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Early Protected Weightbearing for Acute Ruptures of the Achilles Tendon: Do Commonly Used Orthoses Produce the Required Equinus?

Philip Ellison, MCSP, MSc [1], Andrew Molloy, MBChB, MRCS (Ed), FRCS (Tr&Orth) [2], Lyndon William Mason, MBBCh, MRCS (Eng), FRCS (Tr&Orth) [2]

[1] Lower Limb Extended Scope Practitioner, Trauma and Orthopaedic Department, University Hospital Aintree, Liverpool, UK
[2] Consultant Foot and Ankle Surgeon, Trauma and Orthopaedic Department, University Hospital Aintree, Liverpool, UK

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ABSTRACT

Conservative "functional" management of acute Achilles tendon ruptures has become increasingly popular. Critical to this is the use of the walking orthosis, which positions the ankle in equinus to allow for early weightbearing. Our aim was to test whether 2 common orthoses achieved a satisfactory equinus position. A total of 11 sequentially treated Achilles tendon ruptures were assigned to either a fixed angle walking boot with wedges (FAWW) or an adjustable external equinus-corrected brace (EEB). The lateral radiographs of the cast immobilized tendons showed a mean tibiotalar angle (TTA) of 56° (range 54° to 57°) and a mean tibio-first metatarsal angle (1MTA) of 74° (range 62° to 85°). The FAWW resulted in a mean TTA of 28° (range 15° to 35°) and 1MTA of 37° (range 30° to 45°). The EEB resulted in a TTA of 48° (range 43° to 45°) and 1MTA of 54° (range 47° to 57°). Ankle equinus was significantly greater with the EEB than with the FAWW ($p < .05$) and similar to that with an equinus cast. The use of wedges produced an equinus appearance through the midfoot but not at the ankle. We express caution in the use of the FAWW because it is unlikely to achieve sufficient ankle equinus to shorten the Achilles tendon.

Conservative management of acute ruptures of the Achilles tendon has become increasingly popular. Recent research has questioned the dichotomy between conservative and surgical management, when functional rehabilitation has been implemented (1–4). Historical dogma reported that surgical repair of acute ruptures resulted in lower rerupture rates and that conservative management offered lower complication rates. Rerupture rates of ≤29% were seen after cast immobilization compared with rates of <5% with surgical management (5–8). It is has since been accepted that it is the application of appropriate functional rehabilitation protocols, in both surgically and conservatively treated patients, that has reduced the rerupture risk (9–14). A recent systematic review of published studies concluded that no statistically significant difference exists in the rerupture rates between surgical and nonsurgical treatment of acute Achilles tendon ruptures when only studies including functional rehabilitation were considered (1).

The success of rupture management is not based solely on the absence of complications but also on restoration of function (15). It cannot, therefore, be concluded that the absence of rerupture ensures that effective management has been achieved, because that factor alone provides no information regarding restoration of function, return to work and/or sports, and patient satisfaction. The concern in this regard is lengthening of the healing tendon. Apposition of the torn tendon fibers is a critical factor with regard to the healing profile of the functionally treated Achilles tendon rupture (16). The position of immobilization is possibly of greater concern for those patients treated nonoperatively because the ruptured tendon is not directly visualized nor physically approximated with sutures, as would be the case during surgery. Insufficient ankle/hindfoot equinus to allow for reduction of the "rupture gap" during the initial healing phase is therefore the most likely cause of a lengthened tendon in patients treated conservatively. Lower functional outcomes have consistently been described for this group of patients (4,8,17,18). Ten millimeters of Achilles tendon lengthening is considered clinically significant with regard to reduced peak torque of plantarflexion (19,20), although the magnitude of lengthening does not appear to have a linear relationship with loss of function (19,20).

The functional (walking) orthosis has become the key component of functional management protocols, allowing early protected weightbearing on the injured limb. Such management has been shown to be effective in improving the mechanical properties of the healing tendon; however, the most appropriate position of

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Address correspondence to: Philip Ellison, MCSP, MSc, Trauma and Orthopaedic Department, University Hospital Aintree, Lower Lane, Liverpool L9 7AL, UK.
E-mail address: philellison@gmail.com (P. Ellison).

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immobilization has not been described (21,22). Two typical orthotic prescriptions are available for functional rehabilitation, a fixed angle walking boot into which wedges are inserted to position the foot in equinus (FAWW) (4) and an adjustable external equinus system (EEB) (2). Our aim in the present study was to identify the equinus obtained with both orthotic prescriptions and cast immobilization.

Patients and Methods

The management of acute Achilles tendon ruptures within our department is nonoperative functional rehabilitation, including the use of a non-weightbearing maximal equinus cast for 2 weeks, followed by 8 to 10 weeks in a functional orthosis combined with regular physiotherapy. Protected weightbearing is achieved through the use of an "off the shelf" fixed angle walking boot (DH Offloading Walker; Össur, Stockport, UK) and the insertion of heel wedges (Procare Achilles Wedge; DJO Global Inc., Vista, CA). The wedges come in 1 size and are only customizable to the point that the total height of the wedges (4 in.) is divided into 0.75-in. sections that can be removed sequentially. This process is coordinated through a specialist "Heel Pain Clinic" led by an extended scope practitioner physiotherapist, with the support of a foot and ankle surgeon, as required.

An overall equinus position of the foot does not determine that sufficient ankle equinus has been achieved to shorten the healing Achilles tendon. This is because sagittal plane motion distal to the ankle is expected to play no part in the restoration of an appropriate length–tension relationship of the Achilles tendon and gastrosoleus complex. Because of observations in the clinic suggesting that in many cases the equinus position produced by the orthosis was achieved through the midfoot joints and not at the ankle, the use of lateral radiographs has become standard in our practice. Another orthosis has been introduced to the department for comparison with the standard orthotic prescription with an adjustable external equinus system (VACOped; Oped UK Ltd, Devizes, UK).

The present study was a service analysis study in which we prospectively collected data from 10 consecutively treated patients (11 tendons) attending the "Heel Pain Clinic" with acute rupture of the Achilles tendon. Standardized lateral radiographs of the splinted hindfoot were analyzed using the graphics package available on the hospital's Picture Archiving and Communications System. The tibiotalar angle (TTA) and tibio-first metatarsal angle (1MTA) were calculated from within the equinus cast (11 tendons), within the FAWW (5 patients; 6 tendons), and with the EEB (5 patients; 5 tendons) (23).

To obtain a control group for comparative purposes, 10 randomly selected weightbearing lateral ankle radiographs were also selected and analyzed. All data were assessed using SPSS, version 20.0 (IBM Corp., Armonk, NY). Numerical data were tested using the Mann-Whitney *U* test because the data were nonparametric.

Results

Within the control group, the mean TTA was 25° (range 18° to 32°) and the mean 1MTA was 24° (range 17° to 28°). In contrast, the lateral radiographs of the cast immobilization group showed a significant increase ($p < .001$) in the mean TTA at 56° (range 54° to 57°) and mean 1MTA at 74° (range 62° to 85°; Figs. 1 and 2).

All tendons in cast immobilization were then changed to either the FAWW (6 tendons) or EEB (5 tendons). For the 6 Achilles tendons treated in the FAWW, a mean TTA of 28° (range 15° to 35°) and 1MTA of 37° (range 30° to 45°) was achieved. A 3° increase in the mean TTA, relative to the control group, was neither clinically or statistically significant (Figs. 1 and 2). The mean 1MTA, however, was significantly ($p < .001$) greater than that in the control group. This illustrates that the apparent equinus seen in the FAWW is derived from midfoot flexion, because no difference was found in the positioning of the heel compared with normal weightbearing.

For the 5 tendons treated in the EEB, a statistically significant increase was found in both the TTA (48°, range 43° to 45°) and the 1MTA (54°, range 47° to 57°) compared with the control group ($p < .05$). The TTA and 1MTA were also both significantly greater than the corresponding angles in the FAWW group ($p < .05$; Figs. 1 and 2).

Discussion

In recent years, a change has occurred in the favored method for the treatment of Achilles tendon ruptures, to conservative from

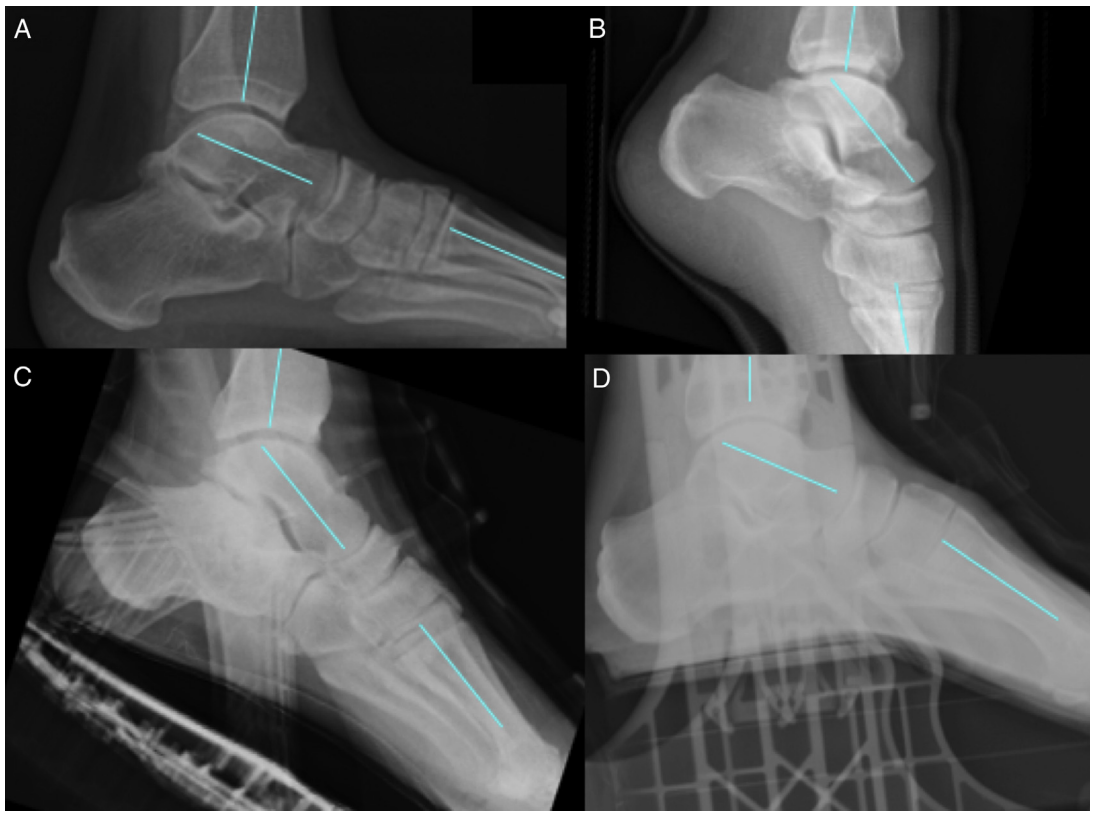

Fig. 1. Lateral radiographs depicting (*A*) typical weightbearing stance (control), (*B*) non-weightbearing patient in an equinus cast, (*C*) weightbearing patient within the external equinus-corrected brace, and (*D*) weightbearing patient within the fixed angle walking boot with wedges.

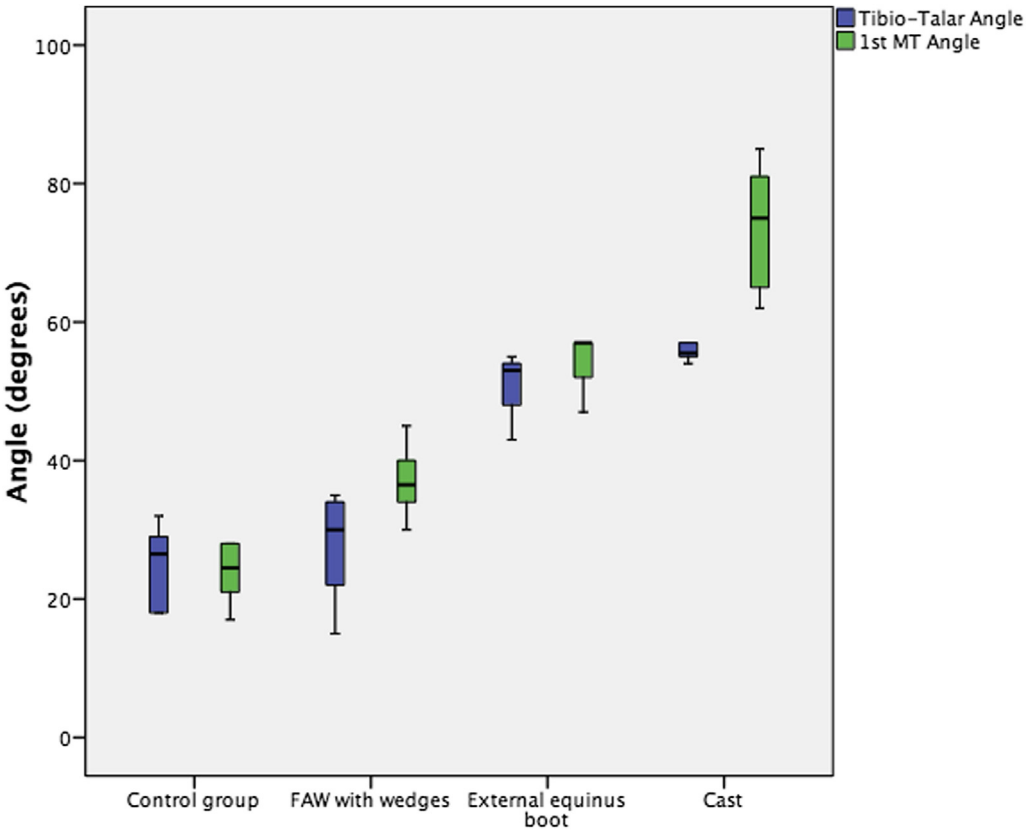

Fig. 2. Boxplot depicting the tibiotalar and tibio-first metatarsal (MT) angles of the control group and patients within the equinus cast, fixed angle walking boot (FAW) with wedges, and external equinus-corrected brace.

surgical management, with the introduction of functional rehabilitation (2,4). Functional management of Achilles tendon ruptures has the benefit of avoiding the potential risk factors and morbidity associated with surgery, with a low risk of rerupture (1,8–14), favorable results compared with nonfunctional management, greater patient satisfaction, and earlier return to occupational and sporting activities (3). However, a healed, but lengthened, tendon must be avoided, because that will result in lower patient-reported outcomes (4,8,16,17). Rehabilitation protocols vary widely, with Frankewycz et al (24) analyzing 213 separate protocols in Germany alone and proposing a randomized control study to optimize the treatment of Achilles tendon ruptures. These protocols differ with regard to casting position (forced maximal or gravity produced), choice of orthosis, and weightbearing "allowance."

The ideal position of immobilization to reduce the probability of elongation has yet to be ascertained. Two of the most pertinent studies in this area excluded patients from the functional conservative management arm of their trials if the tendon gap did not reduce on either palpation (4) or ultrasonography (2). In the former study, all the patients with acute Achilles rupture (<14 days) were found to have satisfactory tendon apposition in full equinus, and it was only a proportion of those presenting late (>14 days) who did not. Similarly, cadaveric studies have suggested that a position of maximal equinus (60°) results in good tendon apposition after transection of the Achilles tendon (25,26). A finding that was corroborated in vivo by ultrasonography (27), which showed maximal equinus to effectively reduce the tendon gap in their series of 25 patients. However, equinus of "60°" and "maximal" are based on the relationship of the tibia to the foot and therefore do not represent isolated tibiotalar equinus. Although this is typical of clinical practice, such measurements will not accurately represent the Achilles length. In our study, the equinus cast achieved the greatest ankle and total equinus. When allied with the aforementioned evidence, this forms the basis of the initial management within our hospital (ie, the injured limb is immobilized for 2 weeks in a non-weightbearing maximal equinus cast). This protocol has allowed us to develop the cast application with our plaster technicians, who now ensure that they apply equinus pressure at the ankle/hindfoot and not at the dorsum of the forefoot, as is typical. With a mean TTA difference of only 8°, immediate application of the EEB could also be clinically advantageous because it will allow for immediate protected weightbearing. However, the relative merits of greater equinus (cast) versus earlier weightbearing (orthosis) is unknown.

Protected weightbearing is most commonly achieved by provision of a fixed-angle orthosis to which wedges are inserted to raise the heel. Research using such orthoses has demonstrated low rerupture rates; however, the secondary outcomes related to function and patient satisfaction have been less conclusive (4,10,14,20). Wallace et al (4) reported "good to excellent" patient-centered outcomes in 99.4% of their cohort. Of the 0.6% with "poor" results in their study, the less than satisfactory results were deemed to have resulted from tendon lengthening, and all 6 patients had undergone surgery. More recently, the EEB was used in a study by Hutchison et al (2), with patient-reported outcomes described as "satisfactory." In our study, the FAWW did not produce a significant change in the ankle position, relative to the comparison group, but did plantarflex the midfoot, thereby giving an overall equinus appearance. This "false" equinus position does not appear to have been mentioned or discussed previously. Because the heel position is unchanged, application of a fixed angle walking boot without wedges would achieve the same Achilles

length as one with wedges. Our concern, therefore, is that the healing tendon will undergo elongation owing to inadequate support from the boot with wedges. We acknowledge that other factors, such as patient compliance and motivation with rehabilitation, general health, and comorbidities, will also affect patient recovery and overall functional level; however, the position of immobilization is of universal importance and is simple to rectify. The prescription of a FAWW must be questioned, especially in those centers that do not use an initial period of immobilization in a maximal equinus cast, because elongation will be even more likely. Within our practice, we believe the FAWW has not ensured appropriate tendon length restoration and has thus been responsible for slower and more difficult restoration of function in our patients. The favorable results with the EEB have prompted us to continue the use of this orthosis after removal of the cast at 2 weeks after rupture.

Further prospective research is required to ascertain the optimal position of immobilization required to ensure maintenance of the normal tendon length and to confirm whether elongation of <10 mm is possible, without functional repercussions (19,20). Studies focusing on the functional management of acute ruptures of the Achilles tendon must use validated self-report questionnaires and functional scoring tools, with a reduced emphasis on the rerupture rate. Furthermore, the effects of the various facets of functional rehabilitation on the tendon healing profile require more detailed study to allow us to improve patient satisfaction and functional outcomes, while maintaining a low rerupture rate. The present work was limited by the small sample size; however, the production of narrow confidence intervals reduced the probability of a type 1 error. We believe our findings are noteworthy and should stimulate further discussion and research in this area.

In conclusion, ankle equinus was significantly greater in the EEB than in the FAWW and very similar to that in the initial equinus cast before conversion to an orthosis. The use of wedges produced an equinus appearance through the midfoot, without producing equinus at the ankle. Thus, we express caution in the use of orthoses requiring the insertion of wedges because they do not produce sufficient ankle equinus to effectively shorten the healing Achilles tendon.

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