

## Management of achilles tendon injury: A current concepts systematic review

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### Abstract

Achilles tendon rupture has been on the rise over recent years due to a variety of reasons. It is a debilitating injury with a protracted and sometimes incomplete recovery. Management strategy is a controversial topic and evidence supporting a definite approach is limited. Opinion is divided

between surgical repair and conservative immobilisation in conjunction with functional orthoses. A systematic search of the literature was performed. Pubmed, Medline and EmBase databases were searched for Achilles tendon and a variety of synonymous terms. A recent wealth of reporting suggests that conservative regimens with early weight bearing or mobilisation have equivalent or improved rates of re-rupture to operative regimes. The application of dynamic ultrasound assessment of tendon gap may prove crucial in minimising re-rupture and improving outcomes. Studies employing functional assessments have found equivalent function between operative and conservative treatments. However, no specific tests in peak power, push off strength or athletic performance have been reported and whether an advantage in operative treatment exists remains undetermined.

**Key words:** Orthopaedic surgery; Achilles tendon injury; Sports injury; Tendon rupture; Conservative management

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**Core tip:** Achilles tendon rupture is a common injury. Simmonds or Thomas' test is a reliable diagnostic tool with a sensitivity of between 0.89-0.93. Studies have not shown conclusive superiority of operative repair compared with non-operative and casting techniques. Non-operative management has a more favourable complication profile. There is emerging evidence that the traditional perception that non-operative management is associated with higher re-rupture rates no longer holds true for the new management strategies which assess tendon gap and use a dedicated "Achilles tendon management infrastructure". It is important that clinicians can recognize the injury and delayed diagnosis can lead to significant morbidity.

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## INTRODUCTION

The Achilles tendon is the most frequently ruptured tendon in the human body<sup>[1]</sup>. The incidence of rupture is on the rise and has been so since the 1980s. The yearly incidence of Achilles tendon rupture is rising and reported as 4.7/100000 in 1981 to 6/100000 in 1994 from a Scottish cohort, and 22.1/100000 in 1991 to 32.6/100000 in 2002 from a Danish cohort. The most rapid increase was noted in the male 30 to 39 age group<sup>[1,2]</sup>. The most hazardous sport appears to be badminton with 83% occurring in males. The mean age of presentation is 35 years with a male:female ratio of 20:1<sup>[3,4]</sup>. The classical patient is the novice sportsmen in his fourth decade engaging in unaccustomed sport.

The commonest site of rupture is in a region 3 to 6 cm above the os calcis which corresponds to a watershed region of poor vascularisation<sup>[5]</sup>. Perfusion in this region is further compromised during stretching and contraction<sup>[6,7]</sup>. With increasing age there is decreased collagen-crosslinking and weakening of the tensile strength of the tendon. Maffulli *et al*<sup>[8]</sup> and Järvinen *et al*<sup>[9]</sup> histologically observed significant collagen degeneration in patients with Achilles tendon rupture. Ruptured Achilles tendon have histologically demonstrated collagen degeneration with a greater content of collagen III and less collagen I<sup>[8,9]</sup>.

Both oral and intratendinous injection of steroids have been implicated in spontaneous tendon rupture<sup>[10]</sup>. Other risk factors for rupture of the Achilles tendon include steroid therapy, hypercholesterolemia, gout, rheumatoid arthritis, long-term dialysis, and renal transplantation<sup>[2,11-15]</sup>.

## PRESENTATION

The patient typically presents with pain, inability to weight bear and a clear popping sensation or sound after an episode of activity during which they sustain a forced dorsiflexion of the ankle. The injury can also be sustained during eccentric contraction. The patient frequently describes the sensation of being kicked, shot or even bitten on the back of the heel.

Acute Achilles tendon rupture can readily be detected on physical examination. Plantarflexion of the foot is understandably weak<sup>[16]</sup>. The Achilles tendon is best examined with the patient kneeling and the feet hanging over the edge of the chair. In this position soft tissues hang off the Achilles tendon like a tent ridge pole and defects can be readily visualised (Figure 1). There is frequently a visible defect in the Achilles tendon. This is accompanied by swelling due to peritendinous haemotoma.

The defect in the Achilles tendon is typically palpable with a sensitivity of 0.71 and specificity of 0.89. Maffulli compared the sensitivity and specificity of the principal clinical tests designed to determine Achilles tendon rupture<sup>[17]</sup>. Specific tests include Simmonds or Thompsons' test with sensitivity of 0.98 and specificity of 0.93. Lesser known are the O'Brien and Copeland tests both with a sensitivities of 0.8. Early reports suggest that up to 20% of Achilles tendon injuries can be missed by clinical assessment alone<sup>[18]</sup>.

## RADIOLOGY

In patients with equivocal clinical signs diagnostic imaging is required.

Ultrasound is readily available, cheap, non-invasive but user dependant. Ultrasound has a diagnostic reported sensitivity, specificity and accuracy of 100%, 89.9% and 94.4% respectively<sup>[19]</sup>.

It can discriminate between partial and complete tears except those located at the proximal pole or musculotendinous junction of the tendon where sensitivity and specificity drop to 0.5 and 0.81 respectively<sup>[20]</sup>. An additional advantage in ultrasound in the dynamic observation of tendon gaps which have been shown to correlate strongly with those observed during operative repair<sup>[21]</sup>. Some authors argue that if the gap between the tendon ends is greater than 5 mm as assessed by ultrasound in full equinus than surgical intervention is indicated<sup>[22]</sup>.

Magnetic resonance imaging remains the gold standard for the diagnosis of the Achilles tendon rupture with a sensitivity of 100% and a specificity of 0.03<sup>[23]</sup>.

## TREATMENT

There is a dichotomy of therapeutic options: operative and conservative. Both are accepted forms of management for acute rupture and the optimal regimen remains contentious. The article discusses cases of acute tendoachilles rupture. In cases of delayed diagnosis the likely success of conservative management may be limited by a lack of apposition of the tendon ends due to scarring and retraction. Therefore, surgical repair is advocated<sup>[24]</sup>. Cases of chronic rupture of the tendoachilles by their very nature will not respond to conservative treatment and therefore will require repair utilising graft<sup>[25]</sup>.

### Conservative

The aim of non-operative means of treatment is to restore and maintain contact between the two ends of the ruptured Achilles tendon to facilitate healing. Conservative treatment regimens vary greatly but commonly involve immobilisation with rigid casting or functional bracing. The foot is initially placed in full equinus (30° namely full plantarflexion). The foot is then brought into neutral sequentially over a period of 8-12 wk. Once ankle position



**Figure 1** View of the right and left Achilles tendon with the patient prone. The left is ruptured. The right Achilles tendon is well defined and soft tissues hang off it like a tent. The suspension of the soft tissues off the Achilles tendon is not visible on the left side as the tendon is ruptured.

permits it, weight bearing is allowed. There is currently no clinical consensus on whether the cast should extend above the knee or if a below knee cast is sufficient. The above knee plaster is applied with the knee in slight flexion which serves to defunction gastrocnemius, having an origin over the posterior aspect of the femora condyles. However, one study shows the position of the knee does not influence gap between the torn ends of the Achilles tendon<sup>[26]</sup>.

Little evidence exists to recommend one regimen over another. The current evidence is summarised in Table 1. These studies demonstrate that patients can be allowed to weight-bear early in an off-the-shelf orthosis/CAM walker/Sheffield splint with no detriment in any long term outcomes<sup>[27,28]</sup>. This has obvious practical advantages compared to the traditional treatment of prolonged non weight-bearing in a below knee equinus cast. This is particularly true for frail or elderly patients where non-operative treatment tends to be preferred. Petersen *et al* also suggest that this may actually decrease the risk of re-rupture although this was not found to be significant ( $P = 0.066$ ). Saleh *et al*<sup>[29]</sup> also suggested that their splint allowed patients to regain mobility significantly more quickly and that patients preferred the splint to the cast. These findings are in keeping with the literature on operatively managed acute Achilles tendon ruptures which suggests that early weight bearing and mobilisation improve outcomes.

Newer splints for immobilisation have been developed with encouraging initial results. The Vacoped© is a cast in which the patient's ankle is supported by an air cushion which is then inflated. The cushion is encased in a robust shell. The design of the cast allows the degree of equinus to be dialled from 30° (full) to 15° (mid) and 0° (neutral). In addition there is latch which allows users the facility to perform a restricted range (-10°-10°) of plantar and dorsiflexion. The Vacoped regimen recommends 2 wk in full equinus followed by a further 2 wk in partial equinus. Then the ankle is held in neutral for 1 wk and then restricted (10°) dorsi- plantar flexion for the final week.



**Figure 2** Achilles tendon repair with plantaris tendon reinforcement.

The Vacoped allows the patient to touch weight bear for two weeks, and partial weight bear from for one week after that. Full weight-bearing is commenced at 3 wk<sup>[30]</sup>. In addition the periodic insufflations and deflation of air facilitates venous drainage theoretically reducing the risk of deep vein thrombosis. Furthermore, the support is buoyant and supple avoiding the risk of pressure areas.

### Operative

There are a variety of approaches to the surgical management of this injury. Contention exists over the surgical approach (open or percutaneous), suture repair method and suture type.

In addition to isolated direct tendon repair, various means of augmentation of the tendon have been described. Gastrocnemius augmentation involves raising a flap 2 cm wide by 8 cm long which is reflected across the repair and sutured. The Plantaris tendon can also be used (Figure 2). It is either weaved around the tendon or may be expanded into a membrane which is sutured around the repair. The evidence supporting augmentation is weak. Pajala *et al*<sup>[31]</sup> performed a large prospective study of tendoachilles repair and found no benefits between augmented and simple end-to-end repair.

Percutaneous repair has been described involving minimally invasive stab incisions on the medial and lateral aspect of Achilles tendon and a suture passer. Reduced infection rates have been shown compared to open repair<sup>[32]</sup>. Increased rates of Sural nerve injury have been demonstrated with this technique<sup>[33]</sup>.

Patient factors have been demonstrated to influence post-operative wound breakdown and infection rates. These included diabetes mellitus, steroid therapy, smoking and rheumatoid disease<sup>[34]</sup>.

**Post-operative regime:** Postoperatively the patient can progressively increase the extent of weightbearing. Typically, at 6 wk the patient commences active and assisted movement of the ankle. Isokinetic strengthening is commenced 2 to 4 wk. The patient can usually expect full strength and endurance 4 mo after surgery. Although

Table 1 Summary of evidence for non-operative management of acute tendo-achilles rupture

Ref.	Patient group	Study type (level of evidence)	Outcomes	Key results	Study weaknesses
Costa <i>et al</i> <sup>[27]</sup>	48 adult patients with acute achilles tendon rupture who chose to have non-operative treatment. Randomised to either six weeks in an off-the-shelf, carbon-fibre orthosis with three 1.5 cm heel raises that were encouraged to mobilise fully weight-bearing and move the ankle within the orthosis (trial group) or to six weeks in a below knee gravity equinus cast that were non weight-bearing (control group). This was followed by serial removal of heel raises or casting in increasing dorsiflexion over 6 further weeks. Immobilisation was discontinued at 12 wk. Reviews at 3, 6 and 12 mo	PRCT	<p>Numbers returning to sport</p> <p>Time to return to normal activities</p> <p>EuroQol health status questionnaire- EQoL</p> <p>Domain EuroQol health status questionnaire- E5D</p> <p>Domain Deficit in calf diameter in mm</p> <p>Loss of movement in degrees</p> <p>Deficit in total concentric and eccentric work</p> <p>Complications</p>	<p>No significant difference found (<math>P = 1.0</math>); 56% trial group <i>vs</i> 52% control group</p> <p>No significant differences found. Sport- (<math>P = 0.631</math>) 18 wk trial group <i>vs</i> 21 wk control group. Walking- (<math>P = 0.765</math>) 16 wk trial group <i>vs</i> 22 wk control group. Stair climbing- (<math>P = 0.484</math>) 16 wk trial group <i>vs</i> 22 wk control group. Work- (<math>P = 0.370</math>) 13 wk trial group <i>vs</i> 17 wk control group</p> <p>No significant differences found. 3 mo- (<math>P = 0.372</math>) 80 trial group <i>vs</i> 85 control group. 6 mo (<math>P = 0.598</math>) 89 trial group <i>vs</i> 88 control group. 12 mo- (<math>P = 0.122</math>) 85 trial group <i>vs</i> 91 control group</p> <p>No significant differences found. 3 mo- (<math>P = 0.450</math>) 0.73 trial group <i>vs</i> 0.69 control group. 6 mo- (<math>P = 0.810</math>) 0.80 trial group <i>vs</i> 0.80 control group. 12 mo- (<math>P = 0.888</math>) 0.85 trial group <i>vs</i> 0.85 control group</p> <p>No significant difference found (<math>P = 0.634</math>). 1.37 trial group <i>vs</i> 1.11 control group</p> <p>No significant differences found. Dorsiflexion (<math>P = 0.879</math>) -0.7 trial group <i>vs</i> 0.27 control group. Plantarflexion (<math>P = 0.248</math>) 4.13 trial group <i>vs</i> 7.27 control group</p> <p>No significant differences found</p>	<p>Of the original 48 patients only 40 were available for review at one year. All patients who presented out of hours were initially placed in below-knee equinus plaster backslab</p>
Peterson <i>et al</i> <sup>[28]</sup>	50 adult patients with acute achilles tendon ruptures. Randomised to either a CAM walker and were encouraged to weight bear (trial group) or to a below knee full equinus cast and were non-weight bearing (control group). Both groups were immobilised for 8 wk. Reviews at 4 and 12 mo	PRCT	<p>Re-rupture rate</p>	<p>1 re-rupture in trial group <i>vs</i> 1 re-rupture, 1 failure of tendon healing and 1 PE in control group</p> <p>No significant difference found (<math>P = 0.066</math>) but suggestive of a trend towards increased re-rupture in the control group. The risk of a type II error was 44% and it was thought likely that should the numbers of patients recruited have been larger this may have become a significant difference. 0% trial group, <i>vs</i> 17% control group</p> <p>No significant difference</p> <p>No significant difference found at 3, 6 or 12 mo</p> <p>No significant difference found at 3, 6 or 12 mo</p> <p>Significantly more in trial group at 3, 6 and 12 mo (<math>P &lt; 0.001</math>)</p> <p>Significantly quicker in trial group (<math>P &lt; 0.001</math>). 6 wk trial group <i>vs</i> 11 wk control group</p> <p>Significantly quicker in trial group (<math>P &lt; 0.001</math>). 9 wk trial group <i>vs</i> 15 wk control group</p> <p>1 re-rupture in each group</p> <p>All patients in the trial group preferred the time spent in the Sheffield splint to the time spent in the cast</p>	<p>Number lost to follow-up: 8. Length of time between injury and treatment not stated although delayed presentations were excluded</p> <p>Randomisation method not stated</p>
Saleh <i>et al</i> <sup>[29]</sup>	40 adult patients with acute achilles tendon ruptures. Randomised to either a below knee full equinus cast for 2 wk followed by a mid equinus cast for 1 wk and then controlled early mobilisation in a Sheffield splint with full weight-bearing (trial group) or to a full-leg cast, with the ankle in full equinus, for four weeks, followed by two weeks in a below-knee cast with the ankle in mid-equinus, and then two more weeks with the ankle in the neutral position with weight-bearing allowed during the final two weeks only (control group). Review at 3, 6 and 12 mo. The Sheffield splint is an ankle-foot orthosis which holds the ankle at 15 degrees of plantar flexion, but allows some movement at the metatarsophalangeal joints. The orthosis is used in conjunction with an insole within an extra-depth shoe. It is removed to allow controlled movement during physiotherapy	PRCT	<p>Patient satisfaction</p> <p>Strength of plantar flexion</p> <p>Range of plantar flexion (degrees)</p> <p>Range of dorsiflexion (degrees)</p> <p>Time to walking indoors</p> <p>Time to walking outdoors</p> <p>Complications</p> <p>Patient preference</p>	<p>No significant difference found at 3, 6 or 12 mo</p> <p>No significant difference found at 3, 6 or 12 mo</p> <p>Significantly more in trial group at 3, 6 and 12 mo (<math>P &lt; 0.001</math>)</p> <p>Significantly quicker in trial group (<math>P &lt; 0.001</math>). 6 wk trial group <i>vs</i> 11 wk control group</p> <p>Significantly quicker in trial group (<math>P &lt; 0.001</math>). 9 wk trial group <i>vs</i> 15 wk control group</p> <p>1 re-rupture in each group</p> <p>All patients in the trial group preferred the time spent in the Sheffield splint to the time spent in the cast</p>	<p>Number lost to follow-up: 8. Length of time between injury and treatment not stated although delayed presentations were excluded</p> <p>Randomisation method not stated</p>

this represents the standard post-operative regimen, the optimum post-operative rehabilitation remains to be determined. Suchak *et al*<sup>[35]</sup> explored the effect of early weight bearing at 2 wk vs weight bearing at 6 wk in their randomised controlled trial. They observed that early weight-bearing had statistically significant improvement in quality of life indices (such as social functioning), vitality scores and physical functioning<sup>[35]</sup>. However, by 6 mo postoperatively there was no difference in the groups. Other sources of clinical controversy include post-operative early mobilisation versus rigid immobilisation for 6 wk. Kangas *et al*<sup>[36]</sup> explored this in a randomised controlled trial. They reported that early mobilisation was associated with improved isokinetic calf strength at 60 wk. The re-rupture rate was higher in the immobilisation cohort. However, the difference did not reach statistical significance<sup>[36]</sup>. Mortenson's group observed that patients who were allowed to perform early restricted motion had a shorter rehabilitation time when compared to a below knee cast for 8 wk<sup>[37]</sup>.

### **Conservative or operative: which is better?**

No published studies conclusively demonstrate the definitive superiority of one modality over another. Meta-analyses of studies have shown that the re-rupture rates are higher in cases of non-operative management: 13% for conservative management compared with 4% for surgically repaired Achilles tendons<sup>[31,38]</sup>. Meta-analyses report a re-rupture rate of 2% for percutaneous reparative techniques.

Tendon elongation and weaker plantar flexion are also associated with non-operative management. However, recent studies suggest that these benefits of operative repair over conservative management in plaster are only short-lived. Keating and collaborators in the recent prospective randomised trial found that operative repair was associated initially with increased range of ankle movement and plantarflexion power when compared with cast management<sup>[39]</sup>. However by 26 wk there was no difference between the two groups.

Plaster or simple immobilisation alone avoids the inherent risks of surgery. These include wound infection (4%), fistula formation, skin necrosis, suture granuloma and damage to the sural nerve<sup>[31,37]</sup>. The skin necrosis can result in significant morbidity and require extensive plastic soft tissue procedures to ensure coverage of the tendon. Operative repair is associated with more rapid rehabilitation and return to work.

Percutaneous operative techniques have been found to have a complication profile superior to that of both conservative and open operative techniques. Meta-analysis report a re-rupture rate of 2%<sup>[31,37]</sup>. Studies involving functional bracing suggest that the disparity between surgical and conservative management may not be as marked as originally suspected. More recent studies show that re-rupture rates in patients treated operatively vs functional bracing are comparative<sup>[19,40-42]</sup>. In a recent study the result of percutaneous operative

management were compared with those achieved by functional bracing using the Vacoped. Investigators found that the incidence of re-rupture to be 3.9% for percutaneous repair and 3.4% for functional bracing with the Vacoped<sup>[43]</sup>. The difference did not reach statistical significance. The Vacoped allows early weight-bearing. The protective effect of early weight-bearing appears to be reproduced when patients are allowed early ankle movements. A recent prospective randomised controlled trial observed no difference in rupture rates between operative and non-operatively managed Achilles tendon rupture when both groups are permitted early movement in a functional brace<sup>[29]</sup>.

Assessment of the gap between the ends of the tendon as determined by magnetic resonance imaging or ultrasound may influence re-rupture rates in patients managed conservatively. Kotnis *et al*<sup>[22]</sup> elected to manage conservatively only those patients whose gap in full equinus was less than 5 mm. All others were managed operatively. They observed no statistically significant difference in re-rupture rates between the groups<sup>[22]</sup>. Wallace *et al*<sup>[44]</sup> based in Belfast, Ireland and Sheffield, United Kingdom studied 875 non-operatively treated Achilles tendon ruptures. The decision to manage patients non-operatively was based on the presence of opposition of the tendon ends on dorsiflexion. The observed re-rupture rate was 2.9%. A recent series studied by the Swansea and Maudsley group used a protocol of dynamic ultrasound and a tendon gap of less than 1 cm in full equinus. Furthermore, a dedicated clinic and service was established to treat and rehabilitate the patients. They found only a single case of re-rupture (< 1%) in 151 conservatively treated patients since 2008. This was comparable to the single case in the operative group of 63 patients<sup>[45]</sup>. In two of these series the re-rupture rate is superior to any anything achieved in a published operative series.

In Wallace's published series of excellent non-operative results patients were managed in a dedicated "Tendo Achilles" clinic. Patients were placed in an equinus non-weight bearing cast for the first four weeks. For the next four weeks they were placed in a pneumatic walker with heel-raises, which were sequentially removed over a period of 4 wk. The combined time in the equinus cast and boot walker was 8 wk. After this patients engaged in a specialist physiotherapy programme involving gait training, strength and mobility training. Final assessment and discharge was at 14 wk from injury or 6 wk from the time of removing the walking boot. It is uncertain how much the dedicated Achilles tendon clinic contributed to the favourable outcome. Patients were attended to by a specialist physiotherapist and were only discharged when the latter deemed that ankle strength was satisfactory.

Some authors would argue the merits of operative intervention in high performing athletes. The rationale for this argument is the potential loss of power or push

off strength with conservative management which is lessened by operative repair. The most recent studies quoted using specific treatment and rehabilitation regimes do not identify a functional benefit to operative repair. It is possible that the cohort may not reflect the athlete group. Furthermore, the measurement tools and assessments may not be sensitive enough to detect a deficit at the high functioning sporting level. For this reason the authors would exercise caution in treating this cohort as it is difficult to draw definitive conclusions.

## CONCLUSION

Tendoachilles rupture causes significant burden. Recovery is slow and potentially incomplete. Simmonds is a sensitive and reliable test. Avoiding missed diagnosis is imperative in good outcome. Both MRI and Ultrasound have potential diagnostic value. The argument of conservative vs operative treatment will no doubt continue; evidence is beginning to shift towards underpinning the benefits of non-operative treatment. Tendon gap assessment may be an important tool in deciding treatment modality. Intensive and specific post-operative regimes are being employed with seemingly positive results. The relative impacts of these factors in not known but certainly it has been demonstrated that favourable re-rupture rates are achievable in the non-operative group.

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