Surgical Interventions for Treating Acute Achilles Tendon Rupture: Key Findings from a Recent Cochrane Review

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Acute Achilles tendon rupture is a relatively common injury resulting in substantial morbidity in young, active patients. It occurs most frequently in male individuals, and the incidence is thought to be increasing[1]. There has been a lack of consensus among orthopaedic surgeons regarding the best management of this injury. Treatment can be broadly divided into surgical (open or percutaneous) and nonsurgical (cast immobilization or functional bracing).

In 2004 and 2005, our group published a meta-analysis of randomized controlled trials concerning treatment of acute Achilles tendon rupture, including different splinting techniques[2,3]. We concluded that open operative treatment of Achilles tendon rupture significantly reduced the risk of rerupture compared with nonoperative treatment, but that such treatment was associated with a significantly higher risk of other complications. Since the 2004 meta-analysis, several new randomized controlled trials on the treatment of acute Achilles tendon rupture have been published.

In the present meta-analysis, we tested the hypothesis that surgical repair of Achilles tendon rupture reduces the rerupture rate and results in improved long-term function, without an increase in other complications. We focused purely on comparisons between surgical and nonsurgical methods and between different surgical techniques. We present data from fourteen studies involving 1085 patients[4-17].

Materials and Methods

We followed the Cochrane guidelines for conducting meta-analyses[18]. The principal investigators searched the Cochrane Bone, Joint and Muscle Trauma Group Specialized Register (July 2009), the Cochrane Central Register of Controlled Trials (The Cochrane Library 2009, Issue 3), MEDLINE (1966 to July 20, 2009), EMBASE (1966 to 2009 week 29), CINAHL (1983 to July 2007), and reference lists of articles. All randomized and quasi-randomized trials comparing surgical with nonsurgical treatment or comparing different surgical treatments of acute Achilles tendon rupture in adults were included. Retrospective studies, studies with insufficient reporting of primary outcomes, and studies with inadequate methods of randomization were excluded.

Only adult patients with acute rupture of the Achilles tendon were included. Patients with delayed presentation (more than three weeks after the injury) or presenting for a rerupture were excluded. The primary outcomes were the rerupture rate, complication rate (infection, adhesions, and altered skin sensation), and long-term function (e.g., return to sporting activity).

Two of the authors independently selected trials for inclusion and extracted data relevant to the review. Potential sources of bias (selection, performance, detection, and attrition) were assessed with use of the Cochrane Collaboration guidelines[18]. For each trial, eleven aspects of the methodology were independently assessed without masking of the study name or study authors. The resulting score could range from 0 to 13 points, with a low score indicating poor methodology (see Appendix). Any differences involving the inclusion criteria, data extraction, or methodology scoring were resolved by discussion.

For each study, risk ratios and 95% confidence intervals (CIs) were calculated for dichotomous outcomes, and mean differences and 95% CIs were calculated for continuous outcomes. Heterogeneity among comparable trials was assessed by visual inspection of the forest plot and by use of the I^2 statistic[19].

Results from individual trials were pooled whenever possible and appropriate with use of a fixed-effect model and 95% CIs. If there was statistical or graphical evidence of heterogeneity, the results were checked with use of a random-effect model.

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The authors did not receive external funding for this study.

Results

Fourteen of thirty-nine potentially eligible trials were analyzed (see Appendix). Twenty-two trials were excluded for reasons that included (but were not limited to) retrospective study design, inadequate randomization, and unclear methodology (see Appendix). Of the three remaining trials, one was ongoing and two were registered but not yet published.

Eight of the fourteen included trials were performed at multiple centers. The fourteen trials included 1085 patients; however, baseline demographic data were only provided for

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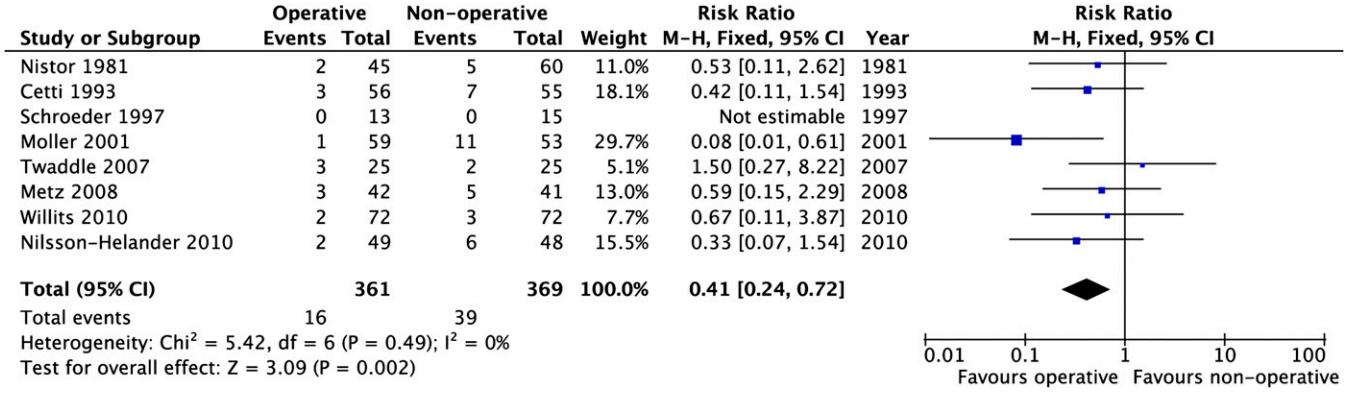

Fig. 1

Prevalence of rerupture associated with operative and nonoperative treatment. M-H = Mantel-Haenszel test, CI = confidence interval, and df = degrees of freedom.

1035 patients. Where described, the majority of patients were male. All patients were adults; the mean age ranged from thirty-six to forty-one years. Where the mechanism of injury was stated, the great majority of patients ruptured the tendon during athletic activity. In general, there was an improvement in study quality over time; however, there were some notable exceptions[4,8] (see Appendix).

Operative Compared with Nonoperative Treatment

Eight[6,9,10,12,13,15-17] of the fourteen trials compared operative with nonoperative treatment in a total of 730 patients. The operative and nonoperative techniques in these studies are listed in the Appendix, and all surgical procedures were performed or supervised by a consultant orthopaedic surgeon.

Rerupture

The rate of rerupture was recorded in all eight studies. The pooled results showed significantly fewer reruptures in the surgically treated group (sixteen [4.4%] of 361 compared with thirty-nine [10.6%] of 369); risk ratio [RR], 0.41 [95% CI, 0.24 to 0.72]; p = 0.002; Fig. 1).

Two studies used plaster cast immobilization following the initial treatment intervention. Both favored operative treatment. When pooled, we found fewer reruptures in the operative group; however, this did not reach statistical significance (five [5.0%] of 101 compared with twelve [10.4%] of 115; RR, 0.46 [95% CI, 0.17 to 1.27]; p = 0.13; Fig. 2).

Five studies used accelerated rehabilitation programs involving a combination of short-term immobilization and functional braces (see Appendix). In these studies, there was no significant difference between the rerupture rates in the operative and nonoperative groups (ten [5%] of 201 compared with sixteen [8.0%] of 201; RR, 0.62 [95% CI, 0.29 to 1.32]; p = 0.21; Fig. 3).

The remaining study[10] used plaster cast immobilization in nonoperatively treated participants and functional bracing in operatively treated participants, and it was therefore not suitable for data pooling. That study strongly favored operative treatment.

Overall, the lowest rate of rerupture was in patients managed operatively and subsequently immobilized in a cast. The highest rate of rerupture was in patients managed nonoperatively followed by cast immobilization.

Complications Excluding Rerupture

Complications other than rerupture were also reported in all eight studies. Infection, adhesions, sural nerve injury, or/sensory disturbance were the most commonly reported complications. Fourteen wound infections (3.9%), including eight deep infections (2.2%), occurred in the surgical group compared with none in the nonsurgical group (RR, 6.3 [95% CI, 1.82 to 21.79]; see Appendix). The pooled results for all reported complications other than rerupture showed a significantly greater prevalence in the surgically treated group (98 [27%] of 361 compared with twenty-two [6%]

Fig. 2

Prevalence of rerupture associated with operative and nonoperative treatment with subsequent cast immobilization. M-H = Mantel-Haenszel test, CI = confidence interval, and df = degrees of freedom.

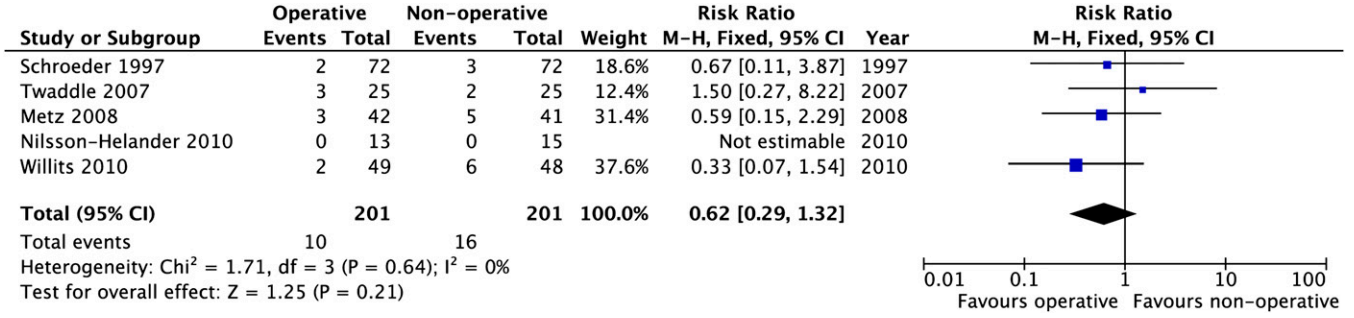

Fig. 3

Prevalence of rerupture associated with operative and nonoperative treatment with subsequent accelerated rehabilitation. M-H = Mantel-Haenszel test, CI = confidence interval, and df = degrees of freedom.

of 369; RR, 4.35 [95% CI, 2.86 to 6.61]; Fig. 4). These results should be viewed with caution because it is not clear from the reporting whether some patients incurred more than one complication. There was also statistically significant heterogeneity in the pooled results, as demonstrated by the I^2 statistic (84%).

Where complications were described individually, we found that open surgical repair was associated with significantly higher risks of wound infection (RR, 6.3 [95% CI, 1.82 to 21.79]), altered sensation (RR, 7.07 [95% CI, 2.4 to 20.87]), and adhesions (RR, 10.64 [95% CI, 3.97 to 28.46]).

Long-Term Function and/or Return to Sports

This was reported in seven of the eight trials[6,9,10,12,15-17]. Because of variability in the definition of activity and in the validated and unvalidated scoring tools used, as well as incomplete data recording, it was not possible to pool results. One trial[6] indicated significantly better return to the previous level of athletic activity in the surgical group (RR, 1.81 [95% CI, 1.15 to 2.84]). No significant differences between groups were reported in the other six trials.

Open Compared with Percutaneous Surgical Repair

Four trials compared open with percutaneous repair of ruptured Achilles tendons in 174 participants[5,7,8,15]. The techniques used varied among trials (see Appendix).

Rerupture

Three reruptures were reported in the four studies comparing open and percutaneous repair of ruptured Achilles tendons. All three reruptures were reported by Lim et al.[8]. The pooled data showed no significant difference between groups in the rerupture rate (RR, 2.00 [95%, CI 0.19 to 21.00]; see Appendix).

Complications Excluding Rerupture

Three trials[5,8,15] included data on the prevalence of postoperative infection. The pooled results demonstrated a significantly higher rate in the open repair group (twelve of sixty-six compared with zero of sixty-eight; RR, 9.32 [95% CI, 1.77 to 49.16]; Fig. 5). Other complications that were reported on, including deep venous thrombosis, sural nerve problems, and hematoma formation, showed no significant difference between treatment arms.

Long-Term Function and/or Return to Sports

Aktas et al.[5] reported that 85% of open surgery patients and 89% of percutaneous surgery patients returned to their preinjury level of sports activity. The timing of recovery of function in the study by Lim et al.[8] was similar in the two groups, and all patients had returned to their activities of daily living by the six-month follow-up visit. Lim et al.[8] provided incomplete data for participation in active athletic or outdoor activities, but thirteen of

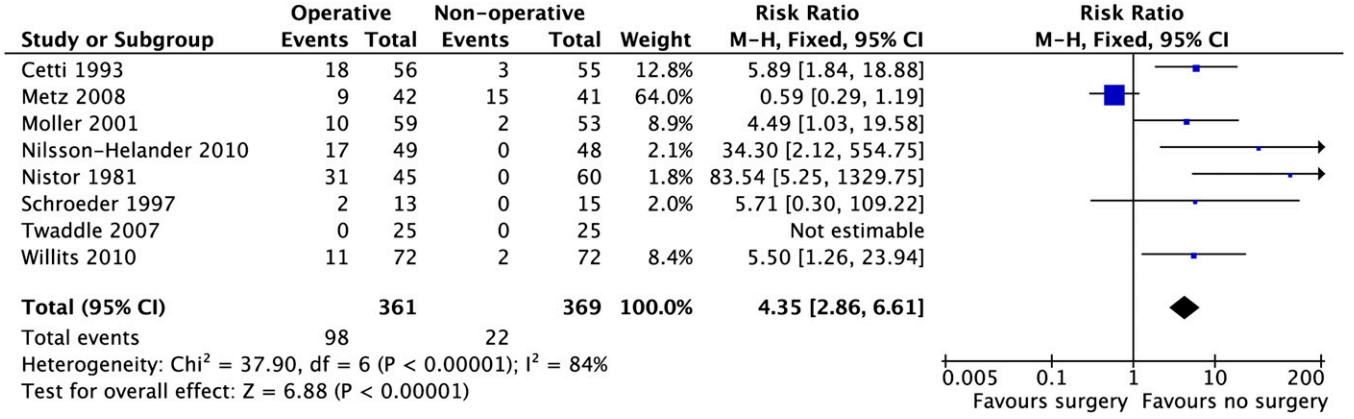

Fig. 4

Prevalence of complications other than rerupture associated with operative and nonoperative treatment. M-H = Mantel-Haenszel test, CI = confidence interval, and df = degrees of freedom.

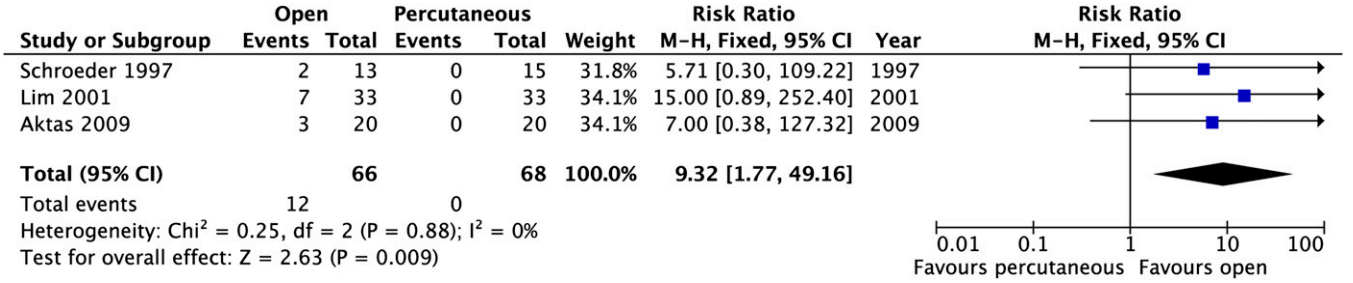

Fig. 5

Prevalence of wound infection associated with open and percutaneous surgery. M-H = Mantel-Haenszel test, CI = confidence interval, and df = degrees of freedom.

twenty participants who had described themselves as "active" before their injury had returned to active sports by the six-month follow-up visit; there was no significant difference between the groups. Nineteen out of the twenty-three patients included in the analysis by Schroeder et al.[15] had attained full-time or leisure-time sports activity. The differences between the two groups in return to sports in this trial also did not reach significance. Gigante et al.[7] did not report on return to sports or work. Pooling of data was not possible because of the lack of uniformity of the outcome measures recorded.

Augmented Compared with Simple Surgical Repair

Two studies (Aktas et al.[4] and Pajala at al.[14]) with ninety patients compared augmented with simple surgical repair. Both studies used a Krackow suture technique in the simple surgical repair group; the technique in the augmented group differed between the studies. Aktas et al.[4] used a plantaris tendon augmentation, with the tendon flattened and spread over the Achilles tendon as a sheath, plus a Krackow end-to-end suture. Pajala et al.[14] used end-to-end suture repair with use of the Krackow technique with a down-turned gastrocnemius fascia flap as described by Silfverskiöld[20].

Rerupture

Pajala et al.[14] reported three reruptures in each treatment group. The mean time to rerupture was fifty-eight days (range, two to 112 days), and all reruptures occurred in male patients. No reruptures occurred in the study by Aktas et al.[4]. The pooled data showed the rerupture rate to be three of forty-four in the augmented group compared with three of forty-six in the simple group (RR, 1.14 [95% CI, 0.25 to 5.21]).

Complications Excluding Rerupture

Analysis of complications other than rerupture showed no significant difference between treatment groups. The pooled data showed that the rate of other complications was five of forty-four in the augmented group compared with four of forty-six in the simple group (RR, 1.38 [95% CI, 0.36 to 5.25]).

Long-Term Function and/or Return to Sports

Aktas et al.[4] reported that 85% of patients in the augmented group and 89% in the simple repair group returned to their preinjury level of sports activity. Pajala et al.[14] reported that all patients, including the eight early treatment failures who had a rerupture or deep infection, returned to their previous level of activity by twelve months.

Two-Strand Compared with Six-Strand Open Repair

This was considered in one study (Mortensen et al.[11]) with fifty-seven patients. Neither group had any reruptures or infections during the follow-up period. The authors reported no significant difference in the complication rate between these two surgical techniques. They did not compare long-term function between techniques.

Discussion

Acute Achilles tendon rupture is a relatively common injury that often occurs in young, healthy people. The management of this injury is controversial. To our knowledge, this is the largest meta-analysis published to date on surgical interventions for Achilles tendon rupture. We used strict methodological quality assessment scores to assess selection bias, performance bias, detection bias, and attrition bias in the included studies[18]. Our findings are in keeping with those of our previous meta-analysis[2,3]; however, the confidence intervals are now smaller and the validity of the results is therefore greater.

We found that open surgical repair of a ruptured Achilles tendon significantly reduced the rerupture rate compared with nonoperative treatment. Summation of data gave a pooled prevalence of 4.4% in the surgically treated group compared with 10.6% in the nonsurgical group (RR, 0.41 [95% CI, 0.24 to 0.72]; p = 0.002). We acknowledge that the study by Möller et al.[10] may skew our results because of the relatively high rerupture rate reported in the nonsurgical group (eleven compared with one in the surgical group). It should be noted, however, that the randomized controlled trial by Möller et al. was of good quality, with the highest score for methodological rigor. Excluding it would represent selection bias and thus be inappropriate in a meta-analysis. More studies are needed to clarify the true effect size.

When the data from the studies were pooled, there were significantly more complications other than rerupture in the open surgical group compared with the nonsurgically managed group (27% compared with 6%; RR, 4.35 [95% CI, 2.86 to 6.61]), although these results should be interpreted with caution as some participants may have had more than one complication.

Where complications were described individually, open surgical repair was associated with significantly higher risks of wound infection (RR, 6.3 [95% CI, 1.82 to 21.79]), altered sensation (RR, 7.07 [95% CI, 2.4 to 20.87]), and adhesions (RR, 10.64 [95% CI, 3.97 to 28.46]).

Percutaneous surgical tendon repair appeared to offer no significant reduction in the rerupture rate compared with open repair; however, it was associated with significantly fewer postoperative infections (RR for open compared with percutaneous repair, 9.32 [95% CI, 1.77 to 49.16]). Sural nerve injury has been reported as a complication of percutaneous repair, with one group finding a prevalence of 18%[21]. However, in our subgroup analysis of open compared with percutaneous repair, only one (1.1%) of eighty-eight participants treated percutaneously experienced altered sensation in the sural nerve distribution.

Only limited conclusions can be drawn from the small number of trials that have compared different repair techniques. The results suggest that there was no advantage to using a six-strand repair compared with a two-strand repair, and that more complex reconstructions offered no improvement in outcome compared with simple surgical repair.

In 2010, the American Academy of Orthopaedic Surgeons (AAOS) published guidelines for the diagnosis and treatment of acute Achilles tendon rupture[22]. They were able to reach consensus on two of their sixteen recommendations—namely, that a detailed history and examination should be performed in patients with suspected Achilles tendon rupture, and that operative treatment should be approached more cautiously in patients who were over the age of sixty-five years or had concomitant medical problems. Pertinent to our study, the AAOS gave a "weak" recommendation for both operative and nonoperative treatment of acute Achilles tendon rupture on the basis of the studies reviewed. Interestingly, the AAOS did not use four of the randomized controlled trials that we included in our study. We suspect that in two cases this may have been because of the timing of publication[12,17]. The reason for excluding Nistor[13] was simply stated as "not best available evidence," with which we and The Cochrane Library disagree. No explanation was given for excluding the study published by Schroeder et al.[15]. However, when we repeated the meta-analysis of the studies included in the AAOS review, there remained a significant reduction in the rerupture rate in patients who underwent operative repair (RR, 0.38 [95% CI, 0.19 to 0.78]) despite the exclusion of those four studies. The important difference between our study and the AAOS study is that the latter was a systematic review rather than a meta-analysis. This probably explains the lack of consensus reached on the majority of recommendations by the AAOS. Our results were based on the pooling of data from each study, with an assessment of trends, significance, and heterogeneity. Thus, we were able to draw more definitive conclusions, which should help orthopaedic surgeons in their decision-making process.

Our study has a number of weaknesses. There was considerable variance not only in the postoperative treatment protocols used in the included studies but also in the nonoperative treatment protocols (see Appendix). Traditionally, Achilles tendon ruptures have been treated with immobilization in a plaster cast after the initial operative or nonoperative intervention. More recently, accelerated "early mobilization" rehabilitation programs using functional braces have been favored.

To attempt to identify whether cast immobilization or functional bracing is better after operative or nonoperative management, we performed subgroup analyses of the results. Although this obviously reduced the numbers of patients in each analysis, there was no statistical heterogeneity. The lowest rerupture rates were found in the operatively managed group, whether treated postoperatively with cast immobilization (3.4%) or with functional bracing (5.0%).

We identified several studies comparing different rehabilitation protocols after operative[23] and nonoperative[24-26] management. In a previous meta-analysis of six studies, Suchak et al.[23] found that the rerupture rate was lower in patients managed with a postoperative functional brace (2.5%) compared with a cast (3.8%). The reason for the discrepancy between that study and the present study is unclear, but it may relate to the small number of patients or to differences in the surgical techniques or the postoperative functional bracing protocols.

Our review of the literature regarding nonoperative management revealed three randomized controlled trials[23-25] that compared cast immobilization with accelerated rehabilitation. The pooled rerupture rate in these studies was two of sixty (3.3%) in the accelerated rehabilitation group compared with eight of seventy (11.4%) in the cast immobilization group. The latter result differs considerably from that in our study, confirming that more well-conducted randomized controlled trials with larger numbers are required to clarify the issue of rehabilitation after initial management. We support the guidelines of the AAOS, which states that they are "unable to recommend for or against immediate functional bracing for patients with acute Achilles tendon rupture."

In our attempt to assess functional outcomes, we encountered multiple scoring tools, incomplete data recording, and a variety of definitions of activity. This made pooling of data impossible. Reporting that is more standardized and uses validated scoring systems is required in future studies.

In summary, our study supports operative repair of Achilles tendon rupture. Operative repair was associated with more infections, but these were reduced by using a percutaneous technique. Complex reconstructions of the tendon appeared to offer no improvement in outcomes. A subgroup analysis favored postoperative cast immobilization over accelerated rehabilitation protocols; however, this is not in agreement with other studies[26]. We look forward to the publication of more high-quality randomized controlled trials regarding rehabilitation protocols.

Appendix

(eA) Tables summarizing the excluded trials, the methodology scoring system, and the methodology scores and techniques of the included trials, as well as figures showing infection rates after surgical compared with nonsurgical treatment and showing rerupture rates after open compared with percutaneous surgery, are available with the online version of this article as a data supplement at jbjs.org. ■

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