Functional Rehabilitation for Nonsurgical Treatment of Acute Achilles Tendon Rupture



Mark Glazebrook, MD, MSc, PhD, FRCS(C)^{a,*}, Daniela Rubinger, BSCPT^b

KEYWORDS

- Achilles Tendon Rupture Functional rehabilitation Nonoperative
- Physical therapy

KEY POINTS

- Current available literature suggests that when treating an acute Achilles tendon midsubstance rupture with accelerated functional rehabilitation, the clinical outcomes for nonoperative and operative treatments are similar.
- If an appropriate accelerated functional rehabilitation program cannot be utilized properly, then consideration should be given to operative treatment.
- The initial diagnosis and initiation of nonoperative treatment with functional rehabilitation must be started within 48 hours with the foot immobilized in plantar flexion and non-weight bearing.
- Patient education and supervision with a physical therapist experienced in functional rehabilitation are essential for success. Patient compliance also is essential for success.
- A problematic complication of nonoperative treatment of Achilles tendon ruptures is weakness secondary to overstretching of the Achilles. This can be mitigated or prevented with close supervision of the rehabilitation protocol and communication between physical therapist and physician, with adjustments in the protocol when necessary.

INTRODUCTION

Rupture of the Achilles tendon is one of the most common sports-related injuries in the adult population¹. Despite the increased incidence, there is no consensus on the best method of treatment, because both operative and nonoperative treatments present unique benefits and disadvantages. It is essential to present patients with the risks and benefits of both operative and nonoperative treatments to allow patients to make an informed choice on the course of their treatment.

^a Queen Elizabeth II Health Sciences Center, Halifax Infirmary (Room 4867), 1796 Summer Street, Halifax, Nova Scotia B3H 3A7, Canada; ^b Citadel Physiotherapy, 1554 Dresdon Row, Suite 3070, Halifax, Nova Scotia B3J 2X2, Canada * Corresponding author.

E-mail address: markglazebr@hotmail.com

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The operative treatment of an Achilles tendon rupture includes open repairs and minimally invasive and percutaneous techniques, all involving the placement of sutures, which provide extra protection during the healing process at the cost of disruption of blood supply. The obvious benefits include additional protection from rerupturing from minor forces and elongation of tendon from careless aggressive rehabilitation. Surgical repair, however, can place patients at increased risk for wound infection, deep infection, scarring, sural nerve sensory disturbances, and deep vein thrombosis (Table 1).²

The nonoperative treatment of Achilles tendon ruptures offers the benefit of no further disruption of blood supply at healing site and decreased rates of surgical complications but requires appropriate monitoring by the medical team and patient compliance with functional rehabilitation. Compliance with the accelerated rehabilitation protocol by patient and physiotherapist is of utmost importance because deviation can lead to tendon elongation, leading to residual weakness. It has been found that clinical outcomes correlate with the degree of tendon lengthening and that early, well-supervised mobilization can reduce the degree of tendon elongation.³

Most importantly, the current available evidence in the literature shows that when the accelerated rehabilitation protocol is administered correctly, there is no significant difference in the clinically important outcomes for patients who receive operative or nonoperative treatments. If the nonoperative treatment functional rehabilitation protocol cannot be supervised and administered correctly, however, then strong consideration should be given to operative treatment.³

Nonoperative treatment methods include several different techniques. A functional rehabilitation protocol can include early weight bearing, early controlled range of motion (ROM), or both.⁴ The degree to which a patient is weight bearing and the amount

Table 1 Risks and benefits of operative treatment and nonoperative treatments		
Benefits	Risks	
Operative treatment		
 Low rate of rerupture similar to nonoperative treatment Good functional outcome similar to nonoperative treatment Possible slightly earlier return to high demanding activity by weeks not months More robust with sutures able to resist poor compliance with rehabilitation program in in early healing phase and possible prevention of rerupture with low force earlier in recovery Improved high torque strength² 	 General risks of operative treatment Risk of wound infection Risk of nerve injury Risk of wound healing problems Scar Blood clot 	
Nonoperative treatment		
 Low rate of rerupture similar to operative treatment Avoid operation and associated risks Similar rate of rerupture to operative treatment Similar functional outcome to operative treatment 	 Blood clot Weakness as a result of tendon over stretching if poor compliance with GAPNOT Rerupture with minor force less than that of the additional strength provided by sutures Possibly slower return to high demanding activity by weeks not months 	

of time before controlled ROM exercises begin are variable between protocols, but there is evidence in the literature that suggests they are important components in the success of nonoperatively treated Achilles tendon ruptures. Nilsson-Helander and colleagues⁴ found that using functional braces results in more favorable outcomes than casting, as demonstrated by a lower rerupture rate. Suchak and colleagues⁵ investigated early weight bearing and its consequence on health-related quality of life and found it increased the quality of life in the early stages of rehabilitation. Lastly, a study conducted by Olsson and colleagues^{6,7} demonstrated early controlled ROM and early loading of the tendon resulted in favorable clinical outcomes. The best studied accelerated rehabilitation protocol for nonoperative treatment of a midsubstance Achilles rupture was described by Willits and colleagues² in a high-quality level 1 randomized controlled trial. This article describes the Glazebrook/Rubinger Achilles protocol for nonoperative treatment (GAPNOT), which is standardized accelerated rehabilitation protocol (see Table 3) modified from the previous study of Willits and colleagues.²

The intent of this article is to provide a comprehensive description of the GAPNOT protocol with key points of the treatment emphasized to provide guidance to rehabilitation team in order to achieve optimal clinical outcomes for patients.

METHODS

Diagnosis

Diagnosis of an acute Achilles tendon rupture is made with careful history, physical examination, and review of diagnostic imaging if necessary. The key history features include complaints of sudden snap, acute severe pain localized to rupture site, and often difficulty with weight-bearing activities.

The physical examination is best done with the patient in the prone position and the feet hanging over the end of the bed (Fig. 1A). The key physical examination features that confirm an acute Achilles tendon rupture include a midsubstance palpable gap (Fig. 2), a lack of plantar-flexion response with calf squeeze (Thompson test), and localized pain, swelling, and ecchymosis (see Fig. 2). Tests are repeated with the knee in flexion and extension (Fig. 1B). Although not essential, ultrasound or magnetic resonance imaging (MRI) can assist in confirming Achilles tendon rupture if clinical history and physical examination are not definitive. Furthermore, a lateral plain radiograph projection excludes a bony avulsion, which may be important in choosing treatment.



Fig. 1. (*A*) Patient positioning for examination of suspected acute Achilles rupture. (*B*) Patient positioned with knee flexed for examination.



Fig. 2. (A, B) Defect of complete midsubstance Achilles tendon rupture.

An MRI has a high sensitivity for identifying a complete versus rupture partial rupture. Caution should be exercised, however, with interpretation of the MRI signal. Radiologists tend to use this to report a gap size. It is more likely that the gap reported is a zone of trauma where the frayed ends of the ruptured Achilles tendon produce an MRI signal different from that of a normal tendon. Furthermore, the current best available evidence in a randomized controlled study² ignored the presence or absence of the gap, when using nonoperative treatment, and showed similar results to operative treatment.

Criteria for Nonoperative Treatment

Patients with confirmed diagnosis of acute Achilles tendon rupture are appropriate for nonoperative treatment if they are diagnosed within 2 days of injury and had minimal weight-bearing activities during that period. It is important that they meet the criteria listed in Table 2. If not, they should proceed with surgical repair.

Glazebrook/Rubinger Achilles Protocol for Nonoperative Treatment

Once patients are deemed appropriate for nonoperative treatment, they should be educated on the benefits, risks, and limitations of both operative and nonoperative

Table 2 Inclusion and exclusion criteria for nonoperative versus operative treatment of Achilles tendon ruptures		
Inclusion Criteria	Exclusion Criteria	
 Complete, midsubstance Achilles tendon rupture (diagnosed by Thompson squeeze test, palpable gap on the tendon, and confirmed by MRI) Willingness and ability to comply with the functional rehabilitation protocol Treatment began within the first 7 d of injury Informed consent was completed 	 Achilles tendon avulsion from calcaneus or calf muscle tear Not placed in plantar-flexed cast within the first 48 h of injury Open Achilles tendon Any additional injury to injured leg Prior rerupture or significant injury to the injured Achilles tendon Any physical or mental impairment that would affect a patient's ability to closely follow the protocol Any factors known to increase the risk for an Achilles tendon rupture (diabetes mellitus and immunosuppressive therapy, including local and systemic steroids and fluoroquinolones) 	

treatments. Patients who choose to undergo nonoperative treatment of Achilles tendon ruptures should be immobilized (preferably in plaster cast) in maximum passive plantar-flexion position (Fig. 3) and instructed to remain non-weight bearing for 2 weeks.

At the 2-week follow-up visit, the patients are placed in the Achilles-specific walking boot with 40° heel lifts (**Fig. 4**) or a similar boot, and the GAPNOT protocol should be initiated under the supervision of a physiotherapist. The detailed physiotherapy protocol is outlined in **Table 3**. Key features are outlined later but it is important to establish a weight-bearing schedule and guidelines with patient on the initial physiotherapy visit. Determining a weight-bearing schedule, as well as dates for the heel lifts to be removed and weaning from the boot walker, may help create compliance in the patient, which is key for successful outcome.

The physician follow-up, supervision, and care should continue at 6 weeks, 12 weeks, 26 weeks, and 52 weeks after the rupture. During these visits, the healing is assessed with history and physical examination, looking for and assessing resolving pain, swelling, ecchymosis, gradual return to activity specified by the GAPNOT protocol, and filling of the palpable defect. The physician also should examination patient length of the Achilles tendon ROM using careful passive dorsiflexion with the knee in extended position compared with the contralateral side. Patients should be counseled on avoiding a fall or stumble and avoiding activities that may force the ankle beyond the 90° dorsiflexion position.

The GAPNOT protocol involves progressive weight bearing, increasing by 25% body weight per week during weeks 3 to 6. During this time, patients commenced



Fig. 3. Achilles rupture immobilized non-weight bearing maximum passive plantar-flexion cast.



Fig. 4. Achilles-specific boot walker with heel wedges. (Achilles Boot image courtesy of Breg, Inc.)

pain-free, gradual active plantar and dorsiflexion exercises below 90° of ankle dorsiflexion, and conventional physiotherapy modalities are used for control of pain and swelling as needed. Electrical muscle stimulation with active heel raises in the sitting position also may be initiated at approximately the 3-week mark, ensuring the ankle does not go past 90° of ankle dorsiflexion. It is important that passive ranging of the ankle into dorsiflexion beyond 90° is avoided during the 2-week to 8-week stage.

During this stage, communication between physician and physiotherapist is optimal to deal with complications, such as reruptures, tendon elongation, noncompliance of patient, and blood clots. It is important that all exercises and weight bearing are pain-free and patients are decreasing activity if they are noticing any pain, swelling, or tension on the injured side. Patients typically use 2 crutches as they progress through weight bearing but often reduce to 1 crutch at approximately weeks 4 to 5 and no crutches by week 6. This progression of weight bearing status, however, is individualized.

Between 6 weeks and 8 weeks, the heel lifts are reduced gradually in height while fully weight bearing, followed by a further week to wean from the Achilles-specific boot. Patients often use assistance of a cane while weaning from a boot walker. An Achilles-specific compression garment (Fig. 5) is recommended to patients when weaning from a boot walker but is not mandatory. Physiotherapy continues during this stage with the addition of resisted ankle plantar-flexion exercises using resistance tubing.

While weaning from the boot walker at end of week 8, it is imperative to do this gradually with a step to gait initially, so as not lengthen the Achilles tendon. Patients are recommended to wear shoes at all times, even indoors, and avoid shoes with low heel rise. Patient cans lengthen their stride gradually over the next few weeks as the tendon lengthens naturally. They are still instructed to do stairs 1 at a time, protecting the Achilles tendon.

Between 8 weeks and 12 weeks, patients can initiate active plantar-flexion strengthening exercises but avoid activities that dorsiflex the ankle past neutral. Thereafter, strength, power, and endurance are worked on. It is imperative that patients are educated to avoid activities that place the foot beyond 90° of ankle dorsiflexion and

Table 3 Glazebrook/Rubinger Achilles protocol for nonoperative treatment		
Time Period	Protocol	
0–2 wk	 Plaster cast with ankle in maximum passive plantar flexion; non-weight bearing with crutches 	
2-4 wk	 Achilles-specific (or other) walking boot with maximum passive plantar-flexed heel lifts Protected weight bearing with crutches: Weeks 2-3—25% Weeks 3-4—50% Weeks 4-5—75% Weeks 5-6—100% Active plantar and dorsiflexion ROM exercises to neutral, inversion/eversion below neutral Modalities to control swelling (ultrasound, interferential current with ice, acupuncture, light/laser therapy) Electrical muscle stimulation to calf musculature with seated heel raises when tolerated. Patients being seen 2–3 times/wk depending on availability and degree of pain and swelling in the foot and ankle Knee/hip exercises with no ankle involvement, for example, leg lifts from sitting, prone, or side-lying Non-weight-bearing fitness/cardio work, for example, biking with 1 leg (with boot walker on), deep water running (usually not started until 3–4 wk point) Hydrotherapy if available (within motion and weight-bearing limitations) 	
4–6 wk	 activities and weight bearing. Continue weight bearing as tolerated Continue 2–4 wk protocol Progress electrical muscle stimulation to calf with lying calf raises on shuttle with no resistance as tolerated approximately weeks 5–6. Please ensure that ankle does not go past neutral while doing exercises. Continue with physiotherapy 2–3 times/wk. Emphasize patient doing non-weight-bearing cardio activities as tolerated with boot walker on. 	
6–8 wk	 Continue physiotherapy 2 times/wk Continue with modalities for swelling as needed. Continue with electrical muscle stimulation on calf with strengthening exercises. Do not go past neutral ankle position. Remove heel lifts in stages dependent on Achilles length. Remove 1 lift daily as tolerated. Always leave 1–2 lifts in to represent regular shoe lift, depending on boot design. Weight bearing as tolerated, usually 100% weight bearing in boot walker now. Graduated resistance exercises (open and closed kinetic chain as well as functional activities)—start with resisted tubing exercises With weighted-resisted exercises, do not go past neutral ankle position. Gait retraining now that 100% weight bearing Fitness/cardio to include weight bearing as tolerated, for example, biking Hydrotherapy 	
8–12 wk	 Ensure patient understands that tendon is still very vulnerable, and patients need to be diligent with activities of daily living and exercises. Any sudden loading of the Achilles (trip, step up stairs, etc.) may result in a rerupture. Wean off boot (usually over 2–5 d process—varies per patient), at night as well 	

Table 3 (continued)	
Time Period	Protocol
	 Wear Achilles compression ankle brace to provide extra stability and swelling control once boot walker is removed. Return to crutches/cane as necessary and gradually wean off. Have patient always wear shoes, limiting time in bare/sock feet. Continue to progress to ROM, strength, and proprioception exercises. Add exercises, such as stationary bicycle, elliptical, and walking on treadmill, as patient tolerates. Add balance board activities—standing with block to prevent dorsiflexion past neutral position. Add calf stretches in standing (gently). Do not allow ankle to go past neutral position. Add double-heel raises and progress to single-heel raises when tolerated. Do not allow ankle to go past neutral position. Continue physiotherapy 1–2 times/wk depending on how independent patient is at doing exercises and access to exercise equipment.
12–16 wk	 Continue to progress ROM, strength, and proprioception exercises. Retrain strength, power, endurance. Ensure patient understands that tendon is still very vulnerable and patients need to be diligent with activities of daily living and exercises. Avoid lunges, squats, etc., because these places excessive stretch on tendon.
16+ weeks	 Increase dynamic weight-bearing exercise, including sport-specific retaining (ie, skipping, jogging, and weight training).
6–9 mo	 Return to normal sporting activities that do not involve contact or sprinting, cutting jumping, etc., if patient has regained 80% strength
12 mo	 Return to sports that involve running/jumping as directed by medical team and tolerated if patient has regained 100% strength.



Fig. 5. Achilles-specific compression stocking. (Courtesy of Bauerfeind.)

allow normal activities of daily activities set the appropriate length of Achilles tendon. Physical therapy should still avoid stretching to achieve normal ROM at this stage.

During this stage, patients initiate using a stationary bicycle with little resistance, being careful to point their toes on the affected side while pedaling. They also can initiate closed kinetic chain strengthening exercises on resistance machines with care placed on not going past neutral (Fig. 6). They also are able to start double-heel raises multiple times daily. Initially, most of the weight and strength are coming from the nonaffected side; however, as they get stronger, they are encouraged to balance weight between both sides and slowly start to put more weight on the affected side, increasing its strength. Balance and proprioceptive retraining exercises can be initiated using a balance board device, which is blocked to prevent dorsiflexion (Fig. 7).

From 12 weeks to 16 weeks, they continue to attend physiotherapy, working on strengthening exercises and progressing the double-heel raises to modified double-heel raises with the nonaffected leg placed behind the affected side to isolate the calf raise on the affected side. Clinically, patients often are not able to do a single-heel raise until the 4-month mark postinjury. Patients also can continue with stationary bicycle, elliptical machine, and strengthening exercises at the gym, that is, seated and standing calf raises with weights if not going past neutral. Patients are cautioned to avoid lunges and squats till 6 months.

During the stage of 10 weeks to 16 weeks, the complication of rerupture and elongation of the tendon may be more common due to patients regaining a more normal activity pattern. Education and careful monitoring of activities that a patient is doing are essential to help prevent rerupture elongation. Patients often stop attending physical therapy during this period because they feel they are better when they can walk normal again. Patient compliance to program is essential for best outcomes.

From 4 months to 6 months, patients usually are doing strengthening exercises on their own at home or in a gym, with periodic rechecks with physiotherapists to ensure that they are not elongating the tendon and that strength in Achilles tendon is returning. Patients may initiate light skipping activities during this stage and light jogging can be initiated if they are able to do 25 consecutive single-heel raises.

From 6 months, gradual return to sporting activities is encouraged but patients are advised to avoid contact sports and high-intensity activities, such as sprinting, cutting, and jumping. From 9 months to 12 months, full return to sporting activity is allowed.



Fig. 6. Resistance training—active plantar flexion in week 8.



Fig. 7. Proprioceptive retraining with balance board blocked in rear to prevent dorsiflexion.

COMPLICATIONS Complete Rerupture

Complete rerupture is an uncommon but devastating complication of both operative and nonoperative treatment, with rates reported in the literature between 3% and 4%.² Patients who are identified with complete reruptures should be assessed by a surgeon for consideration of operative treatment. Although repeat nonoperative treatment is an option, it has not been studied. Patients should be educated on this.

Partial Rerupture

Partial rerupture is an uncommon complication of both operative and nonoperative treatments. When patients are identified with partial reruptures, they should be immediately immobilized in plantar-flexed position and made non-weight bearing and assessed by a surgeon for possible consideration of operative treatment. If operative treatment is deemed unnecessary, the protocol should be adjusted with consensus between the physical therapist and physician as to which time point in the GAPNOT protocol the patient needs to revert to.

Elongation

Elongation likely is more common with nonoperative treatment if protocol is not administered properly or in patients who are noncompliant. Although this may occur at any time point, it is more likely during the 10-week to 16-week mark as patients start walking and gain confidence. Elongation can be identified on follow-up visits by poor progression of strengthening and careful examination of patient extent of passive dorsiflexion with knee in extended position compared with contralateral side (Fig. 8). If elongation is identified, the protocol should be adjusted with consensus between the physical therapist and physician as to which time point in the GAPNOT protocol the patient may need to revert to. If elongation is extreme, patients should be advised



Fig. 8. (A, B) Examination of the patient's Achilles tendon length with knee in extended position.

of risks and benefits of surgical shortening of the tendon and continued nonoperative treatment with shortening surgery as necessary.

Deep Vein Thrombosis and Pulmonary Embolism

Deep vein thrombosis and pulmonary embolism are rare occurrences but serious potential complications with immobilization and casting. They should be considered with calf pain, swelling, and shortness of breath, and emergency treatment should be sought immediately.

Calf Atrophy and Poor Strength

With proper Achilles tendon length, calf atrophy and poor strength are minor complications in the long term when patients do not complete the physical therapy protocol. They often result because patients can resume all normal activities of daily living and sporting events and do not understand the need for doing isolated and specific calfstrengthening exercises. When calf weakness is identified, patients are educated on the importance of isolated Achilles strengthening exercises on the affected side.

SUMMARY

Historically, when functional rehabilitation was not used for the nonoperative treatment of an acute midsubstance rupture of the Achilles tendon, the benefits of surgical treatment have been cited as increased strength, decreased rerupture, and a faster return to high-level activity. However, two high-quality level 1 studies^{2,3} have demonstrated that nonoperative treatment with functional rehabilitation provides equivalent outcomes to surgical treatment. As a result, there has been an increased incidence of patients avoiding the risks of surgery and choosing nonoperative treatment.

It is essential that patients and surgeons alike understand that nonoperative treatment does not mean no treatment. Nonoperative treatment protocols, such as the GAPNOT protocol described in this article, must be closely supervised by an experienced physiotherapist and physician, with open communication to allow optimal results and avoid complications. If this cannot be done, patients should be educated on the historical benefits of surgery in the absence of functional rehabilitation.

Treatment failure and resultant complications with nonoperative treatment almost always are due to noncompliance, overzealous activity, or neglect by physiotherapist or physician. As such, patient selection and education are important and following the GAPNOT protocol is essential. Furthermore, close supervision and good communication by both physical therapist and physician are mandatory to avoid, identify, and treat the complications of nonoperative treatment.

In summary, nonoperative treatment of acute midsubstance Achilles tendon ruptures with functional rehabilitation, such as the GAPNOT protocol, described in this article, provides clinical outcome similar to operative treatment. It is essential that physicians and physiotherapist work closely to supervise and administer care to optimize outcomes and avoid complications.

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