Protocol for Functional Rehabilitation of Achilles Tendon Ruptures

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KEYWORDS

• Achilles tendon rupture • Nonoperative treatment • Functional rehabilitation
• SMART protocol • Conservative management • Rerupture rate

KEY POINTS

- Nonoperative Management of Achilles Tendon Ruptures with accelerated functional rehabilitation, demonstrates equivalent rerupture rates and functional outcomes to surgical treatment.
- Structured Functional Rehabilitation Protocols, such as SMART and LAMP, emphasize early weight-bearing, controlled immobilization, and progressive rehabilitation, which optimize tendon healing and mitigate complications.
- Nonoperative treatment eliminates risks associated with surgical intervention, such as wound infections and sural nerve injury, making it a safer alternative for many patients.

INTRODUCTION

Acute Achilles tendon ruptures (AATRs) are among the most common injuries in active individuals, with an estimated incidence of 8.3 to 14.8 per 100,000 person-years.[1] Historically, surgical management was the preferred treatment, due to the reported lower rerupture rates in individuals managed surgically compared to those managed nonoperatively.[2] However, the emergence of accelerated functional rehabilitation with early range of motion in the nonoperative treatment of AATR, has seen the rerupture rate between treatments become equivalent.[2] The functional outcome following AATR is the same in both nonoperative and surgical treated patients across multiple randomized control trials, reported in 5 meta-analyses and in national registry data.[3–7] Surgical treatment, however, has the added risk of surgical injury, such as nerve injury

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Abbreviations	
AATR	acute Achilles tendon rupture
LAMP	Leicester Achilles Management Protocol
SMART	Swansea Morriston Achilles Rupture Treatment
VTE	venous thromboembolism

and wound complications.[8,9] A review of the results of randomized control trials of nonoperative treatment with functional rehabilitation and surgical management is seen in **Table 1**.

In the UK, nonoperatively managed AATR is now more common than surgical treatment.[20] With an increasing interest in nonoperative approaches, several key aspects, including use of imaging, the optimal duration of immobilization, and what splintage should be used are now being investigated. This protocol seeks to review the current evidence regarding the nonoperative treatment of AATR and provide treating health care professionals with an evidence-based, step-by-step framework.

PATHOPHYSIOLOGY OF ACHILLES TENDON RUPTURE

The majority of AATR occur on a background of Achilles tendinopathy.[21] Histopathological changes in AATR tendons include collagen fiber disorganization, increased ground substance, and neovascularisation.[22] Noback and colleagues reported in a study on asymptomatic individuals, that signs of Achilles tendinopathy were present in almost 10% of individuals, especially when gastrocnemius tightness was present.[23] Therefore, AATR is commonly thought of as an endpoint of Achilles tendinopathy, even without prior symptoms.

Acute rupture often occurs during sudden acceleration or deceleration, such as sprinting, jumping, or pivoting. It is common in middle-aged individuals who participate in sporadic physical activities (weekend warrior phenomenon),[24] typically due to the calf muscles' rapid and forceful contraction while the foot is dorsiflexed. With triceps surae tightness (especially gastrocnemius) being a major etiological factor in the development of Achilles tendinopathy, it may not be the logical treatment to shorten the tendon further, during surgical intervention.

INDICATIONS AND CONTRAINDICATIONS FOR NONOPERATIVE TREATMENT OF ACHILLES TENDON RUPTURES

There are very few contraindications to nonoperative treatment with accelerated functional rehabilitation with early range of motion. An evidence based decisions should take place between the patient and the health care professional on the most appropriate treatment. The following are the contraindications for nonoperative management of AATR.

Contraindications

Specific patient factors make nonoperative treatment less effective or unsuitable. They include:

1. *Open Ruptures or Associated Injuries:* Open Achilles tendon ruptures or those accompanied by complex injuries (eg, fractures or neurovascular compromise) are ideally managed surgically to fully address the extent of the damage.[9]
2. *Chronic or Neglected Ruptures:* Cases where the rupture is identified after a prolonged delay (>4 weeks) are less amenable to nonoperative treatment due to

Table 1
Randomized control trials in functional rehabilitations vs surgical treatment of AATR

Study	Study Type	Patient Numbers	Functional Outcomes	Complications	Rerupture Rates
Costa et al,[10] 2006	Two Independent, Multi Center RCT compared early weight bearing vs plaster cast immobilization in Nonoperative and operative treatment.	Nonoperative – 48 (22 early weight bearing, 26 plaster cast immobilization) Operative – 48 (23 early weight bearing, 25 plaster cast immobilization)	Nonoperative: • Return to sporting activity ○ Treatment group – 56% ○ Control group – 52% • EQoL Health Scores at 1 y: ○ Treatment group – Median EQoL score 85 (range: 58–90) ○ Control group – Median EQoL score 91 (range: 80–95) Operative: • Return to sporting activity ○ Treatment group – 83% ○ Control group – 68% • EQoL Health Scores at 1 y: ○ Treatment group – Median EQoL score 84 (range: 75–95) ○ Control group – Median EQoL score 01 (range: 85–95)	Nonoperative: • Treatment group – 0% • Control group – 4% failure to heal, 4% fatal pulmonary embolism secondary to deep vein thrombosis. Operative: • Treatment group – 26% minor wound complications • Control group – 20% minor wound complications	Nonoperative: • Treatment group – 5% • Control group – 4% Operative: • Treatment group – 9% • Control group – 0%

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Study	Study Type	Patient Numbers	Functional Outcomes	Complications	Rerupture Rates
Twaddle et al,[11] 2007	Single Center RCT compared nonoperative and operative treatment with early rehabilitation for both groups.	Nonoperative – 22 Operative – 20	Nonoperative: • Mean calf circumference at 52 wk: −0.2 (Range −1.3–0) • Mean Musculoskeletal Functional Assessment Index at 52 wk: 4.2 (Range 1–13) Operative: • Mean calf circumference at 52 wk: −0.5 (Range −1.6–0) • Mean Musculoskeletal Functional Assessment Index at 52 wk: 3.4 (Range 0–12)	No wound complications were recorded in this study.	Nonoperative – 4.3% Operative – 9.1%
Metz et al,[12] 2008	Multi Center RCT compared minimally invasive surgery with nonoperative treatment using functional bracing	Nonoperative – 41 Operative – 42	Nonoperative: • Leppilahti Scores: 89% • Return to sports: 82% Operative: • Leppilahti Scores: 81% • Return to sports: 67%	Nonoperative: • Sural nerve injury – 2.4% • DVT – 2.4% • Skin-related (e.g. pressure sores, blisters) – 31.7% Operative • Sural nerve injury – 7.1% • CRPS – 2.4%	Nonoperative – 12.2% Operative – 7.1%

Nilsson-Helander et al,[13] 2010	Single Center RCT comparing nonoperative and operative treatments with both groups receiving early mobilization and rehabilitation.	Nonoperative – 48 Operative – 49	Mean ATRS at 12 mo: • Nonoperative – 86 (median, 90; range, 31–100) • Operative – 88 (median, 93; range, 30–100)	Nonoperative: 0% excluding reruptures. Operative: 10.2% including nerve disturbances, wound infections and Achilles tendon contracture.	Nonoperative – 12.5% Operative – 4.1%
Willits et al,[14] 2010	Multi Center RCT comparing nonoperative and operative treatments with both groups receiving accelerated functional rehabilitation	Nonoperative – 72 Operative – 72	Mean Leppilahti score at 2 years: • Nonoperative – 82.2 ± 12.3 • Operative – 82.6 ± 11.1	Excluding reruptures: • Nonoperative – 4.2% • Operative – 15.2%	Nonoperative – 4.6% Operative – 3.2%
Keating et al,[15] 2011	Single Center RCT comparing open surgical repair with cast immobilization for 6 weeks and nonoperative approach with cast immobilization for 10 wk with progressive position adjustment from equinus to neutral.	Nonoperative – 41 Operative – 39	At 52 wk, Muscle function dynamometry (Peak torque) - Plantarflexion: • Nonoperative: 25% deficit from normal side • Operative: 20% deficit from normal side. Mean score of Short Muscle Function Assessment: • Nonoperative – 1.9 (95% CI: 1.1–2.7) • Operative – 82.6 ± 11.1 (95% CI: 0.6–1.8)	DVT: • Nonoperative – 5% • Operative – 0% Infections: • Nonoperative – 0% • Operative – 8.1%	Nonoperative – 10.3% Operative – 5.4%
Olsson et al,[16] 2013	Single Center RCT comparing nonoperative and operative treatments with both groups receiving accelerated rehabilitation	Nonoperative – 51 Operative – 49	Median ATRS at 12 mo: • Nonoperative – 90 (Range: 2–100); Mean = 80 ± 23 • Operative – 89 (Range: 0–100); Mean = 82 ± 20	• Nonoperative: DVT (4%) • Operative: DVT (2%), superficial infections (12%), persistent sural nerve deficit (2%)	Nonoperative – 9.8% Operative – 2.0%

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Study	Study Type	Patient Numbers	Functional Outcomes	Complications	Rerupture Rates
Lantto et al,[17] 2016	Single Center RCT compared nonoperative and open repair with identical functional rehabilitation for both groups.	Nonoperative – 28 Operative – 32	Mean Leppilahti score at 18 mo: • Nonoperative – 75.7 (SD = 11.2) • Operative – 79.5 (SD = 10.3)	Nonoperative: 0% Operative: 3% with deep infection.	Nonoperative – 14.2% Operative – 3.1%
Manent et al,[18] 2019	Single Center RCT comparing Nonoperative, Open Surgery and Percutaneous Surgery with full early weightbearing for all groups.	Nonoperative – 11 Open repair – 12 Percutaneous surgery – 11	Responder: Ability to do standing heel-rise for 3 s with pain score $\leq$2, and a return to active sports or life: • Nonoperative – 100% • Open repair – 83% • Percutaneous surgery – 82%	• Nonoperative – 0% • Open repair – 17% with scar induration. • Percutaneous surgery – 18% with hyperalgesia and 27% with scar induration.	Nonoperative – 0.0% Operative – 0.0%
Fischer et al,[19] 2020	Single Center RCT comparing Nonoperative, Open Surgery and Minimally Invasive Surgery.	Nonoperative – 30 Open Surgery – 30 MIS – 30	American Orthopaedic Foot and Ankle Society Ankle-Hindfoot Score was recorded at 24 mo: • Nonoperative – 94.9 • Open surgery – 96.9 • MIS – 96.5 Return to sports: • Nonoperative – 78.6% • Open surgery – 83.3% • MIS – 82.8%	Delayed healing, thrombosis and chronic pain were the reported complications, grouping all complications except rerupture: • Nonoperative – 20.0% • Open surgery – 20.0% MIS – 16.7%	Nonoperative – 6.6% Open Surgery – 3.3% MIS – 3.3%

Myhrvoid et al,[8] 2022	Multi Center RCT comparing Nonoperative, Open Surgery and Minimally Invasive Surgery. Functional Orthosis – Equinus cast 2 wk, AFO with wedges	Nonoperative – 178 Open Surgery – 176 MIS – 172	ATRS 12 mo for all groups;s, and any additional Mean change in baseline ATRS at 12 mo was reported for each group: • Nonoperative: −17.0 points (95% confidence interval [CI], −20.0 to −14.0) • Open surgery: −16.0 points (95% CI, −19.0 to −12.9) • MIS: −14.7 points (95% CI, −17.9 to −11.6)	Give specific number of complications for each group. Sensory nerve deficits, deep infections, deep venous thrombosis, Pulmonary embolism, tendon elongation requiring surgery were grouped into serious adverse events reported for each group, excluding reruptures: • Nonoperative – 2.8% • Open surgery – 5.7% • MIS – 8.1%	Nonoperative – 6.2%. Open repair – 0.6%. MIS – 0.6%

Abbreviations: ATRS, achilles tendon rupture score; CI, confidence interval; CRPS, complex regional pain syndrome; DVT, deep vein thrombosis; EQoL, EuroQol; MIS, minimally invasive surgery; RCT, randomized control trial; SD, standard deviation.

scarring and tendon retraction.[14] However, Winson and colleagues reported successful treatment using the SMART protocol in almost 80% of individuals if the rupture occurred less than 12 weeks before initiation of treatment.[25]

3. *Noncompliance to Rehabilitation:* Patients unlikely to follow the structured rehabilitation protocol may not achieve satisfactory outcomes.[26] Noncompliance after surgical treatment does not appear to alter functional outcome.[27]
4. *Obesity:* Increased body weight increases mechanical loading on the healing tendon, potentially leading to suboptimal outcomes with nonoperative management,[28] however there is an increased chance of wound dehiscence seen in surgical management of Achilles tendon ruptures in patients with obesity.[29]
5. *Unavailability of physiotherapy services:* Accelerated functional rehabilitation with early range of motion requires close contact with a specialist physiotherapist. Under-resourced centers, or lack of financial compensation for therapy services can significantly undermine nonoperative treatment. In these cases, surgical treatment may be safer, as aforementioned noncompliance postsurgical treatment does not appear to alter functional outcome.[27]

THE ROLE OF IMAGING IN PATIENT SELECTION

There remains controversy in the use of ultrasound (US) to categorize patients to nonoperative or operative management of AATR. Some studies have indicated lower functional outcomes in patients who have a tendon gap on US of greater than 1 cm.[30,31] However, this is not universal with other studies showing functional outcome has no correlation with tendon gap.[32–34] Hansen and colleagues, completed the only level 1 study to date on the question of use of tendon gap to guide treatment, and showed no significant benefit on functional outcomes if gap size was used as a criteria for surgical intervention.[34] Dams and colleagues reviewed 56 studies for a systematic review indicating that US should only be used to rule out other injuries.[35] The authors do not routinely use US to plan AATR treatment. It is our opinion that gap size is usually measured from normal tendon end to normal tendon end and thus is a measure of the distance over which the tendon has ruptured and the extent of preinjury disease and does not accurately indicate an actual physical gap.

THE NONOPERATIVE TREATMENT PROTOCOL

The primary goal of nonoperative management is to maintain optimal approximation of the ruptured tendon ends in a controlled environment thus allowing the tendon to heal in a nonlengthened position. Functional rehabilitation is then utilized to restore muscle function to its preinjury level. Ideal tendon healing occurs by rapid replacement of unorganized scar tissue with aligned peritendinous connective tissue. Frankewycz and colleagues analyzed rehabilitation protocols provided by orthopedic and trauma institutions in Germany, finding that out of 213 institutions, there were 243 separate protocols with significant variability.[36] In the UK, the two most commonly used protocols for accelerated functional rehabilitation with early range of motion are the Swansea Morriston Achilles Rupture Treatment (SMART) and Leicester Achilles Management Protocol (LAMP).[37,38] Both protocol introductory studies used functional rehabilitation protocols and dynamic and adjustable externally fixed walking boots (VACOped, OPED UK Ltd, Melksham, UK). Both protocols are illustrated in **Table 2** and the rehabilitation process in **Fig. 1**. Both protocols report excellent functional results in the initial studies.[37,38] The patients reported in the British Orthopaedic Foot and Ankle Registry with excellent functional results have predominantly used the SMART protocol.[7] The authors' preferred method of accelerated functional

Table 2
Commonly used functional rehabilitation protocols used in the literature

SMART Protocol[37]

Week	Conservative	Surgical
0–2	Equinus FWB cast with a wedge in the best position that opposes the tendon ends	Back slab NWB
2–5	VACOped boot locked at 30° FWB	VACOped boot locked at 30° FWB
5–7	VACOped boot 30° to 15° FWB Yellow theraband exercises for soleus and gastrocnemius	VACOped boot 30° to 15° degrees Yellow theraband exercises for soleus and gastrocnemius
7–9	VACOped boot 0°–30° with a flat wedge FWB	VACOped boot 0–30° with a flat wedge FWB
9–10	VACOped boot fully unlocked FWB	VACOped boot fully unlocked FWB
10–16	Removal of boot to wear only in vulnerable environments (6/52)	Removal of boot To wear only in vulnerable environments (6/52)

Management of Patients after Immobilization for Operative and Nonoperative Patients

Time	Do	Do Not
Weeks 10–12 postinjury	• Issue patient with a heel raise for shoe • Warn the patient that most reruptures occurs during this phase • Advise the patient to avoid activities which involve extreme dorsi flexion of the ankle combined with active plantar flexion • Advise the patient that they will not return to sports which involve running until they are 6–8 mo postinjury • Advise the patient on a PWB gait pattern; particularly re-educating the toe off phase of gait • Work on ROM of the ankle and foot. Particularly length of soleus and gastrocnemius • Lower limb muscle strength work • Particularly of the plantar flexors • Proprioception exercises • Gentle plyometric exercises • Hydrotherapy – particularly good during this phase • For surgical patients take care of the scar. Any sign of break down refer patient back to clinic as soon as possible	• Do NOT attempt running, jumping or hopping • Do NOT attempt eccentric lowering exercise off a step used for tendinopathies. Do not attempt resistance plantar flexion exercises which requires more than half the patients body weight
3–5 mo postinjury	• Dispense of heel raise • Continue to avoid activities of extreme dorsi flexion combined with active plantar flexion • Aim to single leg heel raise • Plyometric – progress for example, start with 2 feet jumps (bunny hops), jogging on trumpet, PWB jogging, that is, leaning on table	

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Table 2
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Management of Patients after Immobilization for Operative and Nonoperative Patients

Time	Do	Do Not
5–6 mo postinjury	• Gait – Start jogging on the flat Strength – start eccentric exercises off step Progress proprioceptive exercises as appropriate Sports specific rehab exercises	
6–8 mo postinjury	• Gait – introduce hill running • Introduce hopping and progress to long horizontal and vertical hops Return to sport as able	• Return the patient to competitive sports until they can: single leg heel raise; sprint with the toe off phase of gait; until horizontal single leg hop × 3 is at least 75% of good leg and vertical hop is at least 75% of good leg

LAMP Protocol[38]

Management of Patients after Immobilization Period for Operative and Nonoperative Patients

Time from Diagnosis	VACOped Position
0–4 wk	Locked in 30° plantarflexion
4–6 wk	Dynamized 15°–30° plantarflexion
6–8 wk	Dynamized 0°–30° plantarflexion
At 8 wk	Boot removed

Management of Patients During Immobilization Period for Operative and Nonoperative Patients

Exercise	Repetitions/Duration	Frequency
Isometric exercises	10 repetitions	Three times a day
Dorsiflexion/Plantarflexion ROM	10 repetitions	At least once a day
Seated Heel raises	10 repetitions	Three times a day
Walk outdoors in comfortable footwear	10 min	At least twice a day

Abbreviations: FWB, full weight bearing; NWB, non-weight-bearing; ROM, range of movement.

rehabilitation with early range of motion is the SMART protocol. In the last 3 years, we have reported a rerupture rate of 0.84% (2/238) in patients treated using the SMART protocol in our unit, similar to the rerupture rate reported in other accelerated functional rehabilitation with early range of motion studies by Wallace and colleagues (2.9% in 945 patients), Hutchison and colleagues (1.1% of 211 patients) and Aujla and colleagues (2% in 442 patients).

METHOD OF IMMOBILIZATION

There is a variety of immobilization methods used in the literature. Non-weight-bearing equinus casts were traditionally used, which it is thought created unorganized scar tissue at the rupture site. This could have possibly been an area of weakness, resulting in the high rates of rerupture seen with this treatment. Maempel and colleagues also noted significantly improved functional scores in an orthosis as compared to a plaster.[39] As aforementioned, with the use functional rehabilitation protocols in the

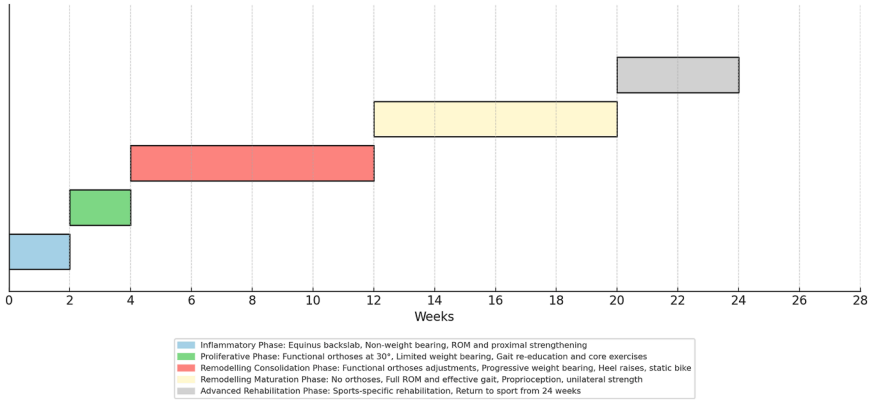

Fig. 1. Rehabilitation Gantt chart.

nonoperative management of AATR, the rerupture rates are equivalent to those seen in surgical management.[2]

For optimum functional results, Silbernagal and colleagues suggested that apposition of the torn tendon fibers was paramount with regard to the healing profile of the AATR.[40] Therefore, any orthosis needs to result in equinus at the ankle in the initial period of healing. Nevertheless, the type of orthosis used is very variable. Ellison and colleagues suggested that insufficient ankle/hindfoot equinus to allow for reduction of the "rupture gap" during the initial healing phase was most likely cause of a lengthened tendon in patients treated nonoperatively.[41] Different orthotics used in the literature are summarized in **Table 3**.

Concerns have been raised with the use of wedges in a boot, if the wedges used have a plateau. Studies by Ellison and colleagues and Mikkelsen and colleagues both reported that orthotics with wedges containing a superior plateau did not cause plantarflexion at the ankle, but at the midfoot, similar to a boot without any wedges.[41,43] Both articles encouraged the move away from any wedge with a plateau to either an externally fixed equinus (like the VACOped boot used in the SMART and LAMP protocols) or wedges without a plateau.

Table 3
Orthotics reported in published studies using functional rehabilitation in the literature (brackets reported degree of hindfoot equinus in paper)

Authors	Description of Orthosis
Costa et al,[10] 2006	Prefabricated carbon orthosis with 3x1.5 cm heel lifts
Willits et al,[14] 2010	Aircast Pneumatic Walker & 2 cm heel lift (20°)
Wallace et al,[42] 2011	Aircast Pneumatic Walker & wedges
Olsson et al,[16] 2013	Aircast XP Diabetic Walker & 3 heel pads (approx. 22°)
Hutchison et al,[37] 2015	VACOped boot (20°–30°)
Aujla et al,[38] 2019	VACOped boot (20°–30°)
Maempel et al,[39] 2020	Ossur boot with 3 cm internal heel wedge
Myhrvold et al,[8] 2022	Walking boot with 3 heel wedges

COMPLICATIONS AND LONG-TERM RECOVERY

Nonoperative management is associated with fewer complications than surgical repair, with surgery posing a higher risk of complications, including infections and sural nerve injury.[44] Deficits in muscle strength and tendon elongation have not been proven to be different to surgical repair at present. Tendon elongation is a critical factor contributing to long-term weakness, potentially impacting return-to-sport outcomes. This can happen in both nonoperative and surgical management with Carmont and colleagues and Eliasson reporting tendon lengthening after surgical AATR management.[45,46] However, eccentric loading during rehabilitation has been shown to address these deficits effectively, improving both strength and functional performance.[47–49] Heterotopic ossification of the Achilles tendon is reported in up to 20% of surgically treated AATR, although there are no reports in the literature of it occurring after nonoperative management.[50] Regarding venous thromboembolism (VTE), the UK FATE trial reported that Achilles tendon ruptures had the highest risk of VTE compared to other foot and ankle injuries, but there was no significant difference in risk between surgical or nonoperatively treated AATR.[20]

PATIENT SATISFACTION AND RETURN TO ACTIVITY

Patient satisfaction with nonoperative management is generally high, especially when outcomes are coupled with reduced morbidity and quicker recovery times. Wallace and colleagues reported that patients managed nonoperatively with functional rehabilitation resumed everyday activities within a similar timeframe to surgical patients, with no significant differences in satisfaction levels.[42] Furthermore, evidence suggests that nonoperative treatment can facilitate an earlier return to work and sports when rehabilitation protocols are strictly followed.[37,40]

CHALLENGES IN IMPLEMENTING NONOPERATIVE PROTOCOLS

The implementation of nonoperative protocols for the management of acute Achilles tendon ruptures is not without challenges, particularly regarding standardization, patient compliance, and constraints within the health care system. One significant obstacle is the inconsistency in rehabilitation protocols, with variations in immobilization methods, weight-bearing strategies, and rehabilitation timelines.[36] This lack of uniformity can lead to confusion for both clinicians and patients, potentially adversely affecting outcomes. Another critical factor is patient adherence; noncompliance with rehabilitation regimens, has been linked to suboptimal functional recovery and an increased risk of tendon elongation.[40] Additionally, the availability of physiotherapy personnel and facilities presents a considerable challenge. Many health care systems, particularly in rural or underserved areas, lack access to trained physiotherapists or advanced rehabilitation centers.[51] The absence of these resources can hinder the implementation of essential exercises and monitoring, vital for the success of nonoperative protocols. Finally, financial implications introduce an additional layer of complexity, as the costs associated with functional orthoses and repeated follow-up visits may burden both patients and health care systems.[52] Addressing these challenges requires efforts to standardize protocols, enhance patient education, improve resource accessibility, and expand physiotherapy infrastructure, thereby ensuring that nonoperative management achieves its full potential across diverse clinical settings.

SUMMARY

Nonoperative management of Achilles tendon ruptures is an effective alternative to surgery, with equivalent functional outcomes and rates of rerupture. A structured

approach that includes precise diagnosis, structured immobilization, gradual physiotherapy led rehabilitation and focus on patient care is essential to ensure patient satisfaction while reducing complication risks. Ongoing research and the improvement and standardization of rehabilitation protocols will continue to support recovery, helping patients regain their preinjury function and quality of life.

CLINICS CARE POINTS

The effective management of Achilles tendon ruptures, especially through nonoperative protocols, necessitates strict adherence to essential clinical care points to ensure optimal patient outcomes. These evidence-based insights and potential challenges provide practical guidance for clinicians:

- Accurate Initial Diagnosis
  - Use clinical tests like the Simmonds-Thompson test to confirm an Achilles tendon rupture.
  - Use US if the clinical diagnosis is not clear.
- Tailored Immobilization Strategies
  - Immobilize the ankle in maximum plantar flexion. Depending on practicalities, either progress to boot or full equinus cast in first 2 weeks. Use of a functional orthosis (without the use of wedges with plateau) is conducted under physiotherapy guidance to control progression from plantar flexion to neutral over 8 to 10 weeks.
  - Avoid immobilization positions that risk tendon elongation, which can lead to long-term functional deficits.
- Early Weight-Bearing and Functional Loading
  - Encourage early weight-bearing within a protected range. Controlled loading promotes collagen alignment, tendon remodeling, and accelerates recovery. This is best completed with a rehabilitation prescription.
  - Avoid premature excessive range of motion (ROM), as it can increase the risk of tendon elongation or rerupture.
- Structured Physiotherapy Protocols
  - Follow a structured rehabilitation plan that aligns with the stages of tendon healing, beginning with pain management and range of motion exercises and progressing to strengthening proprioception and functional recovery.
- Vigilance Against Rerupture
  - Inform patients on the risks of rerupture, especially during the shift from protected immobilization to functional activity.
  - Avoid high-risk activities such as running, jumping, or hopping until the tendon demonstrates sufficient strength and resilience.
- Monitoring for Complications
  - Be alert for complications, including deep vein thrombosis or pulmonary embolism, especially in immobilized patients. It is advisable to use thromboprophylaxis selectively based on individual risk factors.
  - In patients managed nonoperatively, look for indications of tendon elongation, as this can impact long-term strength and stability functionality.
- Patient Education and Compliance
  - Inform patients about the significance of adherence to rehabilitation protocols, such as using orthoses correctly, gradually increasing activity, and steering clear of compensatory movement patterns.
  - Set realistic expectations regarding recovery timelines, stressing that functional recovery can take as long as 9 to 12 months, especially for athletes.
- Individualized Rehabilitation Goals
  - Tailor rehabilitation programs to match with individual patient factors like age, activity level, and clinical progress.

- For athletes or those with high functional demands, include sport-specific drills, advanced strengthening exercises and possible return to sport psychology to address their specific needs.

- Multidisciplinary Team Approach
  - Ensure seamless coordination among health care providers to improve treatment outcomes.
  - Use dedicated clinics, where feasible, to standardize care and improve patient education and compliance.

By following these clinical care guidelines, health care providers can optimize the chances of a successful recovery, reduce complications, and help patients regain their full functional capacity after an AATR.

DISCLOSURE

Prof. L. Mason is an implant designer and receives royalties from Orthosolutions. The other authors have nothing to disclose.

REFERENCES

1. Soroceanu A, Sidhwa F, Aarabi S, et al. Surgical versus nonsurgical treatment of acute achilles tendon rupture: a meta-analysis of randomized trials. J Bone Joint Surg Am 2012;94(23):2136–43.
2. Ochen Y, Beks RB, van Heijl M, et al. Operative treatment versus nonoperative treatment of Achilles tendon ruptures: systematic review and meta-analysis. BMJ 2019;364:k5120.
3. Meulenkamp B, Woolnough T, Cheng W, et al. What is the best evidence to guide management of Acute achilles tendon ruptures? A systematic review and network meta-analysis of randomized controlled trials. Clin Orthop Relat Res 2021;479-(10):2119–31.
4. Seow D, Yasui Y, Calder JDF, et al. Treatment of acute achilles tendon ruptures: a systematic review and meta-analysis of complication rates with Best- and worst-case analyses for rerupture rates. Am J Sports Med 2021;49(13):3728–48.
5. She G, Teng Q, Li J, et al. Comparing surgical and conservative treatment on Achilles tendon rupture: a comprehensive meta-analysis of RCTs. Front Surg 2021;8:607743. https://doi.org/10.3389/fsurg.2021.607743.
6. Zhou K, Song L, Zhang P, et al. Surgical versus non-surgical methods for acute Achilles tendon rupture: a meta-analysis of randomized controlled trials. J Foot Ankle Surg 2018;57(6):1191–9.
7. Mason L, Wood E, Makawana N, et al. British orthopaedic foot aand ankle society registry report 2023. 2023. Available at: https://www.bofas.org.uk/Portals/0/Registry%20Documents/Annual%20Reports/BOFAS_Registry_Report_2023.pdf?ver=ITRdWj_4jsBzBsckYQS58Q%3d%3d.
8. Myhrvold SB, Brouwer EF, Andresen TKM, et al. Nonoperative or surgical treatment of acute Achilles' tendon rupture. N Engl J Med 2022;386(15):1409–20.
9. Shoap S, Backer HC, Freibott CE, et al. Rerupture and wound complications following Achilles tendon repair: a systematic review. J Orthop Res 2023;41(4):845–51.
10. Costa ML, MacMillan K, Halliday D, et al. Randomised controlled trials of immediate weight-bearing mobilisation for rupture of the tendo Achillis. J Bone Joint Surg Br 2006;88(1):69–77.

11. Twaddle BC, Poon P. Early motion for Achilles tendon ruptures: is surgery important? A randomized, prospective study. Am J Sports Med 2007;35(12):2033–8.
12. Metz R, Verleisdonk EJ, van der Heijden GJ, et al. Acute Achilles tendon rupture: minimally invasive surgery versus nonoperative treatment with immediate full weightbearing–a randomized controlled trial. Am J Sports Med 2008;36(9): 1688–94.
13. Nilsson-Helander K, Silbernagel KG, Thomee R, et al. Acute achilles tendon rupture: a randomized, controlled study comparing surgical and nonsurgical treatments using validated outcome measures. Am J Sports Med 2010;38(11): 2186–93.
14. Willits K, Amendola A, Bryant D, et al. Operative versus nonoperative treatment of acute Achilles tendon ruptures: a multicenter randomized trial using accelerated functional rehabilitation. J Bone Joint Surg Am 2010;92(17):2767–75.
15. Keating JF, Will EM. Operative versus non-operative treatment of acute rupture of tendo Achillis: a prospective randomised evaluation of functional outcome. J Bone Joint Surg Br 2011;93(8):1071–8.
16. Olsson N, Silbernagel KG, Eriksson BI, et al. Stable surgical repair with accelerated rehabilitation versus nonsurgical treatment for acute Achilles tendon ruptures: a randomized controlled study. Am J Sports Med 2013;41(12):2867–76.
17. Lantto I, Heikkinen J, Flinkkila T, et al. A prospective randomized trial comparing surgical and nonsurgical treatments of acute Achilles tendon ruptures. Am J Sports Med 2016;44(9):2406–14.
18. Manent A, Lopez L, Corominas H, et al. Acute Achilles tendon ruptures: efficacy of conservative and surgical (Percutaneous, open) Treatment-A randomized, controlled, clinical trial. J Foot Ankle Surg 2019;58(6):1229–34.
19. Fischer S, Colcuc C, Gramlich Y, et al. Prospective randomized clinical trial of open operative, minimally invasive and conservative treatments of acute Achilles tendon tear. Arch Orthop Trauma Surg 2021;141(5):751–60.
20. Mangwani J, Houchen-Wolloff L, Malhotra K, et al. UK foot and ankle thromboembolism (UK-FATE). Bone Joint J 2024;106-B(11):1249–56.
21. Park YH, Kim TJ, Choi GW, et al. Achilles tendinosis does not always precede achilles tendon rupture. Knee Surg Sports Traumatol Arthrosc 2019;27(10):3297–303.
22. Magnan B, Bondi M, Pierantoni S, et al. The pathogenesis of Achilles tendinopathy: a systematic review. Foot Ankle Surg 2014;20(3):154–9.
23. Noback PC, Freibott CE, Tantigate D, et al. Prevalence of asymptomatic achilles tendinosis. Foot Ankle Int 2018;39(10):1205–9.
24. Khan RJ, Fick D, Keogh A, et al. Treatment of acute achilles tendon ruptures. A meta-analysis of randomized, controlled trials. J Bone Joint Surg Am 2005;87-(10):2202–10.
25. Winson DMG, MacNair R, Hutchinson AM, et al. Delayed Achilles tendon rupture presentation: non-operative management may be the SMART choice. Foot (Edinb) 2021;46:101724. https://doi.org/10.1016/j.foot.2020.101724.
26. Kearney RS, Costa ML. Current concepts in the rehabilitation of an acute rupture of the tendo Achillis. J Bone Joint Surg Br 2012;94(1):28–31.
27. Rogero RG, Corr D, Fisher A, et al. Postoperative noncompliance following repair of acute achilles tendon ruptures. Foot & Ankle Orthopaedics 2020;5(4):247301 1420S00410.
28. Olsson N, Nilsson-Helander K, Karlsson J, et al. Major functional deficits persist 2 years after acute Achilles tendon rupture. Knee Surg Sports Traumatol Arthrosc 2011;19(8):1385–93.

29. Hillam JS, Mohile N, Smyth N, et al. The effect of obesity on achilles rupture repair. Foot Ankle Spec 2019;12(6):503–12.
30. Lawrence JE, Nasr P, Fountain DM, et al. Functional outcomes of conservatively managed acute ruptures of the Achilles tendon. Bone Joint J 2017;99-b(1):87–93.
31. Yassin M, Myatt R, Thomas W, et al. Does size of tendon gap affect patient-reported outcome following Achilles tendon rupture treated with functional rehabilitation? Bone Joint J 2020;102-B(11):1535–41.
32. Mubark I, Abouelela A, Arya S, et al. Achilles tendon rupture: can the tendon gap on ultrasound scan predict the outcome of functional rehabilitation program? Cureus 2020;12(9):e10298.
33. Qureshi A, Gulati A, Adukia V, et al. The influence of the site of rupture and gap distance in acute Achilles tendon rupture treated with functional rehabilitation. Injury 2023;54(4):1216–21.
34. Hansen MS, Bencke J, Kristensen MT, et al. Achilles tendon gait dynamics after rupture: a three-armed randomized controlled trial comparing an individualized treatment algorithm vs. operative or non-operative treatment. Foot Ankle Surg 2023;29(2):143–50.
35. Dams OC, Reininga IHF, Gielen JL, et al. Imaging modalities in the diagnosis and monitoring of Achilles tendon ruptures: a systematic review. Injury 2017;48(11):2383–99.
36. Frankewycz B, Krutsch W, Weber J, et al. Rehabilitation of Achilles tendon ruptures: is early functional rehabilitation daily routine? Arch Orthop Trauma Surg 2017;137(3):333–40.
37. Hutchison AM, Topliss C, Beard D, et al. The treatment of a rupture of the Achilles tendon using a dedicated management programme. Bone Joint J 2015;97-b(4):510–5.
38. Aujla RS, Patel S, Jones A, et al. Non-operative functional treatment for acute Achilles tendon ruptures: the Leicester Achilles Management Protocol (LAMP). Injury 2019;50(4):995–9.
39. Maempel JF, Clement ND, Duckworth AD, et al. A randomized controlled trial comparing traditional plaster cast rehabilitation with functional walking boot rehabilitation for acute achilles tendon ruptures. Am J Sports Med 2020;48(11):2755–64.
40. Silbernagel KG, Steele R, Manal K. Deficits in heel-rise height and achilles tendon elongation occur in patients recovering from an achilles tendon rupture. Am J Sports Med 2012;40(7):1564–71.
41. Ellison P, Molloy A, Mason LW. Early protected weightbearing for acute ruptures of the achilles tendon: do commonly used orthoses produce the required equinus? J Foot Ankle Surg 2017;56(5):960–3.
42. Wallace RG, Heyes GJ, Michael AL. The non-operative functional management of patients with a rupture of the tendo Achillis leads to low rates of re-rupture. J Bone Joint Surg Br 2011;93(10):1362–6.
43. Mikkelsen RK, Somodi S, Hölmich P, et al. Calcaneal positioning in equinus immobilization of the ankle joint: a comparison of common orthoses used in the treatment of acute Achilles tendon ruptures. Foot Ankle Surg 2022;28(8):1314–20.
44. Seow D, Islam W, Randall GW, et al. Lower re-rupture rates but higher complication rates following surgical versus conservative treatment of acute achilles tendon ruptures: a systematic review of overlapping meta-analyses. Knee Surg Sports Traumatol Arthrosc 2023;31(8):3528–40.
45. Eliasson P, Agergaard AS, Couppé C, et al. The ruptured achilles tendon elongates for 6 months after surgical repair regardless of early or late weightbearing

in combination with ankle mobilization: a randomized clinical trial. Am J Sports Med 2018;46(10):2492–502.
46. Carmont MR, Grävare Silbernagel K, Brorsson A, et al. The Achilles tendon resting angle as an indirect measure of Achilles tendon length following rupture, repair, and rehabilitation. Asia-Pacific Journal of Sports Medicine, Arthroscopy, Rehabilitation and Technology 2015;2(2):49–55.
47. Silbernagel KG, Thomee R, Eriksson BI, et al. Continued sports activity, using a pain-monitoring model, during rehabilitation in patients with Achilles tendinopathy: a randomized controlled study. Am J Sports Med 2007;35(6):897–906.
48. Krapf D, Kaipel M, Majewski M. Structural and biomechanical characteristics after early mobilization in an Achilles tendon rupture model: operative versus nonoperative treatment. Orthopedics 2012;35(9):e1383–8.
49. Marrone W, Andrews R, Reynolds A, et al. Rehabilitation and return to sports after Achilles tendon repair. Int J Sports Phys Ther 2024;19(9):1152–65.
50. Magnusson SP, Agergaard AS, Couppé C, et al. Heterotopic ossification after an achilles tendon rupture cannot be prevented by early functional rehabilitation: a cohort study. Clin Orthop Relat Res 2020;478(5):1101–8.
51. McKinney J, Kelm N, Windsor B, et al. Addressing health care access disparities through a public health approach to physical therapist practice. Phys Ther 2024;104(10). https://doi.org/10.1093/ptj/pzae136.
52. Costa ML, Achten J, Marian IR, et al. Plaster cast versus functional brace for non-surgical treatment of Achilles tendon rupture (UKSTAR): a multicentre randomised controlled trial and economic evaluation. Lancet 2020;395(10222):441–8.