Weight-Bearing in the Nonoperative Treatment of Acute Achilles Tendon Ruptures

A Randomized Controlled Trial

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Investigation performed at the North Shore Hospital and Middlemore Hospital, Auckland, New Zealand

Background: The rate of Achilles tendon ruptures is increasing, but there is a lack of consensus on treatment of acute injuries. The purpose of this trial was to compare outcomes of weight-bearing casts with those of traditional casts in the treatment of acute Achilles tendon ruptures.

Methods: Eighty-four patients with an acute Achilles tendon rupture were recruited over a two-year period. Patients were randomized to be treated with either a weight-bearing cast with a Böehler iron or a non-weight-bearing cast for eight weeks. Patients underwent muscle dynamometry testing at six months, with additional follow-up at one and two years. The primary outcomes that were assessed were the rerupture rate and the time taken to return to work. Secondary outcomes included return to sports, ankle pain and stiffness, footwear restrictions, and patient satisfaction.

Results: There were no significant differences between groups with regard to patient demographics or activity levels prior to treatment. At the time of follow-up at two years, one (3%) of the thirty-seven patients in the weight-bearing group and two (5%) of the thirty-seven in the non-weight-bearing group had sustained a rerupture (p = 0.62). The patients in the weight-bearing group experienced less subjective stiffness at one year. There were no significant differences in time taken to return to work, Leppilaiti scores, patient satisfaction, pain, or return to sports between the groups.

Conclusions: Use of weight-bearing casts for the nonoperative treatment of Achilles tendon ruptures appears to offer outcomes that are at least equivalent to those of non-weight-bearing casts. The overall rerupture rate in this study was low, supporting the continued use of initial nonoperative management for the treatment of acute Achilles tendon ruptures.

Levels of Evidence: Therapeutic Level I. See Instructions for Authors for a complete description of levels of evidence.

Peer Review: This article was reviewed by the Editor-in-Chief and one Deputy Editor, and it underwent blinded review by two or more outside experts. It was also reviewed by an expert in methodology and statistics. The Deputy Editor reviewed each revision of the article, and it underwent a final review by the Editor-in-Chief prior to publication. Final corrections and clarifications occurred during one or more exchanges between the author(s) and copyeditors.

Acute Achilles tendon ruptures are common in adults and can result in prolonged disability. Currently, the incidence is approximately seven per 100,000, and evidence suggests that this is increasing. Despite the large number of patients with this injury, there is a lack of consensus regarding the optimum treatment for acute ruptures. Randomized studies comparing operative with nonoperative treatment have shown that operative treatment can achieve a significantly lower rerupture rate; a 2004 Cochrane Collaboration meta-analysis showed open surgical repair to be associated with a 3.5% risk of rerupture compared with 12.6% following nonsurgical treatment. However, many of the pooled trials in the meta-analysis used non-weight-bearing casts in the nonoperative group. More recently, meta-analyses of trials comparing “functional” nonoperative protocols have demonstrated rerupture rates equivalent to those of operative management.

Functional bracing protocols generally combine early motion and early weight-bearing, two factors that basic-science
studies have suggested may prevent detrimental alterations in muscle characteristics and favorably influence maturation of collagen fibers within the tendon during healing. It is unclear which of these factors contributes most to the reported clinical gains. Early motion requires the additional cost of a removable orthosis, and the results depend on patient compliance, without which there is an increased risk of complications such as rerupture or healing in an elongated position.

Early weight-bearing alone may improve outcomes following surgical repair of Achilles tendon ruptures, however, to our knowledge, only two small studies have directly compared weight-bearing casts with traditional non-weight-bearing casts for non-operative treatment. Weight-bearing casts may also have the advantages of convenience, reduced risk of falls, and possibly an early return to work. The aim of this study was to compare outcomes of traditional non-weight-bearing casts with those of weight-bearing casts in the treatment of acute Achilles tendon ruptures.

Materials and Methods

This randomized controlled trial with a two-year follow-up was conducted at three centers: Middlemore, North Shore, and Waitakere Hospitals in New Zealand. The study protocol was approved by the Northern X regional ethics committee, and all patients in the study provided informed consent. The trial was registered with the Australian New Zealand Clinical Trials Registry (ANZCTR), registration number ACTRN12612000028808. The full trial protocol is available on this organization’s web site.

Patients who presented to the emergency department or were referred by their general practitioner with an acute Achilles tendon rupture were offered inclusion in the study if they were at least eighteen years old, had a unilateral Achilles tendon rupture, presented within seventy-two hours after injury, were able to return for a six-month evaluation, and would be available for a twelve and twenty-four-month telephone follow-up. Exclusion criteria included a previous tendon rupture, previous tendon surgery, open injury, and multiple injuries on presentation.

As part of the recruitment process, all patients were given a standardized information sheet explaining the current protocol of treatment. Those who declined to participate were treated conservatively with a standard non-weight-bearing cast as per standard treatment at the time. Those who consented were randomized to treatment with either a below-the-knee non-weight-bearing cast or a below-the-knee weight-bearing cast fitted with a Böhler iron (see Appendix). Patients in the weight-bearing group were instructed to begin full weight-bearing immediately after the Böhler iron was fitted. Enrollment was done by a third party with no affiliations to the investigators, and patients were randomized with use of computer-generated numbered, sealed, opaque envelopes opened prior to treatment.

The patients’ age and sex as well as occupation, ankle activity index score (modified Tegner score), and time from injury to application of the cast were recorded. The diagnosis of midsubstance Achilles tendon rupture was made

<table>
<thead>
<tr>
<th>TABLE I One-Year Results</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>No. of reruptures</td>
</tr>
<tr>
<td>Time to return to work* (wk)</td>
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<tr>
<td>Return to work in &lt;4 wk†</td>
</tr>
<tr>
<td>Leppilahti questionnaire score* (out of 70)†</td>
</tr>
<tr>
<td>No pain</td>
</tr>
<tr>
<td>No stiffness or minimal stiffness</td>
</tr>
<tr>
<td>No footwear restrictions</td>
</tr>
<tr>
<td>Very satisfied</td>
</tr>
<tr>
<td>Self-rated Achilles tendon score*</td>
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<td>Ankle Tegner score*</td>
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</tbody>
</table>

*The values are given as the mean and standard deviation. †The values are given as the number and percentage of patients.

<table>
<thead>
<tr>
<th>TABLE II Six-Month Results</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>Leppilahti score*</td>
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<tr>
<td>Categorized score†</td>
</tr>
<tr>
<td>Excellent</td>
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<tr>
<td>Good</td>
</tr>
<tr>
<td>Fair</td>
</tr>
<tr>
<td>Poor</td>
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<tr>
<td>Isokinetic strength score*</td>
</tr>
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</table>

*The values are given as the mean and standard deviation. †The values are given as the number and percentage of patients.
Clinically on the basis of a positive history, local swelling and tenderness, and a positive Thompson calf-squeeze test. An equinus cast was applied to all patients, who wore the cast for eight weeks. Initially, the cast was placed in a position of maximal passive plantar flexion in both groups, and then all patients were seen in the clinic at four weeks for a cast change to a resting 20° equinus cast position. Heel-lifts measuring 2 cm were also fitted, and after eight weeks all casts were removed and the patients were instructed to wear the heel-lift for another four weeks (Fig. 1).

The primary outcome was the rerupture rate at one year and two years. In addition, all patients were evaluated at fourteen weeks after cast removal as part of standard clinical practice. At this visit, they were asked about the time between their injury and return to work as a specific outcome measure of the study. The patients were asked to return for ankle dynamometry at six months, as part of determining their Leppilahti score.²²

Ankle dynamometry was performed with use of a Biodex Multi-Joint System 3 dynamometer (Biodex Medical Systems, Shirley, New York). Participants lay supine on the positioning chair of the Biodex system with the knee supported and extended. Care was taken to securely strap the foot down in the axis of rotation on the dynamometer. The same blinded investigator performed this evaluation for all patients. The subjects performed five suboptimal contractions to familiarize themselves with the procedure. They then performed five isokinetic plantar flexion and dorsiflexion cycles at three test speeds (30°, 90°, and 240° per second). A final isokinetic strength score was calculated as described by Leppilahti et al.²² Briefly, the peak torques generated at each of the three speeds by the injured limb for both plantar flexion and dorsiflexion are compared with those generated by the contralateral limb, giving a percentage difference between the sides. The percentage difference at each testing speed is converted to

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**Fig. 1**
Study protocol. GP = general practitioner.
a score with use of a scale and summated to give a final isokinetic strength score out of 102. This score is also used as a component of the overall Leppilahti score.

The Leppilahti scoring scale is a standardized protocol for evaluating recovery following Achilles tendon ruptures, with a total score between 0 and 100. This score is arbitrarily categorized as excellent (90 to 100), good (75 to 85), fair (60 to 70), and poor (<55). The isokinetic strength score outlined above and ankle motion together contribute 30 points. The remaining 70 points are derived from subjective ratings of pain, calf muscle weakness, stiffness, footwear restrictions, and satisfaction. Although the Leppilahti score was originally designed to assess outcome following surgical repair of Achilles tendon ruptures, it is commonly used in the assessment of outcomes following nonoperative treatment.

A comprehensive telephone assessment was performed at twelve months, with the patients asked to respond to the subjective elements of the Leppilahti scoring system (pain, stiffness, footwear restrictions, weakness, and satisfaction). They were also asked about their level of sports activity according to the modified Tegner scoring system and to give a rating on a 10-point scale for the current condition of the injured tendon. They were also asked if any acute or subacute loss of function had developed, related to an injury or otherwise, or if medical consultation had been sought due to functional concerns. The modified Tegner score used to assess sports-related function was derived from the scoring system originally described by Tegner and Lysholm to assess recovery after knee ligament injuries. It was modified for use following ankle injuries. For this study, the Tegner scoring system was modified to reflect the range of sports activities common to our patient community. For all but the fourteen-week assessment (a regular follow-up examination that was not used for this study), evaluators were blinded to the group to which the patient had been allocated.

Statistical Methods

In a previous randomized trial of nonoperatively managed patients, Petersen et al. recorded a rerupture rate of 17% in their non-weight-bearing group compared with 0% in their weight-bearing group. A power calculation based on data from that study determined that thirty-seven patients were required in each arm of our study to provide an 80% chance of detecting a significant difference (p < 0.05) in rerupture rates.

All categorical variables were analyzed with use of the chi-square test. Continuous variables were evaluated with use of the Student t test or Mann-Whitney U test, depending on the distribution characteristics of the data. In all comparisons, a p value < 0.05 was considered significant.

Source of Funding

Funding support was received from the Wishbone Foundation.

Results

From 2007 to 2009, 309 patients presenting to the three study centers were diagnosed with an acute Achilles tendon rupture; 225 were excluded as outlined in Figure 2, leaving eighty-four randomized patients. As per current practice at the treating centers, patients with a delayed presentation (more than seventy-two hours following the initial injury) were advised to undergo operative treatment (Fig. 2). Of the eighty-four patients randomized, forty-three were male and forty-one were female. The average age of the patients was 39.7 years (standard deviation [SD], 10.7). The average time from injury to application of the cast was ten hours (SD, 12.5) for the weight-bearing group and 8.5 hours (SD, 7.0) for the non-weight-bearing group (see Appendix).

Apart from reruptures, no complications were reported in either group; however, three patients in the weight-bearing group did not tolerate the Böhler iron and asked for it to be removed. They were treated with conventional non-weight-bearing casts. Intention-to-treat analysis was performed for all data obtained.

At the time of the two-year follow-up, which was performed for thirty-seven patients in each group, there was one rerupture in the weight-bearing group and two reruptures in the non-weight-bearing group (Table I), representing a rerupture rate of 3% and 5%, respectively (p = 0.62). Neither partial reruptures nor tendon elongations were reported.
The average time until the patients returned to work was nine weeks (SD, 11.5) for the weight-bearing group and 7.8 weeks (SD, 6.2) for the non-weight-bearing group. The two groups had similar demographic profiles with respect to type of work. However, in the weight-bearing group, 58% returned to work within four weeks compared with 43% in the non-weight-bearing group. These reported differences were not significant (Table I).

Twenty-two patients from the weight-bearing group and eighteen from the non-weight-bearing group returned for the six-month dynamometry testing. The groups showed no significant difference in isokinetic strength, which, when calculated with Leppilahti’s method, averaged 65.0 (SD, 11.9) in the weight-bearing group and 69.0 (SD, 20.3) in the non-weight-bearing group (Tables II and III).

Subjective outcomes were assessed by telephone interview at one year for thirty-two patients in the weight-bearing group and thirty-five patients in the non-weight-bearing group. Outcomes were slightly more favorable in the weight-bearing group but not significantly so. The weight-bearing and non-weight-bearing groups had average scores for the subjective section of the Leppilahti questionnaire (out of 70) of 53.8 (SD, 11.7) and 52.3 (SD, 15.7), respectively; average ankle Tegner scores of 4.9 (SD, 2.7) and 4.3 (SD, 2.4); and average self-rated Achilles tendon scores (out of 10) of 8 (SD, 1.3) and 7.3 (SD, 2.0). Furthermore, fewer patients in the weight-bearing group reported pain, stiffness, or weakness at one year (Table I). However, apart from the subjective stiffness rating, none of these differences were significant.

### Discussion

Functional rehabilitation is being increasingly utilized in the nonsurgical treatment of Achilles tendon injuries. These protocols usually combine both early weight-bearing and early motion in an orthosis, and may result in lower rerupture rates and earlier functional gains compared with the results with traditional casts. 

There is considerable variation in such protocols with regard to when weight-bearing and early motion are initiated, and it is unclear which of these factors is most important. Basic-science evidence suggests that, as the gastrocnemius muscle crosses the knee joint, weight-bearing may allow the fibroblasts and collagen fibers filling the tendon gaps to orient themselves along the long axis of the tendon in response to mechanical stress, potentially increasing the strength of the healed tendon. Similarly, weight-bearing may also promote increased plantar flexor activity, which may also aid the healing process. In a randomized trial of 110 patients treated with surgical repair, Suchak et al. reported improved health-related quality-of-life scores and fewer limitations of daily activities in their weight-bearing group. Ingvar et al. reviewed the results for 196 patients who had been treated nonoperatively with a cast without early motion, and expressed the belief that immediate weight-bearing explained the low rerupture rate of 7% in their series.

To our knowledge, the present randomized controlled trial is the largest study directly investigating the effect of weight-bearing on the rehabilitation process of conservatively treated Achilles tendon ruptures. Overall, the results demonstrate that low rerupture rates can be achieved with conservative management following acute Achilles tendon ruptures, and the rerupture rates in the weight-bearing and non-weight-bearing groups were not significantly different. In the subsequent two-year follow-up period, we recorded a rerupture rate of 3% for the weight-bearing group and 5% for the non-weight-bearing group. The rerupture rate in the non-weight-bearing group is lower than those traditionally associated with nonoperative treatment. Khan et al. reported a combined rerupture rate of 12.6% following traditional cast treatment in their meta-analysis. Our weight-bearing group also had a lower than expected rerupture rate. Wallace et al. reported on a series of 140 patients who were encouraged to mobilize and bear weight beginning at four weeks after the initial injury; they found an overall complication rate of 8%, which included three complete and five partial reruptures. Willits et al., Saleh et al., and Metz et al. reported a combined rerupture rate of 7.3% for nonoperatively treated patients who used functional braces that allowed both early mobilization and weight-bearing. Our low rerupture rate may be explained in part by the acute presentation of the patients in this study. The standard practice in all three study hospitals was to offer nonoperative treatment only if the patient presented within seventy-two hours after injury.

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### TABLE III Six-Month Dynamometry Data Showing Mean Peak Torque Deficit

<table>
<thead>
<tr>
<th>Degrees Per Second</th>
<th>Weight-Bearing*</th>
<th>Non-Weight-Bearing*</th>
<th>P Value</th>
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</thead>
<tbody>
<tr>
<td>Dorsiflexion peak torque</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30°</td>
<td>11.4%</td>
<td>−1.9%</td>
<td>0.28</td>
</tr>
<tr>
<td>90°</td>
<td>−9.3%</td>
<td>−9.0%</td>
<td>0.99</td>
</tr>
<tr>
<td>240°</td>
<td>7.4%</td>
<td>2.5%</td>
<td>0.65</td>
</tr>
<tr>
<td>Plantar flexion peak torque</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30°</td>
<td>−16.5%</td>
<td>4.9%</td>
<td>0.47</td>
</tr>
<tr>
<td>90°</td>
<td>6.8%</td>
<td>8.4%</td>
<td>0.50</td>
</tr>
<tr>
<td>240°</td>
<td>−12.3%</td>
<td>−10.3%</td>
<td>0.84</td>
</tr>
</tbody>
</table>

*Expressed as percent deficit (minus values) or gain (plus values) compared with the unaffected limb for each test speed.
This practice is based on the rationale that, by seventy-two hours, an organized hematoma may prevent tendon apposition in an equinus cast, although evidence for this is limited. Authors of previous studies have either not stated that a delay in presentation was an exclusion criterion or allowed a longer time window for inclusion. The authors of two previous randomized studies assessed the effect of weight-bearing in the nonoperative treatment of Achilles tendons, and they were also unable to demonstrate a significantly lower rerupture rate in the weight-bearing group. Petersen et al. reported on fifty patients with an acute Achilles rupture who were randomized to be treated with either a non-weight-bearing cast or a weight-bearing orthosis. The rerupture rate was 17% in the non-weight-bearing group compared with 0% in the weight-bearing group. Because of the small number of patients, this difference was also not significant. Costa et al. reported on forty-eight patients who had been treated for twelve weeks with either a non-weight-bearing cast or a weight-bearing orthosis that also allowed for early mobilization. A rerupture rate of 5% (one of nineteen) was seen in the weight-bearing group and 10% (two of twenty-one) was seen in the non-weight-bearing group, an insignificant difference. Although Costa et al. were unable to demonstrate a clear functional advantage in the weight-bearing group, they noted a number of practical advantages of immediate weight-bearing, including an earlier return to work. This was also suggested in our study, although the benefit of early weight-bearing in enabling return to work depends on the nature of the employment.

Previous studies in which orthoses were utilized to achieve early weight-bearing and mobilization have shown an association between patient compliance and the success of treatment. Early, unwarranted removal of an orthosis can cause failure to heal or healing in an elongated position, and early removal is avoided with the use of a weight-bearing plaster cast. In our study, no serious complications except for reruptures were recorded in either group. However, a weight-bearing cast remains more cumbersome to use than an orthosis, and three patients in the weight-bearing group did not tolerate the Böhler iron attachment due to back pain and difficulty with mobilization. Additionally, while the remaining weight-bearing patients were all instructed to bear full weight as soon as the cast was fitted, we did not specifically monitor compliance.

There are a number of limitations to our study. First, a large number of patients who presented initially with an acute Achilles tendon injury were excluded from the study, which may limit the generalizability of the results. In particular, we excluded patients who presented more than seventy-two hours following their injury, and the results of nonoperative treatment may have been different in that group. Second, although to our knowledge this is the largest study to date comparing weight-bearing and non-weight-bearing protocols for conservatively treated Achilles tendon ruptures, this study was unable to detect a difference in rerupture rates between the two groups. In 2006, when this study was first designed, the study by Petersen et al. was the only randomized trial on weight-bearing in the nonoperative management of Achilles tendon ruptures, and the reported difference in rerupture rates was 17%. Costa et al. reported a much smaller difference in a later series. The pooled results of these two studies demonstrated a rerupture rate of 3.6% with weight-bearing and 14% with traditional cast protocols. On the basis of these data, a much larger study, with 232 patients, would be required to investigate whether a true difference is present. Therefore, the lack of a significant difference between our groups may be due to patient numbers rather than true parity of the two treatment methods. However, the findings of this study suggest that if there is a true difference between the groups, it is likely to be small. Finally, only 48% of the patients returned for dynamometry testing, which we performed relatively early (six months postinjury) with the aim of detecting differences between groups with regard to early recovery of strength. This makes comparison of these scores with those of other studies difficult, as dynamometry was typically performed one to two years postinjury in other studies.

In conclusion, nonoperative treatment with a weight-bearing cast is a viable option for the management of acute Achilles tendon ruptures; it does not appear to increase the risk of rerupture or other serious complications compared with that found after treatment with a non-weight-bearing cast.

Appendix

A table showing baseline data and figures demonstrating the Böhler iron are available with the online version of this article as a data supplement at jbjs.org.

Note: The authors thank Margie Olds, MHSc, for her assistance with assessment and dynamometry.
References