilitation protocol. Results were followed up for 2 years. This study was novel as it was the first high-level randomized control trial to use the accelerated functional rehabilitation protocol as nonoperative treatment in comparison to surgical management, as opposed to nonweight-bearing in a cast for 6–8 weeks as per previous studies. The operative group received the same accelerated functional rehabilitation protocol as the nonoperative group.

Willits et al. found that between the two groups, there were no statistically significant differences in rerupture rates, plantarflexion strength, dorsiflexion strength, calf circumference, pain, failure to heal, and functional outcomes at 12 months and 24 months. The only benefit observed in the operative group over the nonoperative group was improved plantarflexion strength at high-velocity testing. However, this difference was only small and its clinical relevance is uncertain. Plantarflexion strength at lower to middle velocities was statistically comparable (80% of the contralateral side), and dorsiflexion strength was equal at all velocities (100% of the contralateral side) in both operative and nonoperative groups.

There was an increase in complications in the operative group (18%) compared to the nonoperative group (8%), which consisted of a greater number of skin issues in the operative group. These included superficial wound infection, hypertrophic scar, Achilles tendon tethered to skin, skin sinus, deep infection following revision reconstruction, and pulmonary embolus.

**Biology of Tendon Healing**

When assessing both operative and nonoperative management, tendon healing occurs in three main phases (Table 2): hemorrhagic/inflammatory, proliferative, and remodeling. During the hemorrhagic/inflammatory phase, hematoma is formed, subsequently recruiting polymorphonuclear cells, macrophages, and fibroblasts. This process takes 0–2 weeks and is the period the patient is nonweight-bearing in an equinus cast so as to keep the tendon ends opposed and avoid disruption to the blood clot. The proliferative phase results in angiogenesis, with the predominant connective tissue being type III collagen, which transforms the healing tissue from viscous to elastic. This phase takes place 2–4 weeks post injury, and it is the time patients begin to weight bear in a boot. The remodeling phase can then take up to 2 years. It is during this period type III collagen is slowly converted to type I collagen, where matrix reorganization results in physiological alignment of the tendon fibers. Loading exercises take place during this time period.

Animal studies have assessed the effect immobilization has on tendon healing. Prolonged periods of immobilization have been seen to result in decreased strength, increased stiffness, increased tissue metabolism, increased immature collagen, and decreased quality of cross-links between collagen. With respect to the theory behind the accelerated functional rehabilitation protocol, the Wolff’s law for tissue regeneration states that tissue will remodel in response to mechanical load, so-called “form follows function.” Therefore, controlled movement and loading the tendon increases tensile strength. Collagen and prostaglandin synthesis is stimulated, promoting proper physiological collagen fiber orientation.

**Discussion**

Since the introduction of the accelerated functional rehabilitation protocol, several studies have supported the use of nonoperative management in the patient with a ruptured Achilles tendon over operative management. The recent and more modern evidence favors nonoperative management as there is no statistically significant outcome in the rerupture rate and calf strength in both groups. However, the operative group carries the risk of catastrophic complications such as Flexor Hallucis Longus transfers, prolonged antibiotics, and a deterioration in the functional outcome.

A single-center randomized control trial by Olsson et al. analyzed rerupture rates, physical activity levels, and patient-reported outcomes between operative and nonoperative management. The primary outcome was to analyze the achilles tendon total rupture score (ATRS). It was found ATRS scores significantly improved with both groups at 3, 6, and 12 months, and showed no statistically significant difference between the two groups. The physical activity scale (PAS) showed no statistically significant difference between the groups. Activity of daily living (ADL) subscores and foot and ankle outcome scores (FAOS) were also comparable with no significant difference. The quality of life was measured by the EQ-5D and found it was significantly decreased in both operative and nonoperative groups at 12 months; however, there was no difference between the groups at that time point. Power and strength were slightly improved in the operative group at earlier stages of rehab; however they were not statistically different at the 12 months mark. Interestingly, patients who went on to having a rerupture and subsequent reconstruction showed no difference in outcome at 12 months compared to those with primary ruptures who had gone on to healing.

One of the largest systematic reviews and meta-analyses carried out on the topic by Van Der Meijsen et al. looked at 29 studies that encompassed 15,862 patients. Two sets of data were looked at and compared. The first was the outcome of operative vs nonoperative management of Achilles tendon ruptures where the traditional nonoperative management was carried out (6–8 weeks nonweight-bearing in cast). The second was the outcome of operative vs nonoperative management.
nonoperative management where early functional rehabilitation and early mobilization were carried out. There was a significantly lower rerupture rate in the operative group when compared to nonoperative patients who were treated with nonweight-bearing in a cast for 6–8 weeks (28 studies; RR = 0.43 [95% CI 0.31, 0.60], p < 0.001). However, when comparing operative to nonoperative using the accelerated functional rehabilitation protocol, there was no statistically significant difference in rerupture rates between the two groups (6 studies; RR = 0.60 [95% CI 0.26, 1.37], p = 0.23). Throughout both groups, complication rates were significantly higher in the operative groups compared to nonoperative groups (24 studies; RR = 2.76 [95% CI 1.84, 4.13], p < 0.001). There was no significant difference in functional outcomes, return to sport, and return to work in both groups when early weight-bearing was used.8

The strict use of the accelerated functional rehabilitation protocol in nonoperative patients is not the specific regime needed in order to achieve comparable outcomes to the operative group. The idea of early mobilization over prolonged immobilization will help in reported outcomes. Twaddle et al. carried out a prospective randomized control study comparing operative vs nonoperative management with early mobilization. Both groups received the same early mobilization regime. No significant difference was observed in calf circumference, plantarflexion strength, dorsiflexion strength, and the musculoskeletal functional assessment instrument (MFAI) at 8 weeks, 12 weeks, 6 months, and 1 year. No significant difference was found between the two groups with regards to rerupture rates and further complications.9

Barfod et al. carried out a single-blinded (assessor) randomized control study comparing early weight-bearing and immobilization in the treatment of nonoperative patients. Interestingly, no significant difference was found between the two groups with regards to strength and stiffness at 12 months.10 Rerupture rates were not analyzed, only the recovery on ankle biomechanics.

Conclusion

Based on the literature, our group recommends strong consideration toward treating Achilles tendon ruptures nonoperatively with the accelerated functional rehabilitation protocol. A discussion is to be had with the patient with regards to the advantages and disadvantages of both treatments, and a decision to be made together. Treating patients nonoperatively must take place in patients who have presented to the department no longer than 48 hours post injury and immediately placed in an equinus cast. If the first presentation is after 48 hours, then depending on the individual patient, we advocate surgical repair. The thought process behind this is that the hematoma around the rupture site is disturbed following a prolonged period of mobilization, therefore potentially worsening the outcome in nonoperative management. By treating patients nonoperatively with the accelerated functional rehabilitation protocol, rerupture rates are equal, as is strength, return to work, return to sport, range of movement, and functional outcomes. Surgical management carries the same success rate; however it has the significant increased risk of complications, in particular, wound infections requiring further surgeries.

Consideration toward surgical management could be advocated in certain, rarer, circumstances. If a patient was to have an avulsion of the Achilles tendon off the calcaneal attachment, rather than an intrasubstance tear, then surgery is recommended. It has been shown that there are earlier improvements in higher velocity exercises in the operative group, therefore surgery could be considered in elite athletes who wish for a possibility of earlier return to high-velocity sports. The clinical significance of this improvement is however yet to be analyzed. Open injuries to Achilles tendons, where lacerations have occurred, should also be considered for repair due to the nature of the injury. Last, if a patient has strong wishes for surgical repair, such as a very good outcome following a contralateral repair, then surgery may also be considered.

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