Early functional rehabilitation or cast immobilisation for the postoperative management of acute Achilles tendon rupture? A meta-analysis of randomised controlled trials

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ABSTRACT

Objective To determine which postoperative rehabilitation regime is superior following surgical repair of acute Achilles tendon rupture. The primary outcomes were patient safety and satisfaction.

Design Intervention meta-analysis.

Data sources The MEDLINE and CINAHL electronic databases were searched from their date of inception until June 2015 using keywords related to acute Achilles tendon rupture, surgical repair and rehabilitation. The electronic database search was supplemented with forward citation tracking using the Web of Science.

Eligibility criteria Randomised controlled trials comparing clinical and/or patient-reported outcomes between patients receiving early functional postoperative ankle motion and weight bearing (bracing group), and traditional ankle immobilisation with a non-weight bearing rigid cast (cast group) were eligible for inclusion. Fourteen articles were identified as potentially eligible; 10 sufficient-quality randomised controlled trials involving 570 patients were included for meta-analysis.

Main results A high proportion of patients were able to return to prior employment and sporting activity in both groups. Five of the six trials measuring the time interval showed a faster return to prior sporting level in the bracing group. Subjective patient outcomes were significantly better in the bracing group (for good and excellent results, p=0.01; OR, 3.13; 95% CI 1.30 to 7.53). There was no difference in major complications between the two groups (p=0.21; RD, −0.03; 95% CI −0.06 to 0.01). Dynamometry and anthropometry measurements favoured functional rehabilitation at 6–12 weeks postoperation; however, by 6 months postoperative, the differences were negligible.

Conclusions Compared to traditional ankle immobilisation, with a non-weight bearing cast following surgical repair of acute Achilles tendon rupture, early dynamic functional rehabilitation is as safe with higher patient satisfaction.

Acute Achilles tendon rupture is a common injury, most frequently occurring during sporting activity and in males in their fourth and fifth decades. The reported incidence ranges from 3 to 17 ruptures per 100 000 people per year, and this appears to be increasing. Achilles tendon rupture can be managed conservatively or surgically, followed by 3–6 months of rehabilitation. Postoperative rehabilitation of must balance the risk of complications resulting from prolonged immobilisation (eg, adhesions and muscle atrophy) with the risk of tendon rerupture, due to early mobilisation and tendon loading.

Surgical management of acute Achilles tendon rupture has traditionally involved operative repair followed by a prolonged period of ankle immobilisation in a rigid cast, similar to closed treatment of fractures. However, initial reports of early postoperative ankle motion and functional rehabilitation after acute Achilles tendon rupture repair did not demonstrate an increase in the rate of rerupture. Subsequently, a number of randomised controlled trials (RCTs) have been performed comparing immobilisation to functional postoperative rehabilitation across a wide range of patient outcomes. Several studies found functional bracing produced favourable outcomes in terms of motor performance, anthropometrics and patient satisfaction.

We present the results of a meta-analysis of RCTs comparing the two rehabilitation regimens following surgical repair of acute Achilles tendon rupture. The primary objective was to determine which is superior for postoperative management: early, functional mobilisation with weight bearing in a brace, or non-weight bearing immobilisation in a rigid cast? Outcomes considered were return to normal function, patient-reported outcomes, complication rates, muscle strength and anthropometrics.

METHODS

Data sources

A systematic literature search of peer-reviewed articles was performed to identify all RCTs comparing cast immobilisation and functional rehabilitation for the postoperative management of acute Achilles tendon rupture. Databases searched were CINAHL and MEDLINE (Ovid), which included EMBASE, BIOSIS, Cochrane Database of Systematic Reviews (CDSR), Database of Abstracts and Reviews of Effects (DARE), the Cochrane Controlled Trials Register (CCTR) and the American College of Physicians (ACP) Journal Club. The keywords Achilles and ruptur* and surg* or operat* and mobil* or immobi* or cast* or rehab* or weight bearing were combined and results were limited to human RCTs, controlled clinical trials or clinical trials published in the English language (table 1).

All databases were searched from their date of inception until June 2015, producing 113 articles from MEDLINE and 9 from CINAHL for a total of 114 unique articles. EndNote was used to combine results from different search engines, and cited reference searches of eligible RCTs were
performed using ISI Web of Science (figure 1). After removal of duplicates, both authors evaluated potentially eligible articles utilising the criteria outlined in the eligibility section below. Differences and grading were discussed and resolved by consensus. Data were extracted by two independent reviewers and reviewed by the senior author.

Eligibility criteria

Studies included were RCTs comparing rehabilitation regimes for patients with surgically repaired acute Achilles tendon rupture. Studies were excluded if they were non-Achilles tendon rupture; editorial, commentary, observation or non-randomised studies; trials comparing non-operative treatments; trials comparing operative techniques; trials comparing operative and non-operative treatments; trials not comparing immobilisation versus functional rehabilitation; or meta-analyses.

Two independent reviewers assessed the risk of bias in the included studies using Downs and Black’s validated 27-item checklist. This checklist assesses study quality, internal and external validity as well as bias. Studies had to meet a minimum total score of 19 for inclusion in the current meta-analysis.

Masking of trial findings was not possible, as this scale includes appraisal of statistical methods and adjustments. Individual authors were contacted for data clarification and further information when necessary.

Outcomes

Return to employment and sport activities, subjective patient satisfaction, and rate of major complications were evaluated using pooled statistical analysis. At both early and late follow-ups, muscle strength and anthropometrics were also evaluated in terms of ankle strength, muscle atrophy, ankle range of motion (ROM) and tendon elongation. These measurements were excluded from meta-analysis due to differences in trial methodology and data presentation.

Statistical analysis

Pooled statistical analysis was conducted using ReviewManager 5.3 (The Cochrane Collaboration), and comparisons were made between patients who received early functional rehabilitation (bracing group) and patients who received immobilisation in a cast (casting group). Statistical heterogeneity was assessed using the I² statistic. The statistical method, analysis model and summary statistics were determined by the type of data, amount of heterogeneity and number of events. Dichotomous data were statistically analysed using the Mantel-Haenszel (M-H) method and continuous data with the inverse variance (IV) method. A fixed-effects model was used when heterogeneity was minimal or moderate (I²=0–50%), whereas the random effects was used when there was substantial or considerable heterogeneity (I²=50–100%).

The risk difference (RD) was reported when the number of events was low; otherwise, the OR was used. Mean difference (MD) was calculated for continuous data. The level of statistical significance taken was p=0.05 in each individual trial and in the present analysis. When SD was not available from published data or communication with authors, it was estimated from the range. A normal distribution was assumed unless otherwise stated, and given median values were estimated as mean values.

RESULTS

Description of included studies

In total, 10 RCTs (11 articles) involving a total of 570 patients were included in the meta-analysis (table 2). The bracing group comprised 281 patients and the casting group, 289 patients. Two RCTs were excluded from the meta-analysis because they did not address the outcomes specified for the review. Another RCT was excluded because the length of intervention in the functional rehabilitation group was 2 weeks. Two similar trials by Maffulli et al with overlapping inclusion dates were included, as the author confirmed that they involved separate patient populations. The same patient population from one RCT was analysed in two separate articles, and data from these patients were only included once in the meta-analysis.

No other potential sources of bias (including differing patient types, recruitment periods, patient compliance, or follow-up) between the groups were identified.

Included patients were at least 17 years of age and had a complete Achilles tendon rupture, while exclusion criteria were use of immunosuppressory therapy, reruptures and history of Achilles tendonitis. Within each trial, the proportions of men and women, and affected side were similar between the bracing and casting groups. The majority of injuries leading to the Achilles tendon rupture were sports-related, most frequently soccer or racquet sports.

All operations were performed within 14 days of the initial injury, and patients were allocated to bracing (weight-bearing and protected range of motion) or casting (immobilisation and non-weight bearing) using random envelope selections, computer randomisation, or day of presentation to services. Tendon repairs were carried out using Kessler sutures, modified Kessler sutures, Bunnel sutures or an alternate 4-string suture technique. In three trials, dressings were applied on the day of surgery or the day following surgery. A temporary rigid cast was applied to both groups in five trials for 7 to 14 days before start of functional movement in the bracing group.

The postoperative rehabilitation of patients who received bracing involved mobilisation and weight bearing between 24 h and 2 weeks of surgery, either in a dynamic brace, rigid dorsal splint, removable cast boot or semirigid wrap. Patients who received casting were treated with a traditional non-weight bearing rigid cast or cast boot, and immobilised for 6 to 8 weeks postoperatively. All patients completed a course of physiotherapy following cast or brace removal.
Follow-up was defined as early (6 to 12 weeks postoperatively) and late (greater than 6 months). A total of 22 patients (3.9%) had incomplete follow-up data across all trials, and two patients were lost to follow-up before 12 weeks. In all trials, losses were stated to be equally representative of bracing and casting groups.

**Return to employment and sport activities**

Based on the results of six trials, pooled analysis (figures 2 and 3) demonstrated that almost all patients were able to return to normal employment duties during the follow-up period, with no difference between the two treatment groups (p=0.33; OR, 4.62; 95% CI 0.21 to 101.15). There was also no difference in the rate of return to prior sporting activity (p=0.44; OR, 1.23; 95% CI 0.73 to 2.06).

For time to resumption, the mean difference was 1.5 weeks shorter for return to prior employment and 2.4 weeks for prior sporting level; although these results were not statistically significant (p=0.23; MD, −1.53; 95% CI −4.02 to 0.95 and p=0.48; MD, −2.38; 95% CI −8.95 to 4.19, respectively). Moreover, differences in patient demographics and employment protocols generated considerable heterogeneity across the studies (I²>80%). When analysing the studies individually, five of the six trials showed a faster return in the bracing group. Only the trial by Costa et al. did not favour bracing, although this may be explained by a higher proportion of manual jobs in the early motion group. The time to resume walking and stair climbing, which are unaffected by occupation, were also reported by Costa et al. and the bracing group had a significantly faster return to normal function (p=0.027 and p=0.023, respectively).

**Patient-reported outcomes**

Patient satisfaction was assessed in six trials using questionnaire results or multiple factor scoring systems (figure 4). The pooled
results demonstrated that the bracing group had three times the odds of rating their satisfaction as ‘good’ or ‘excellent’ compared to the casting group (p=0.01; OR, 3.13; 95% CI 1.30 to 7.53).

In one trial, the RAND-36, was used to measure health-related quality of life at all follow-up visits. At 6 weeks follow-up, the bracing group reported significantly better scores for the physical functioning, social functioning, vitality and role-emotional domains than the casting group. Fewer limitations in daily activities were reported by the bracing group at 6 weeks compared to the casting group.

Complications
Complications during the follow-up period were documented in all 10 trials, and were categorised as minor or major complications based on the criteria in table 3. There was no difference in the incidence of major complications (figure 5) between the two groups (p=0.21; RD, −0.03; 95% CI −0.06 to 0.01). Rerupture was an infrequent complication, occurring in fewer than 3% of patients in both groups. There was no difference in the number of reruptures between bracing (n=6) and casting (n=6) (p=0.98). Statistical analysis of minor complications was omitted due to disparities in the level of detail available in each article.

Dynamometry and anthropometrics
Nine trials included some form of serial anthropometric and dynamometry measurements during the follow-up period. The methods of measurement,
comparisons and interval from injury to assessment were not standardised sufficiently for pooled analysis. The parameters measured included plantarflexion and dorsiflexion strength, degree of calf atrophy, ankle ROM and tendon length.

**Strength** Ankle plantarflexion and dorsiflexion strength was assessed by nine authors. At early follow-up, ankle strength in the injured leg tended to be closer to normal for the bracing group than for patients in the casting group. Over time this difference diminished, and the overall mean deficit in strength was approximately equal in both groups by 6 months. Regarding late follow-up, Cetti et al. found that the mean deficit was significantly different between the injured and uninjured legs in both groups at 1 year, suggesting that a return to preinjury level of ankle strength does not occur within 1 year for patients in either group.

**Calf atrophy:** Six articles reported on the level of calf atrophy, and all noted a significant loss of muscle mass in the injured leg compared with the uninjured leg. Although there was little or no difference between the bracing and casting groups.

**Ankle range of motion:** Five articles measured ROM either in terms of median loss of ROM or regaining normal ROM. Similar to the change in strength over time, the between-group difference in ROM tended to favour bracing within the first year and diminished over time.

**Tendon elongation:** Tendon elongation was measured radiographically using intratendinous markers in three articles. Radiopaque markers were implanted into the tendons of all patients at operation, and the distance separating these markers was measured successively using calibrated radiographs during the follow-up period. Mortensen et al. reported slightly more tendon elongation with early mobilisation after 12 weeks (p=0.20). However, Cetti et al. cited less elongation in the bracing group at all follow-ups and significantly lower tendon elongation after 1 year (p=0.0033). Long-term follow-up by Kangas et al. also found less tendon elongation in the bracing group at 60 weeks postoperative (p=0.054), and noted a significant correlation between less tendon elongation and a better clinical outcome (p=0.017). Although these trials could not be pooled statistically because of inconsistent data presentation, they provide no support for increased tendon elongation with early mobilisation.

**DISCUSSION**

We systematically reviewed two types of postsurgical rehabilitation of patients with acute Achilles tendon rupture. Studies were carefully assessed for methodological quality before inclusion. Randomisation methods used in three trials were suboptimal, but given the limited number and small size of available trials, we included otherwise high-quality trials that had low-quality...
methods of randomisation. All studies use similar methods of perioperative care, time of randomisation and follow-up investigation. Trial populations were generally well matched for patient characteristics and presentation.

Five outcomes—including time to return to play, complications and patient satisfaction

All but one trial that assessed return to the preinjury level of function favoured bracing. Pooled analysis revealed no difference in time to return to preinjury employment (1.5 weeks) and sporting level (2.4 weeks) in the bracing group. We were not able to assess the impact of the duration, or type, of formal therapy on the patient activity. This is an important consideration that merits further research, particularly for high demand individuals.

In both groups, a high proportion of patients returned to their preinjury employment and sporting level during the follow-up period. Therefore, a more sensitive measure of the difference between the treatments may be the time taken to return. Another option would be to measure the time to resumption of normal walking. These may be a more valid measures of patient function, as they are unaffected by prior level of activity. Unfortunately, these measurements could not be adequately assessed in this review as many study protocols directed patients when to commence walking.

Muscle strength could not be evaluated by meta-analysis as because of the considerable heterogeneity of methods used to assess it. Nevertheless, muscle strength, range of motion and tendon elongation all improved more rapidly in the group that used the brace postoperatively. Early tendon loading promotes collagen deposition and strengthens the healing tendon. This benefit appears to outweigh the theoretic disadvantage of greater strain placed on the Achilles tendon with early loading. This tendon benefit was seen in the first year postoperatively. Over the long-term, the strength and anthropometric outcomes in both groups were similar. For all outcomes, the injured leg remained deficient compared to the uninjured leg during the follow-up period.

We report a trend towards a lower rate of major complications in the bracing group. There was no difference in the rupture rate (both groups had six reruptures). These findings counter the concern about overloading the healing tendon which provided the rationale for postoperative cast immobilisation.

Patient satisfaction levels were higher for the bracing group in all trials assessing this outcome. This is arguably the most important outcome which likely integrates all of the outcomes reported above. Such higher level of patient satisfaction with early mobilisation regimes were surprising, as dynamic braces are lightweight and some models are removable. Moreover, early mobilisation protocols encouraged early weight-bearing, minimising patient disability. A validated, patient-oriented outcome measure confirmed a significantly higher health-related quality of life with early weight bearing.

Strengths and limitations

Compared to previous meta-analyses, the current analysis benefits from a greater pooled population and longer follow-up. In addition, outcome measures such as time to return to normal activities have not been evaluated previously. Nevertheless, the quality of evidence from any meta-analysis is dependent on the quality of the component trials. Although the trials available to date included low follow-up losses and long follow-up periods, they featured small patient populations and non-standardised rehabilitation protocols. Nevertheless, we believe the results are generalisable. The Downs and Black assessment of study quality focuses on this issue and there are no identifiable sources of significant bias.

Summary

The benefits and convenience of bracing, without increased complication rates, has led to bracing for Achilles tendon rupture being a popular choice among both patients and physicians. Pooled analysis of randomised controlled trials shows higher patient satisfaction with no increase in complications. Thus, dynamic functional bracing may contribute to evidenced-based practice in the postoperative rehabilitation of acute Achilles tendon rupture.
What are the new findings?

Compared to cast immobilisation, early functional rehabilitation after Achilles tendon repair

- is safe.
- results in higher patient satisfaction.
- leads to earlier return to function.

How might it impact clinical practice?

- It is safe to start functional rehabilitation early following Achilles tendon repair.
- Early functional rehabilitation can improve patient satisfaction and facilitate earlier return to activity following Achilles tendon repair.
- Postoperative immobilisation is not necessary or helpful.

Competing interests None declared.
Provenance and peer review Not commissioned; externally peer reviewed.

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