

## Long-Term Results After Functional Nonoperative Treatment of Achilles Tendon Rupture

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### ABSTRACT

**Background:** Nonoperative treatment of complete Achilles tendon ruptures generally involves a long period of cast immobilization and is associated with frequent reruptures. Functional nonoperative treatment of complete Achilles tendon ruptures involves the use of a high-shaft boot with a 3-cm hindfoot elevation, in which physical therapy is begun after 3 weeks of wear. We reviewed our long-term results with this treatment protocol to determine its effectiveness. **Methods:** The indications for nonoperative treatment, defined by ultrasound, were a distance of 10 mm or less between the tendon ends with the ankle in neutral position and complete apposition of the tendon ends in 20 degrees of plantarflexion. From 1990 to 1996, 168 patients were treated; 125 (74%) were available for followup at a mean of 5.5 (2 to 12.7) years after the injury. **Results:** Good or excellent results were achieved in 92 (73.5%) with complete rehabilitation and return to sports activity at their pre-injury levels. Satisfactory (9%) and poor results (17.5%) were due to pain in the Achilles tendon region, a lengthened Achilles tendon, markedly reduced strength, or a marked reduction of calf size in 25 patients (76%). Eight patients (6.4%) sustained a rerupture. **Conclusions:** Functional nonoperative treatment achieved good results in patients who had precise sonographic evaluation and who were compliant. As a result of our study, we modified our protocol: (1) a repeat ultrasound examination is done by an experienced sonographer 2 to 5 days after the first to confirm the indications for nonoperative treatment, (2) the use of the 3-cm hindfoot elevation is extended from 6 to 8 weeks to provide a longer protection of the tendon, and

(3) patients then wear shoes with 1-cm hindfoot elevation for another 3 months.

**Key Words:** Achilles Tendon Rupture; Nonoperative Treatment

### INTRODUCTION

Primary operative treatment of acute Achilles tendon ruptures is favored by most authors because of a consistently low rate of reruptures. Lo et al.<sup>5</sup> reviewed the English literature and found a 3% rate of reruptures in operatively treated patients compared to 12% in those treated nonoperatively. Operative treatment, however, is associated with significant postoperative complications. Wills et al.,<sup>10</sup> in a review of the literature, found 155 (20%) complications in 777 patients, including infection, sural nerve injury, adhesions, and keloid formation. For nonoperative treatment most reports in the literature recommend the use of a cast.<sup>2,3,4,5</sup>

Functional nonoperative treatment is distinctly different from nonoperative treatment in a cast; the latter method is associated with a high rate of reruptures, averaging 12% to 18%,<sup>2,5</sup> a longer period of rehabilitation, and a return to the preinjury level of activity in 69%.<sup>2</sup> We reviewed our results with a new method of functional nonoperative treatment using a special boot (Figure 1) in a prospective randomized study,<sup>9</sup> and at a 2-year followup found no substantial difference in function and length of rehabilitation between 28 patients with this treatment and 22 treated operatively. No reruptures occurred in either group. The results from this study led to the introduction of this protocol into our department. Our indications for functional nonoperative treatment are a distance of 10 mm or less between the tendon ends with the ankle in neutral position and complete apposition of the tendon stumps in 20 degrees of plantarflexion as seen on ultrasound examination. We reviewed the long-term results of functional nonoperative treatment of Achilles tendon ruptures to determine its effectiveness and the accuracy of the sonographic determination of indications for the protocol.

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**Fig. 1:** The Variostabil® (Adidas, Herzogenaurach, Germany) high-shaft boot maintains plantarflexion position with a 3-cm hindfoot elevation. The sole is flexible in the forefoot area. Full weightbearing is allowed in the boot.

## MATERIALS AND METHODS

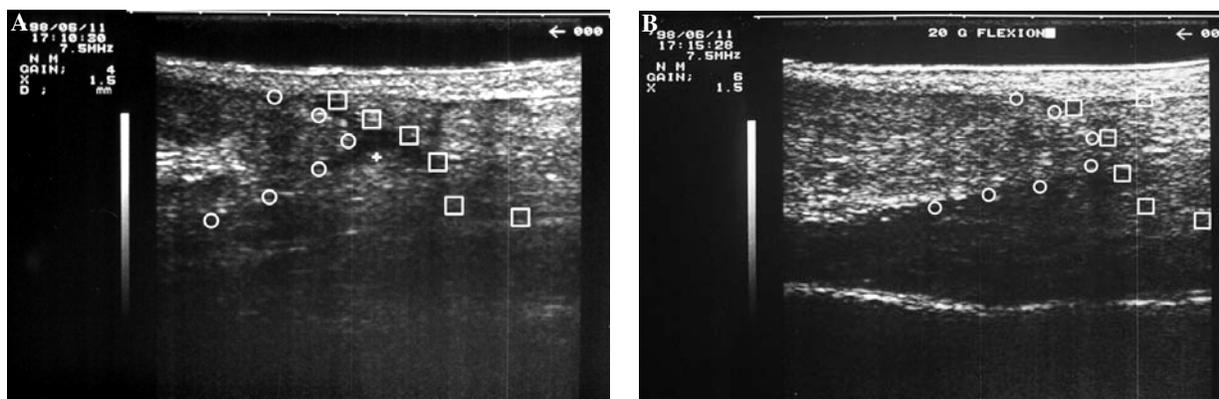
All patients with functional nonoperative treatment of a complete Achilles tendon rupture between 1990 and 1996

were included. Exclusion criteria were an incomplete rupture, primary indication for nonoperative functional treatment identified at another institution, followup at another institution, and operative treatment. All patients included in our previous study<sup>9</sup> (1987–1989) also were excluded.

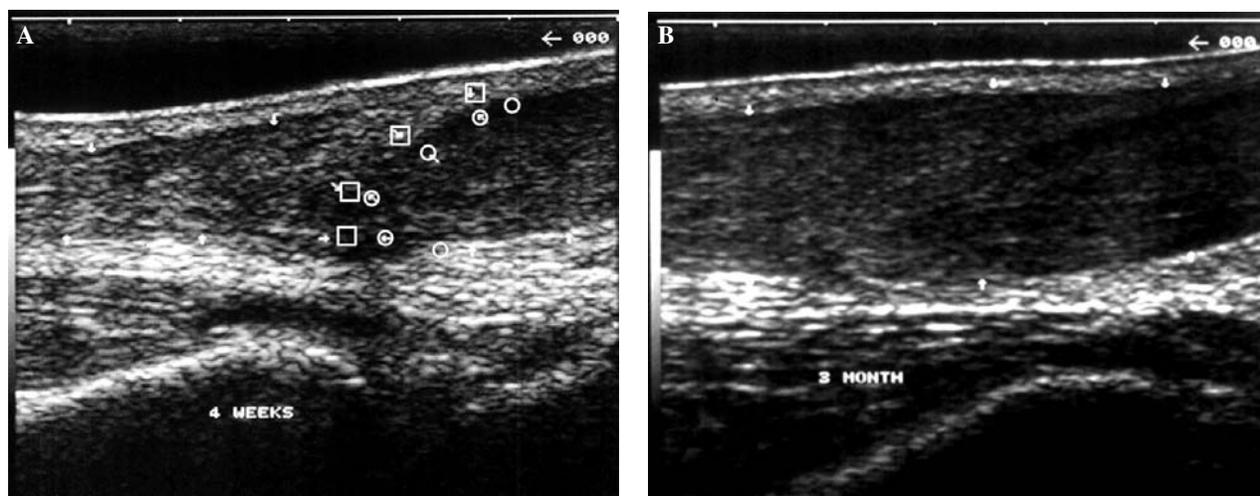
## Treatment Protocol

An acute Achilles tendon rupture was diagnosed by a palpable gap and a positive calf squeeze Thompson test.<sup>2,3,4,5,9,10</sup> Indications for functional nonoperative treatment were identified by sonographic evaluation with a 7.5 MHz linear transducer with the patient prone: separation of 10 mm or less of the tendon ends with the ankle in neutral position and full apposition in 20 degrees of plantarflexion (Figure 2, A and B). A contraindication was separation of more than 10 mm. Interposition of a clotted hematoma between the tendon ends also was a contraindication, although this could not always be distinguished from the tendon itself. Initially, patients were treated for 1 to 3 days in a cast. After reduction of the soft-tissue swelling, treatment was continued for 8 weeks in a special therapy boot with a 3-cm elevation of the heel with full weightbearing. Physical therapy began in the third week in the boot with isometric and gait exercises. After 4 weeks, the exercises, including proprioceptive exercises, were done without the boot, and drainage and friction therapy were added. After 6 weeks, the muscle training was increased. Clinical and ultrasound examinations were done after 4, 8, and 12 weeks (Figure 3, A and B). If the sonographic evaluation after 8 weeks revealed a healed tendon, the boot was discontinued and the patient wore insoles with a 1-cm heel rise for 3 months. If the tendon had not healed after 8 weeks, use of the boot was extended for another 2 weeks. If rerupture occurred, nonoperative treatment was prolonged or an operative procedure was performed, depending on the sonographic morphology of the rerupture.

Follow-up assessment included the patient's complaints, a clinical examination, and an ultrasound examination. The



**Fig. 2:** **A**, One criterion for functional nonoperative treatment is a separation of 10 mm or less of the tendon ends with the ankle in neutral position. At left is the distal end (dots) and at the right is the proximal end (rectangles) of the ruptured tendon. **B**, At day 4 of treatment, a second ultrasound evaluation with the ankle in 20 degrees of plantarflexion confirms apposition of the tendon ends. The distal part of the tendon is on the left side (dots).



**Fig. 3:** A, Ultrasound evaluation after 4 weeks of treatment: the rupture is partially healed as no retraction of the tendon ends occurs while the rupture zone is still clearly visible (arrow). B, At 3 months (4 weeks after discontinuation of the boot), the tendon structure is homogenous with an increased diameter.

subjective parameters of the evaluation were pain, strength during daily sports activities, and activity level (especially sports) before and after the rupture. The objective parameters included function (range of motion of the ankle joint) and strength (active plantarflexion and 1-minute tiptoeing). A functional lengthening of the tendon was defined as increased passive dorsiflexion of the ankle joint compared to the healthy side. Bilateral calf muscle circumference was measured 15 cm below the medial knee joint line. The diameter of the tendon was measured with ultrasonography. On ultrasound examination a tendon was defined as being healed when a homogenous structure was present or only a minimal signal change within the former rupture zone was visible. The tendon was classified as pathological if edema, paratendineal fluid, or calcifications were present. An increased diameter alone was not classified as pathologic.

The subjective and objective clinical results were scored on a 100-point scale that included subjective and objective functional criteria<sup>9</sup>; 90 to 100 points were classified as excellent, 80 to 89 as good, 70 to 79 as satisfactory, and below 70 as poor. Using a Student's t-test, the level of significance was set at  $p < 0.05$ .

Of 168 patients who fit the inclusion criteria, 125 (74%) were available for follow-up, 105 (84%) men and twenty (16%) women. The mean age at the time of the rupture was 39.8 (19.9 to 69.8) years. In 65 patients (52%) the right side and in 60 (48%) the left side was injured. One hundred twenty patients (96%) had no concomitant disease, two (1.6%) had noninsulin-dependent diabetes (NIDDM), two (1.6%) chronic polyarthritis with cortisone medication, and one had chronic renal failure that required dialysis. The decision for nonoperative treatment was made by 23 surgeons of the Department of Traumatology who performed the dynamic ultrasound examinations. In Germany, ultrasound examinations for disorders of tendons and muscles are done by surgeons as well as by radiologists.

Treatment was started in 115 patients (92%) within the first 24 hours after the rupture occurred, in four (3%) between 24 and 48 hours, in four (3%) between 48 and 72 hours, in one at 4 days, and in one patient at 6 days after injury. The mean duration of treatment in the boot was 8.1 (3 to 12) weeks. Six patients with partial ruptures wore the boot only 4 weeks, one patient, against medical advice, only 3 weeks. The overall duration of treatment (boot and physical therapy) was 17.6 (3 to 40) weeks. Followup averaged 5.5 (1.5 to 12.7) years after the injury.

## RESULTS

In 112 patients (81.6%) there were no complications. Three patients (2.4%) developed deep venous thrombosis (DVT). In two patients (1.6%) the DVT resolved without residual problems, and the other developed a postthrombotic syndrome. Two patients (1.6%) who developed soft-tissue problems due to the boot were treated with modified soles without residual problems. Eight patients (6.4%) sustained reruptures; four were treated nonoperatively and two with open repair.

Of the 125 patients, 120 (96%) were pain free. Three patients had moderate pain (one of these was a patient with cerebral palsy), and two had severe pain that restricted daily pain-free walking to only 45 minutes. Ultrasound examination revealed no pathologic findings in any of the five patients with pain.

No patient had quit or had changed his or her job because of the rupture. The mean duration until return to work was 4.5 (0 to 15.8) weeks. Fifty-six patients (44.8%) returned to work within the first 2 weeks after surgery. Ninety-four (75.2%) continued their sport activities as before the rupture, and 31 (24.8%) changed or quit their sport; however, only five of the 31 (16%) stated it was because of the rupture.

In the other 26 patients the reasons for changing the sport activity were aging (six), other interests (14), and sequelae after injuries of the upper extremities (six).

The objective and subjective strength was normal in 82 (65.6%) and reduced in 43 (34.4%). The calf muscle on the injured side was an average of 2.1 (0 to 3) cm smaller than the healthy side. A calf muscle difference of up to 2 cm did not influence strength significantly ( $p > 0.05$ ), but a difference of 3 cm or more correlated with decreased subjective and objective strength ( $p < 0.01$ ). In 98 patients (78%) the Achilles tendons in the uninjured and injured limbs were equal in length; in 21 (17%) the injured Achilles tendon was longer and in six (5%) it was shorter than the uninjured side. Of the twenty-one patients with lengthened Achilles tendons, 12 were noncompliant with the treatment protocol and did not wear the boot continuously after 4 weeks. In nine patients the analysis of the primary ultrasound did not show a complete apposition of the tendon ends with the ankle plantarflexed. There was a strong correlation between a lengthened Achilles tendon and a 3-cm difference in calf muscle size and impaired strength ( $p = 0.01$ ). Only two of 38 (5%) patients with lengthened tendons could not walk on tiptoes.

Eight patients (6.4%) sustained reruptures an average of 7 (2.2 to 17.5) months after the primary rupture. Five patients sustained a forced dorsiflexion injury mechanism at an average of 6.2 (2.2 to 17.8) months after the injury, and three had reruptures during walking at an average of 3.7 (3.1 to 4.4) months after the primary injury. In two of eight patients the rupture was distal (less 2 cm from the calcaneal insertion). Three of eight patients were heavy smokers and also were noncompliant with continuous boot wear. Two of the eight reruptures were treated operatively and six were treated nonoperatively in the boot. The risk for a rerupture was not associated with the age of the patient, the period of time between injury and beginning of treatment, or a concomitant disease.

#### Followup ultrasound examinations

The diameter of the injured tendon averaged 9.5 (6.8 to 13.5) mm. This was significantly ( $p < 0.05$ ) larger than the uninjured side, which averaged 6.5 (5.1 to 8.2) mm in diameter. No patient had the same diameter bilaterally. In 119 patients (95.2%) a homogenous tendon was seen. Pathologic findings were documented in six patients (4.8%): hypertrophic scar in two (1.6%), peritendineal fluid or an edematous tendon in two (1.6%), and a calcified tendon in another two (1.6%) patients. Three of the six patients with pathologic findings sustained reruptures: one with edema of the tendon, one with paratendineal fluid, and one with calcifications. The diameter of the tendon had no significant ( $p > 0.05$ ) influence on the functional outcome.

#### Functional Scoring

Functional scores averaged  $86.5 \pm 5$  (38 to 100), with 92 (73.6%) classified as good or excellent, 11 (8.8%) as

satisfactory, and 22 (17.6%) as poor. Lengthening of the tendon was present in 14 of the 22 (64%), markedly reduced strength in 16 (73%), and a marked reduction of the calf size in 18 (82%). Two of the 22 patients (10%) had severe pain.

Further analysis of the overall results in relation to tendon length revealed that scores of patients with a normal tendon length averaged  $87.1 \pm 9$  (55 to 100) points; those with a shortened tendon,  $79.7$  (42 to 90) points ( $p > 0.05$ ); and those with a lengthened tendon,  $73.5 \pm 16$  (38 to 90) points ( $p < 0.05$ ). The eight patients with reruptures had at the last followup an average score of 83.6 (60 to 98) points. The low average score in these patients is due mainly to one patient with only 60 points at followup because of a lengthened tendon. He had reduced strength and increased pain and had to change his sport activities. Without this patient the scores of the seven remaining patients was 85.6 (80 to 98) points which was not significantly lower than in other patients ( $p > 0.05$ ).

#### DISCUSSION

Functional nonoperative treatment in a special therapy boot allows early full weightbearing and physical therapy.<sup>8,9</sup> The indication for this therapy is determined by dynamic ultrasound examination with the criterion of full approximation of the tendon ends in 20 degrees of plantarflexion. Additionally, the patient must wear the therapy boot continuously during the 8-week period.

With one experienced sonographer performing the examination and instructing the patients, 95% excellent or good results were achieved.<sup>9</sup> The current study used 23 sonographers, and good or excellent results were obtained in 74% of patients. Poor results occurred in 18% because of a lengthened Achilles tendon or sequelae after reruptures. We believe that this difference in results was because the indication for functional nonoperative treatment was based on misinterpretation of the primary ultrasound in the 22 patients with poor results. Failure to wear the boot as instructed also might have been a problem, but this could not be proven in a retrospective study. To ensure appropriate patient selection for this therapy, we included another ultrasound examination 2 to 5 days after the first by an experienced sonographer to re-evaluate the criteria for inclusion. To improve patient compliance and understanding, the initial information about the treatment concept was reinforced and during the follow-up period the patient was seen by only one surgeon.

The high rate (12% to 18%) of reruptures with nonoperative cast immobilization treatment<sup>2,5,6</sup> was reduced significantly by functional nonoperative treatment to 0 to 5.3%.<sup>8,9</sup> This is within the range of the 1% to 3% rerupture rates reported after operative treatment.<sup>2,5,8,9,11</sup> The 6.4% rate of reruptures in our patients may be due to the large number of surgeons as primary sonographers. Reilmann et al.<sup>8</sup> demonstrated that an incomplete apposition of the tendon ends

explained two of seven reruptures in their patients.<sup>8</sup> Therefore this treatment protocol can be recommended only when complete apposition is determined by an experienced sonographer.

Few studies have compared nonoperative to operative treatment of acute Achilles tendon ruptures. Gillies et al.<sup>1</sup> found no significant difference in the strength of plantarflexion between seven patients treated nonoperatively and six treated operatively. Nistor et al.,<sup>7</sup> in a prospective randomized trial, compared operative treatment (45 patients) to nonoperative treatment (60 patients) and found that those with nonoperative treatment had better functional outcomes with less ankle stiffness and similar strength compared to the operative group. Our study is limited because we did not use a measurement device to evaluate strength. However, the clinical evaluation revealed similar strength in the injured and uninjured limbs in 66% of patients. Reduced strength in the injured limb was associated with a decrease in calf muscle size of more than 3 cm and a lengthened Achilles tendon.

Ultrasound examination revealed an increased diameter of the ruptured tendon in all patients, but this had no clinical relevance. Pathologic findings, such as hypertrophic scar or peritendineal fluid, did not correlate with clinical findings such as pain.

As a consequence of the findings of this study, we have modified our protocol in several ways. The adequacy of apposition of the tendon ends is now verified with a second ultrasound evaluation by an experienced examiner after 2 to 5 days of treatment. If the criteria for functional nonoperative treatment are not met, the patient is scheduled for operative repair. Information about the importance of patient compliance and wearing time is now reinforced when treatment in the boot is begun. The treatment protocol now includes

8 weeks in the boot with a 3-cm heel lift and then 3 months in a normal shoe with a 1-cm sole. Operative treatment is recommended if no apposition of the tendon ends can be achieved with the ankle in 20 degrees of plantarflexion and in very distal ruptures.

## REFERENCES

1. **Gillies, H; Chalmers, J:** The management of fresh ruptures of the tendo Achilles. *J. Bone Joint Surg.* **52-A:**337–343, 1970.
2. **Kellam, JF; Hunter, GA; McElwain, JP:** Review of the operative treatment of Achilles tendon rupture. *Clin. Orthop.* **201:**80–83, 1985.
3. **Lea, RB; Smith, L:** Non-surgical treatment of tendo Achilles rupture. *J. Bone Joint Surg.* **54-A:**1398–1407, 1972.
4. **Lildholdt, T; Munch-Jorgensen, T:** Conservative treatment to Achilles tendon rupture. A follow-up study of 14 cases. *Acta Orthop. Scand.* **47:**454–458, 1976.
5. **Lo, IK; Kirkley, A; Nonweiler, B; Kumbhare, DA:** Operative versus nonoperative treatment of acute Achilles tendon ruptures: a quantitative review. *Clin. J. Sport Med.* **7:**207–211, 1997.
6. **Maffulli, N:** Rupture of the Achilles tendon. *J. Bone Joint Surg.* **81-A:**1019–1036, 1999.
7. **Nistor, L:** Surgical and non-surgical treatment of Achilles tendon rupture. A prospective randomized study. *J. Bone Joint Surg.* **63-A(3):**394–399, 1981.
8. **Reilmann, H; Forster, EW; Weinberg, AM; Bruggemann, F; Peukert, J:** Conservative functional therapy of closed rupture of the Achilles tendon. Treatment approach and analysis of results. *Unfallchirurg.* **99(8):**576–580, 1996.
9. **Thermann, H; Zwipp, H; Tscherne, H:** Functional treatment concept of acute rupture of the Achilles tendon. Two years results of a prospective randomized study. *Unfallchirurg.* **98:**21–32, 1995.
10. **Wills, CA; Washburn, S; Caiozzo, V; Prietto, CA:** Achilles tendon rupture. A review of the literature comparing surgical versus nonsurgical treatment. *Clin. Orthop.* **207:**156–163, 1986.
11. **Zwipp, H; Sudkamp, N; Thermann, H; Samek, N:** Rupture of the Achilles tendon. Results of 10 years' follow-up after surgical treatment. A retrospective study. *Unfallchirurg.* **92:**554–559, 1989.