Outcomes of Functional Weight-bearing Rehabilitation of Achilles Tendon Ruptures

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abstract

Full article available online at Healio.com/Orthopedics. Search: 20130724-23

The introduction of functional rehabilitation for patients with Achilles tendon rupture has dramatically changed treatment programs for this condition. The authors introduced a functional weight-bearing protocol for patients with an acute Achilles tendon rupture treated operatively and nonoperatively in 2002. They hypothesized that no significant differences would exist in the rerupture rates and functional outcomes between the groups.

Between 2002 and 2008, the authors collected data on 80 consecutive patients treated with a weight-bearing functional orthosis for complete Achilles tendon rupture. Following evidence-based counseling, 51 patients chose nonoperative treatment and 29 chose operative treatment. Outcome measures included rerupture rates, other complications, and functional scoring. The nonoperative group was a decade older (median age, 47 years [range, 27-80 years]) than the operative group (median age, 37 years [range, 24-55 years]). Rerupture was noted in 2 (4%) patients in the nonoperative treatment group and 1 (3%) patient in the operative group. Two (7%) patients in the operative group developed superficial wound infections and reported no nerve injuries. Median Achilles Tendon Total Rupture Score was 82 points in the nonoperative group and 94 in the operative group. Median Victorian Institute of Sports Assessment-Achilles tendinopathy questionnaire scores were 60 and 91 for the nonoperative and operative groups, respectively.

Both groups had low rerupture rates. Functional scores, using the newly validated Achilles Tendon Total Rupture Score, were lower in the nonoperative group.

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doi: 10.3928/01477447-20130724-23
The introduction of functional care for patients with Achilles tendon rupture has dramatically changed treatment programs for this condition. Previously, patients were offered nonoperative management with a period of immobilization of at least 6 to 8 weeks in a cast or splint and an accepted high risk of rerupture offset against the risk of nerve damage and wound breakdown after surgical repair.1-3

Functional rehabilitation with early weight bearing has produced favorable results in patients who underwent primary surgical repair and those who had nonoperative treatment and rehabilitation. Functional nonoperative treatment appears to produce a rerupture rate more comparable with the operative rate without the associated surgical risks.4-6 Various braces and dynamized casting techniques have been reported in the literature.7-11 Immediate weight bearing after injury shows no evidence of tendon elongation or increased rerupture rates.7 In the operative group, early range of motion (ROM) reduced tendon elongation.12 Active ankle movement with restriction of dorsiflexion was started from within days after injury to as late as 4 weeks after injury in various protocols.7,9,11 One study reported increased soft tissue problems in a functional brace, but these braces were worn full-time for several weeks.13

Functional bracing in the nonoperative group can facilitate a return to preinjury activities.8,14 A meta-analysis of postoperative regimes found more good results in patients treated functionally, with no increase in the rerupture rate.15 Patient satisfaction improved with functional early weight bearing, with a reduced rehabilitation period in these patients.7,10,15

Randomized, controlled studies in which patients had functional aftercare in both groups had lower rerupture rates than were traditionally quoted. One study proposed that early ROM is the most important factor in predicting outcome following Achilles tendon rupture.6 If little overall difference exists between the results of operative and nonoperative treatment, patients could make choices depending on their own preference after receiving evidence-based advice.

Previously, the rerupture risk was a major influence on the recommended treatment. If the difference in rerupture rates is smaller with functional care, overall functional outcome becomes a more important factor for patients to consider. A patient-reported outcome score may help differentiate between these 2 functional treatment regimes.

Until recently, no specific patient-reported score has been reported for this injury.9 Some studies have used indicators such as time to return to work or sport,16,17 ankle range of motion (ROM), isokinetic strength, and calf circumference have been used, with various outcome scores, such as the Musculoskeletal Functional Assessment Instrument score.4,6,10,12,18,19 The Victorian Institute of Sports Assessment-Achilles tendinopathy (VISA-A) questionnaire was designed to be a valid and reliable measure of the severity of Achilles tendonopathy and is easy to administer.20 The Achilles Tendon Total Rupture Score (ATRS) was the first score specific to this injury that has been validated, but it is not widely used.21

In the authors’ department, patients are told about operative and nonoperative treatments but are advised that functional aftercare is beneficial with both treatments. Patients are encouraged to make their own choice on primary treatment depending on their perception of goals, needs, and attitudes about the risks. This article describes a case series in which the focus is on functional treatment and patient choice. The authors investigated whether patient choice would lead to the patients selecting predictable groups and whether their initial treatment choice was associated with differences in functional score, return to activity, or complications. This information could help improve the advice surgeons give to future patients. The authors also examined the usefulness of 2 functional scores (VISA-A and ATRS) in assessing patient outcomes.

**Materials and Methods**

Between December 2002 and May 2008, the authors treated 80 consecutive patients for acute Achilles tendon rupture at their institution. A prefabricated ankle orthosis (VACOped; OPED, Valley, Germany), which is a self-adapting vacuum cushion within a rigid shell with a removable sole that allows for different settings of ankle position, was used for postoperative rehabilitation and nonoperative care. Although the authors’ focus was the functional aftercare, they also present brief details of the overall care program. This was constructed by the senior author (J.B.) and based on evidence available in the literature.1 Approval was obtained from the local research and ethics committee to follow these patients.

Patients presenting to the authors’ institution with an acute closed rupture of the Achilles tendon were counseled about operative and nonoperative treatment, including functional rehabilitation in a prefabricated ankle orthosis. Patients were advised that the functional results of both treatment programs are similar, although recovery may be quicker after surgery. Rerupture rates of 12% for nonoperative treatment and 5% for operative treatment were initially quoted, along with a 10% wound complication rate for surgery. Patients chose their treatment program after discussing their care with their surgeon. In patients undergoing surgery, informed consent was confirmed by completing the Department of Health–approved hospital surgical consent form, with a thorough explanation of the risks and complications by a senior clinician.

All patients were diagnosed based on history and clinical examination findings using standard tests, such as the Thompson calf squeeze test and tendon palpation for a gap.22-24 In 1 patient, the diagnosis was confirmed using an ultrasound scan. The
authors did not have ready access to ultrasonography for trauma patients in the early period of data capture. Reduction of the tendon gap was assessed by palpation. No patient was excluded because of inability to close the gap in plantarflexion. All patients presented within 2 weeks of injury.

Surgical Technique

Patients in the operative group underwent open Achilles tendon repair by an orthopedic consultant or specialist registrar under consultant supervision. All surgeons used a standard Kessler technique. The suture materials varied with surgeons’ preferences. Intraoperatively, the ankle position was compatible with avoiding excessive tension on the repair and was assessed visually. This position could be plantigrade, but some degree of plantarflexion was necessary to avoid tension in many patients. The paratenon was repaired with 2-0 braided absorbable sutures, and the skin was repaired with various techniques according to the surgeons’ preferences.

Postoperatively, a posterior plaster-of-Paris splint was applied in the ankle position chosen intraoperatively. No orthosis was applied immediately postoperatively because the authors were uncertain about whether this might lead to wound problems. The orthosis was fitted 1 week postoperatively when the wound was healing satisfactorily. The dorsiflexion block was reduced over a 6-week period (Table 1). Active ROM exercises, protected dorsally by the flange of the boot, were started when the ankle was at 15° of plantarflexion.

Nonoperative Treatment

For nonoperative treatment, the orthosis was applied immediately at 30° of plantarflexion. At week 3, the ankle orthosis was reset to 15° of plantarflexion, and protected active ROM was started. The orthosis was normally worn for 8 weeks following the protocol provided in Table 1. Patients in both groups were permitted to bear full weight as pain allowed.

When the study began, the thromboembolism risk was thought to be low after Achilles tendon repair. No patient was prescribed routine thromboprophylaxis.

Patients were supervised throughout treatment in the VACOped boot by the senior orthotist (C.M.) but remained under the care of a consultant orthopedic surgeon who was available if needed. Patients attended weekly clinical reviews with the orthotist. At each visit, the ankle orthosis was removed, the tendon was palpated, and the soft tissues were assessed. The wound was also inspected. After weeks 3 to 4, the Thompson calf squeeze test was performed, and the apparent integrity of the tendon on resisted plantarflexion was assessed.24 The ankle was gradually brought from the equinus position to plantigrade and could be adjusted depending on the examination findings. The orthotist was trained how to examine the Achilles tendon by a consultant foot and ankle surgeon (J.B.) as part of the authors’ multidisciplinary foot and ankle team. The Thompson calf squeeze test and tendon palpation are common clinical tests; the authors have no data on their reliability.

Patients were evaluated by medical staff if they had concerns about their progress or wounds. Otherwise, they were referred by the orthotist for physiotherapy at the conclusion of their time in the brace.

Data for the study were collected by the orthotist at each clinic visit. The authors also reviewed the clinic letters and the physiotherapy database. All known reruptures were recorded in the orthotist’s database. However, a specific search of all case notes was performed to ensure the completeness of the data.

Patients were contacted via telephone or mail. Informed consent was obtained, and patients completed the VISA-A and ATRS questionnaires. Patients also answered questions to ascertain whether any reruptures were not treated at the authors’ institution, what the injury mechanism was, their preinjury activity level, and their type of employment pre- and postinjury.

The VISA-A questionnaire, which comprises 8 questions and has a maximum score of 100, was originally validated for Achilles tendinopathy.20 The ATRS questionnaire, which comprises 10 questions and has a maximum score of 100, is a recently validated outcome score for acute total Achilles tendon rupture. This is the only score specific to this condition, but it is not commonly used.21

The authors summarized the findings using descriptive statistics. The exact test was used to compare proportions, and nonparametric tests were used to compare values for each group because the data were not normally distributed.

RESULTS

Eighty patients were originally entered into the study. Patient characteristics are shown in Table 2. Patients in the nonoperative group (median age, 45 years [range, 27-80 years]) were a decade older than those in the operative group (median age, 36 years [range, 24-55 years]). The

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Nonoperative Group</th>
<th>Operative Group</th>
</tr>
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<tbody>
<tr>
<td>1-2</td>
<td>30° plantarflexion</td>
<td>30° plantarflexion</td>
</tr>
<tr>
<td>3-4</td>
<td>15° plantarflexion</td>
<td>15° plantarflexion</td>
</tr>
<tr>
<td>5-6</td>
<td>Plantigrade</td>
<td>Plantigrade</td>
</tr>
<tr>
<td>7-8</td>
<td>10° dorsiflexion</td>
<td>10° dorsiflexion</td>
</tr>
</tbody>
</table>


male-to-female ratios for the nonoperative and operative groups were 2:1 and 9:1, respectively. Table 3 shows the complication rates. The rerupture rate was 4% (n=2) in the nonoperative treatment group. Of these patients, 1 chose further brace treatment and the other chose surgical repair. In the operative group, 1 (3%) patient sustained a rerupture and chose nonoperative treatment. The difference between the rerupture rates of the 2 groups was nonsignificant. Two (7%) wound infections occurred in the operative group, and both were treated with oral antibiotics; no surgical debridement was required. No sural nerve injuries were identified. Including the patient who developed a keloid scar, the overall incidence of wound problems was 10.3% (3 of 29 patients; 95% confidence interval, 2.2%-27.4%). No patient sustained clinically apparent deep vein thrombosis, wound breakdown, or pressure sores. The authors did not attempt to diagnose occult venous thrombosis by ultrasound.

The overall questionnaire follow-up rate was 66 (83%) patients (43 of 51 nonoperative patients and 23 of 29 operative patients). Fourteen (17%) patients were lost to follow-up because they could not be contacted at their home telephone number and did not return the questionnaire that was subsequently mailed to their address on file.

Table 4 shows the pre- and postinjury sporting activity levels. The operative and nonoperative groups were different in several respects. Twenty-four percent of the nonoperative group was retired preinjury compared with none in the operative group (P=.001). Half of the nonoperative group compared with three-quarters of the operative group had active occupations, but this difference was not significant. Nine patients (24%) in the nonoperative group compared with 1 patient (5%) in the operative group did not play a sport before injury, although the difference in sports-related injuries was not statistically significant. A trend existed in which

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### Table 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Nonoperative Group</th>
<th>Operative Group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients (N=80)</td>
<td>51</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Mean age (range), y</td>
<td>47 (27-80)</td>
<td>37 (24-55)</td>
<td>.000005</td>
</tr>
<tr>
<td>Median age</td>
<td>45</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>No. of M/F (ratio)</td>
<td>35/16 (2:1)</td>
<td>26/3 (9:1)</td>
<td></td>
</tr>
<tr>
<td>Comorbidities</td>
<td>3 long-term steroids (RA, SLE, COPD); 2 diabetes mellitus</td>
<td>1 long-term steroid (anabolic)</td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations:** COPD, chronic obstructive pulmonary disease; RA, rheumatoid arthritis; SLE, systemic lupus erythematosus.

### Table 3

<table>
<thead>
<tr>
<th>Complication</th>
<th>Nonoperative Group (n=51)</th>
<th>Operative Group (n=29)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rerupture</td>
<td>2 (4)</td>
<td>1 (3)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0 (0)</td>
<td>3 (10)</td>
<td></td>
</tr>
<tr>
<td>Wound infection</td>
<td>0 (0)</td>
<td>2 (7)</td>
<td></td>
</tr>
<tr>
<td>Keloid scar</td>
<td>0 (0)</td>
<td>1 (3)</td>
<td></td>
</tr>
<tr>
<td>Sural nerve injury</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviation:** NS, not significant.

### Table 4

<table>
<thead>
<tr>
<th>Variable</th>
<th>Nonoperative Group (n=51)</th>
<th>Operative Group (n=29)</th>
<th>P</th>
</tr>
</thead>
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<tr>
<td>Injury mechanism</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Sports</td>
<td>17 (46)</td>
<td>13 (60)</td>
<td>NS</td>
</tr>
<tr>
<td>Fall/trip/slip</td>
<td>12 (32)</td>
<td>3 (13)</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>8 (22)</td>
<td>6 (27)</td>
<td>NS</td>
</tr>
<tr>
<td>Sports prior to injury</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>28 (76)</td>
<td>21 (95)</td>
<td>NS</td>
</tr>
<tr>
<td>No</td>
<td>9 (24)</td>
<td>1 (5)</td>
<td>.04</td>
</tr>
<tr>
<td>Return to sports</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not all</td>
<td>7 (25)</td>
<td>3 (14)</td>
<td>.08</td>
</tr>
<tr>
<td>Modified training and competition</td>
<td>13 (46)</td>
<td>7 (33)</td>
<td></td>
</tr>
<tr>
<td>Full training, modified competition</td>
<td>2 (7)</td>
<td>1 (5)</td>
<td></td>
</tr>
<tr>
<td>Full return to training and competition</td>
<td>6 (22)</td>
<td>10 (48)</td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviation:** NS, not significant.

*Not all patients could be contacted or agreed to follow-up for scoring.*
operative patients were more likely to return to sport, but this was not statistically significant. All patients who were working before injury returned to work.

Table 5 shows the functional scores. Median ATRS was 84 points (range, 25-100 points) in the nonoperative group compared with 94 points (range, 23-100 points) in the operative group, which represented a statistically significant difference. Median VISA-A score was 66 points (range, 9-100 points) in the nonoperative group compared with 91 points (range, 18-100 points) in the operative group. However, on the VISA-A score, 40 points are awarded for a return to sport and the level at which it is achieved. Twenty-four percent of the nonoperative group played no sport prior to injury and were thus significantly handicapped in the VISA-A score. Therefore, the authors also analyzed the VISA-A scores excluding patients who did not participate in sports prior to injury. Median score in the nonoperative group then increased to 74 points compared with 92 points in the operative group, and the difference was no longer significant. Because the nonoperative group was older than the operative group, the authors investigated whether age might predict the functional scores; however, because a slight negative correlation existed between age and both functional scores, this was not statistically significant (Spearman correlation coefficient).

When reviewing the individual question scores, the nonoperative group score was worse in 4 particular questions that related to sports rather than activities of daily living. Questions 8 and 9 of the ATRS refer to activities involving running and jumping, and, as previously mentioned, questions 7 and 8 of the VISA-A are sport specific. Some patients reported that they had not or would not attempt running, jumping, or sports postinjury. Several of these patients, particularly those who were older, did not participate in these activities preinjury. These item-related findings limit the applicability of these scores to a non-sporting population.

**DISCUSSION**

This study did not set out to directly compare the nonoperative and operative management of Achilles tendon ruptures. Instead, the authors sought to establish that functional rehabilitation with early mobilization is a satisfactory approach for the management of these patients in terms of patient-reported function and rerupture rates and believe that the study has confirmed this.

Therefore, the authors offered patients an evidence-informed choice between operative and nonoperative treatment, both with functional aftercare. When the study began, the main difference seemed to be a lower risk of rerupture but a higher risk of soft tissue problems with initial surgical treatment, although subsequent studies have suggested that the risk of rerupture in nonoperatively treated patients is lower than was previously thought.  

Patients selected dissimilar groups, with the operative group being 10 years younger, more physically active, and more likely to play sports preinjury. A previous study reported similar findings but did not state the advice on which patients chose operative or nonoperative treatment. Given these dissimilar groups, any comparison between outcomes must be treated with caution. However, the rehabilitation principles were the same in each group and were the main focus for this study.

The current authors divided operative and nonoperative patients in their results, primarily to illustrate the low rerupture rates in the nonoperative group, which were lower than may have been anticipated. The nonoperative group also scored well on the ATRS, which may be a more realistic reflection of some activities of daily living.

**Rerupture**

The current rerupture rates were low and consistent with other functional treatment series. In a meta-analysis of 12 studies, Khan et al. reported rerupture rates of 12.6% for nonoperative and 3.5% for operative treatment, which was similar to the findings of Bhandari et al. However, both studies referenced studies with variable treatment regimens, not all of which were functional, weight bearing, or both. The more relevant subanalysis of pooled data showed rerupture rates of 12.2% after cast treatment and 2.4% after functional nonoperative treatment. Subsequent studies, including functional nonoperative treatment, suggest the possibility that rerupture rates are lower after functional than nonfunctional nonoperative treatment, and the current study supports this. This was an important advance in the safety of nonoperative care and should be studied further.

**Soft Tissue Complications**

The wound infection rate in the operative group was as expected, with 1 keloid scar formation. Pooled rates of soft tissue complications from the meta-analyses in the literature ranged from 2.7% in the nonoperative group to 34.1% in operative group, with infection rates of 4.7%, No nerve injuries occurred.

<table>
<thead>
<tr>
<th>Table 5</th>
<th>ATRS and VISA-A Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Score</strong></td>
<td><strong>Points, Median (Range)</strong></td>
</tr>
<tr>
<td>ATRS</td>
<td>84 (25-100)</td>
</tr>
<tr>
<td>VISA-A</td>
<td>66 (9-100)</td>
</tr>
</tbody>
</table>

**Abbreviations:** ATRS, Achilles Tendon Total Rupture Score; VISA-A, Victorian Institute of Sports Assessment-Achilles tendinopathy questionnaire.
In a randomized, controlled trial, Metz et al\textsuperscript{13} compared operative with nonoperative treatment using the same brace used by the current authors and raised an important concern about the 32% soft tissue complication rate attributed to the brace, including fungal infections, blisters, and pressure sores. Metz et al\textsuperscript{13} kept patients in the brace continuously for the entire 7-week treatment program. The current authors had no such problems, suggesting that attending the orthotists’ weekly reviews and educating patients to remove part of the ankle orthosis for ROM prevents such complications. A good nonoperative management protocol should be as meticulous as that following operative treatment to ensure comparable results. Patients treated nonoperatively should be monitored as regularly as those treated operatively to prevent these problems.

**Functional Outcomes**

*Return to Work.* All patients returned to their previous level of employment in both groups, which is in accordance with another series’ conclusion that this injury does not commonly prevent return to work.\textsuperscript{13}

*Return to Sport.* Costa et al\textsuperscript{7} reported functionally treated ruptures; their rate of return to sport was 83% (compared with 86% in the current study) in the operative group and 56% (compared with 75% in the current study) in the nonoperative group. However, in the current study, the operative group was more active preinjury and returned to a higher activity level than the nonoperative group. Twenty percent of patients did not return to sport (several chose not to do so after injury).

*Achilles Tendon Total Rupture Score and Victorian Institute of Sports Assessment-Achilles Tendinopathy Questionnaire Scores.* Higher VISA-A and ATRS scores were found in the younger, more active, and predominantly male patients in the operative group despite functional aftercare in both groups. However, the VISA-A score gives 40 points for return to sport, which builds in a bias against patients who did not play sports preinjury or chose not to attempt to return. On the ATRS, some older patients marked 0 on some questions because they stated that they had no reason to run, jump, or undertake hard physical labor. These considerations should be taken into account in interpreting the findings of trials using these scores.

The current series is one of the first to use the ATRS, with scores of 84 and 94 points in the nonoperative and operative groups, respectively. In the original article that describes and validates the score, Nilsson-Helander et al\textsuperscript{21} obtained a median ATRS of 84 points for 82 patients with Achilles rupture; however, the treatment protocol was not specified, and the control group had a median of 100 points.

No conclusions can be drawn from the current study as to whether nonoperative or operative treatment is preferred; this was not the intention of the study. Patients were allocated to treatment by their own choice after receiving evidence-based counseling. Younger, more physically active patients were more likely to choose surgery, and older, less-active patients were more likely to choose nonoperative treatment. Thus, the groups are not as comparable as they would be in a randomized trial.

Rather, this study presents likely patient outcomes in realistic modern practice that incorporate patient choice and multidisciplinary management with support from a good orthotic service. Patients who chose nonoperative treatment scored lower on both scores. In the series by Costa et al\textsuperscript{7} the outcome measures were similar for patients who chose operative and nonoperative treatment, although their outcome measures were more generic. The outlook, activity level, and goals of the patients may have affected their approach to treatment, rehabilitation, and functional scores. Although the current authors did not include formal satisfaction ratings, both groups expressed general satisfaction with their personal outcomes. Qualitative enquiry into the experience of treatment for an Achilles tendon rupture may shed further light on the findings. Furthermore, the pattern of patient preference shown in the current study and that reported by Costa et al\textsuperscript{7} should inform the design and generalization of future randomized trials comparing operative and nonoperative treatment.

The current series was limited due to its retrospective, nonrandomized nature, with an 83% questionnaire follow-up rate. Informed patient choice has created treatment selection bias, with older, more sedate patients choosing nonoperative management. However, the current functional outcomes and adverse event rates are comparable with other reports of functional treatment in Achilles tendon rupture.\textsuperscript{5,6,13}

**CONCLUSION**

This series showed low rerupture and complication rates in nonoperative and operative functional weight-bearing Achilles tendon rupture treatment. Follow-up can safely be performed by orthotists and physiotherapists in the context of the multidisciplinary team. Functional scores using the ATRS and VISA-A score were lower in the older nonoperative group. The younger operative group had higher rates of return to sport. All patients returned to their previous levels of employment. Both treatment modalities are safe and can be recommended to patients with advice regarding the difference in outcome scores and return to sport but similarities in rerupture rates.

**REFERENCES**


