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## Early Functional Rehabilitation for Acute Achilles Tendon Ruptures: An Update Meta-Analysis of Randomized Controlled Trials

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## ABSTRACT

The aim of this study was to investigate the role of early functional rehabilitation in acute Achilles tendon ruptures. Eligible studies were identified from PubMed, Embase, and the Cochrane Library using the following search keywords: “Achilles tendon rupture” and “rehabilitation” or “function” or “functional” or “mobilization” and “randomized” or “random” or “blind” or “control” or “compare” or “comparative.” A heterogeneity test based on  $I^2$  statistic and Cochran’s Q test was conducted. The pooled risk ratio and weighted mean difference with 95% confidence interval was calculated for each outcome using the random-effect ( $p < .05$  or  $I^2 > 50\%$  for significant heterogeneity) or fixed-effect ( $p > .05$  or  $I^2 < 50\%$  for nonsignificant heterogeneity) model. A subgroup analysis was also performed. Fourteen randomized controlled trials were identified. Pooled data demonstrated no difference in the complication rates, time taken to return to sports, total number of patients returning to work or sports, and satisfaction rate between the early functional rehabilitation and conventional cast immobilization groups. Early functional rehabilitation significantly decreased the time taken to return to work (weighted mean difference  $-1.56$ ; 95% confidence interval  $-3.09$  to  $0.04$ ;  $p = .04$ ). Early functional rehabilitation for acute Achilles tendon ruptures appeared to be related to a shorter time taken to return to work; however, it did not affect the other variables between the groups.

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Acute Achilles tendon (AT) ruptures are a common injury, and the reported incidence appears to be increasing during the 20-year period from 1994 to 2013 (1). AT ruptures can be managed surgically or non-surgically, followed by 3 to 6 months of rehabilitation (2). Rehabilitation can be nonfunctional (conventional cast immobilization) or functional (early functional rehabilitation or functional mobilization). Early functional rehabilitation belongs to dynamic rehabilitation with weight-bearing or exercise, followed by nonoperative or operative treatment (3). Recently, the commonly used methods of managing acute AT ruptures include traditional percutaneous and open repairs with sutures and minimally invasive procedures (4–6). Functional rehabilitation is initiated with walking with the assistance of a crutch and appropriate weightbearing on the affected ankle immediately after application of an orthosis with an adjustable range of motion ( $15^\circ$  to  $40^\circ$  of plantarflexion) (7). In some centers, patients with acute AT ruptures were commonly treated with conventional cast immobilization for 8 to 10 weeks until the late 1980s (8). However, over the past 3 decades, early functional rehabilitation has obtained increasing popularity and become a

well-accepted regimen in some centers (9) because it has the advantage of improved healing through increasing callus production and metabolic activity.

Several high-quality meta-analyses comparing early functional rehabilitation and conventional cast immobilization for acute AT ruptures have been published over the past several years (10–13). The results have generally demonstrated that early functional rehabilitation yields a higher patient satisfaction rate but is not associated with better outcomes, such as a lower rerupture rate and a shorter time to return to work. Previous meta-analyses presented some limitations, however, such as considering some studies that were not randomized controlled trials (RCTs) (14,15) for evaluation, which might have introduced bias to the results. In addition, several high-quality RCTs published over the past several years revealed that early functional rehabilitation yielded results that were superior to those of conventional cast immobilization when the time taken to return to work (16) and sports were compared (17). Using early functional rehabilitation or conventional cast immobilization, which is the superior option for acute AT ruptures, remains a controversy. To the best of our knowledge, no high-level meta-analysis has been conducted on early functional rehabilitation after acute AT ruptures based only on RCTs. The purpose of the present study is to compare early functional rehabilitation and conventional cast immobilization based on the latest evidence from RCTs to obtain more reliable results.

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## Materials and Methods

In this study, we extracted and combined data from other related studies and indirectly obtained patient information. Ethical approval was therefore not necessary for the present study.

### Search Strategy and Selection Criteria

All relevant reports were searched systematically from PubMed (<http://www.ncbi.nlm.nih.gov/pubmed>), Embase (<http://www.embase.com>), and the Cochrane Library (<http://www.cochranelibrary.com>), without language restrictions. The last date of the literature search was May 4, 2017. The search terms were as follows: “Achilles tendon rupture” and “rehabilitation” or “function” or “functional” or “mobilization” and “randomized” or “random” or “blind” or “control” or “compare” or “comparative.” The references cited in the related literature and reviews were also searched to obtain more available studies. Clinical studies or trials that satisfied all of the following selection criteria were enrolled in the present study: (1) dealing with cases of acute AT ruptures receiving surgery or conservative treatment; (2) RCTs; (3) the intervention group, also named functional rehabilitation group (FG), in which participants received early functional rehabilitation, and control group, also named immobilization group (IG), in which participants received conventional cast immobilization; and (4) including at least 1 of the following outcome data: complication rate, patient satisfaction rate, rehabilitation duration (time taken to return to work and sports), and total number of patients returning to work or sports. Conversely, the exclusion criteria included the following: (1) no complete data or data that could not be used for statistical analysis and (2) reviews, letters, or comments. For repeated literature publications or data of the same population in multiple studies, only the latest research or the most complete study was included.

### Data Extraction and Quality Evaluation

The present study adhered to the standards in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (18). Data relevant to the outcomes were extracted independently by 2 reviewers from each study. These data included the name of the first author, publication year, location of the study, follow-up time, age of patients, total number of subjects, and outcome data. Differences in the data were rechecked via consensus.

This study used the Cochrane risk assessment tool (19) to evaluate the literature. This tool includes 7 basic contents: generation of random sequence, concealment of allocation, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other bias, which can objectively and comprehensively evaluate all kinds of bias in the study.

### Sensitivity Analysis and Publication Bias

A sensitivity analysis was conducted to evaluate the influence of each study on the pooled results by omitting 1 of the included studies each time. The sensitivity analysis for

rerupture, wound infection, deep venous thrombosis, time to return to work, time to return to sports, and satisfaction was conducted through omitting relevant studies that reported these outcomes. Funnel plots were applied to investigate potential publication bias.

### Statistical Analysis

The present meta-analysis used risk ratios (RRs) and the 95% confidence intervals (CIs) of the RRs to summarize the dichotomous data. The continuous data were presented as weighted mean differences (WMDs) and their 95% CIs. A heterogeneity test based on  $I^2$  statistic and Cochran's Q test (20) was conducted.  $p < .05$  and/or an  $I^2$  value  $>50\%$  was considered to indicate a statistically significant heterogeneity. The fixed-effect model was used when there was no significant heterogeneity among the enrolled studies; the random-effect model was used when there was significant heterogeneity among the primary studies. A subgroup analysis according to whether the patients underwent surgery was also performed.

## Results

### Description of the Included Studies

A total of 788 studies were identified after the initial article search. Fourteen trials (3,7,16,17,21–30), which satisfied the selection criteria, were finally screened. The flow of article selection is provided in Fig. 1. A total of 443 trials were obtained from PubMed, 266 from Embase, and 79 from the Cochrane Library. Hand searching failed to find any available articles for the analysis. First, 210 duplicate studies were eliminated. Second, 556 articles were excluded after browsing the titles and abstracts. Finally, 8 articles (including 4 non-RCTs, 2 duplicate studies, and 2 trials not dealing with acute AT ruptures) were omitted after full-text reading. Among the 14 included studies, 10 studies compared the outcomes between early functional rehabilitation and conventional cast immobilization after surgical repair of acute AT rupture (7,16,17,21–26,28); 3 studies compared the outcomes after nonsurgical treatment of acute AT rupture (27,29,30); and 1 study included patients with acute AT rupture treated with surgical or nonsurgical treatment (3).

These trials enrolled a total of 829 adult patients with acute AT rupture, including 409 patients treated with FG and 420 with IG. Detailed characteristics of the selected studies are provided in the Table. The selected articles were published between 1994 and 2016 and had been

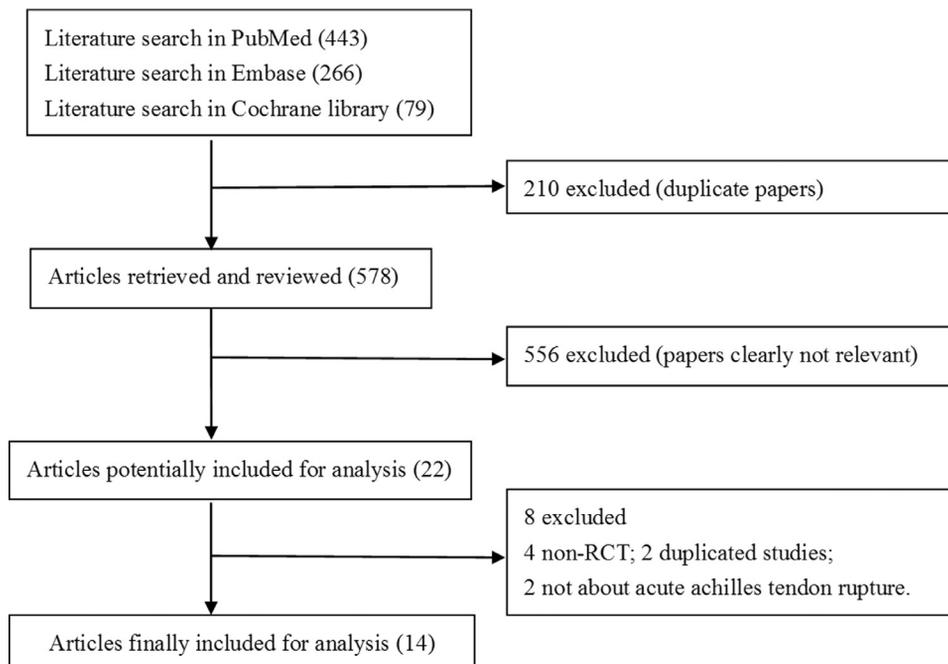


Fig. 1. Flow of literature search and study selection. RCT, randomized controlled trial.

**Table**  
Main characteristics and results of the eligible studies included in the meta-analysis

Study, Year, Country	Treatment of AATR	Age (SD or range), n (M/F)	Group	Intervention	Number of Patients	Follow-Up
Barfod et al (27), 2014 Denmark	Nonoperative	41.2 (6.4), 29 (24/5)	FG	WB orthosis	29	12 months
			IG	NWB orthosis	28	
Cetti et al (21), 1994 Denmark	Operative	37 (20–60), 30 (25/5)	FG	WB dorsal splint	30	12 months
			IG	NWB rigid cast	30	
Costa et al (24), 2003 UK	Operative	41, 28 (24/4)	FG	WB dorsal splint	13	12 months
			IG	NWB rigid cast	13	
Costa et al (3), 2006 UK	Operative	42 (28–61), 23 (18/4)*	FG	WB dynamic brace	23	12 months
			IG	NWB rigid cast	25	
	Nonoperative	53 (21–79), 22 (15/7)	FG	WB dynamic brace	22	12 months
			IG	NWB rigid cast	26	
De la Fuente et al (16), 2016 Chile	Operative	41.4 (8.3), 20 (20/0)	FG	WB cast boot	20	3 months
			IG	NWB cast boot	19	
Groetelaers et al (28), 2014 The Netherlands	Operative	43 (19–65), 60 (46/14)	FG	WB dynamic brace	32	12 months
			IG	NWB fiberglass cast	28	
Kangas et al (25), 2003 Finland	Operative	35 (21–55), 25 (22/3)	FG	WB dorsal splint	25	60 weeks
			IG	NWB rigid cast	25	
Kerkhoffs et al (23), 2002 The Netherlands	Operative	36.1 (22–51), 16 (13/3)	FG	WB semirigid wrap	16	6.7 years
			IG	NWB rigid cast	23	
Korkmaz et al (30), 2015 Turkey	Nonoperative	37.5 (4.5), 23 (19/4)	FG	WB cast	23	12 months
			IG	NWB cast	24	
Mortensen et al (22), 1999 Denmark	Operative	35 (20–73), 36 (26/10)	FG	WB dynamic brace	36	20 weeks
			IG	NWB rigid cast	35	
Porter and Shadbolt (17), 2015 Australia	Operative	32.2 (19–45), 26 (22/4)	FG	WB cast boot	26	12 months
			IG	NWB dorsal splint	25	
Suchak et al (26), 2008 Canada	Operative	40.6 (9.5), 55 (47/8)	FG	WB cast boot	55	6 months
			IG	NWB cast boot	55	
Valkering et al (7), 2017 The Netherlands	Operative	40.8 (6.0), 27 (24/3)	FG	WB orthosis	27	12 months
			IG	NWB plaster cast	29	
Young et al (29), 2014 New Zealand	Nonoperative	39.7 (10.7), 84 (43/41)	FG	WB cast	32	12 months
			IG	NWB cast	35	

Abbreviations: AATR, acute Achilles tendon rupture; F, female; FG, functional rehabilitation group; IG, immobilization group; M, male; NWB, non-weightbearing; SD, standard deviation; WB, weightbearing.

\* One patient's sex information was missing.

conducted in different regions worldwide, including Europe, America, Asia, and Oceania. Quality assessment showed that most included studies were high quality with a low level of methodologic bias on the incomplete outcome data and selective reporting, as shown in the Supplemental Fig. 1. The performance bias of the included studies was unclear. Overall, the present study had moderately good quality.

## Main Results and Subgroup Analysis

### Complication Rates

The complications were categorized as rerupture, wound infection, and deep venous thrombosis in this meta-analysis. There was no significant heterogeneity ( $I^2 = 0\%$ ,  $p > .05$ ) among the studies for rerupture, wound infection, and deep venous thrombosis; thus, the fixed-effect model was used to calculate the pooled size. The rerupture data of 378 patients in the FG group and 390 patients in the IG group from 13 trials were pooled; the statistical results indicated that early functional rehabilitation was not related to the rerupture rates of acute AT rupture (RR 0.95; 95% CI 0.51 to 1.80;  $p = .88$ ). The subgroup analysis showed similar findings between the operative subgroup (RR 0.77; 95% CI 0.32 to 1.86;  $p = .57$ ;  $I^2 = 0\%$ ;  $p$  for heterogeneity = .97) and nonoperative subgroup (RR 1.20, 95% CI 0.48 to 3.01;  $p = .70$ ;  $I^2 = 0\%$ ;  $p$  for heterogeneity = .91) (Fig. 2A).

Five of the 14 included articles had wound infection data; these studies enrolled 153 patients in the FG group and 151 in the IG group. The pooled results revealed that the wound infection rate of acute AT rupture had no difference between the FG and IG groups (RR 0.43; 95% CI 0.13 to 1.42;  $p = .17$ ;  $I^2 = 0\%$ ;  $p$  for heterogeneity = .89). No subgroup analysis was performed for wound infection because all patients were treated with surgery in each article reporting wound infections (Fig. 2B).

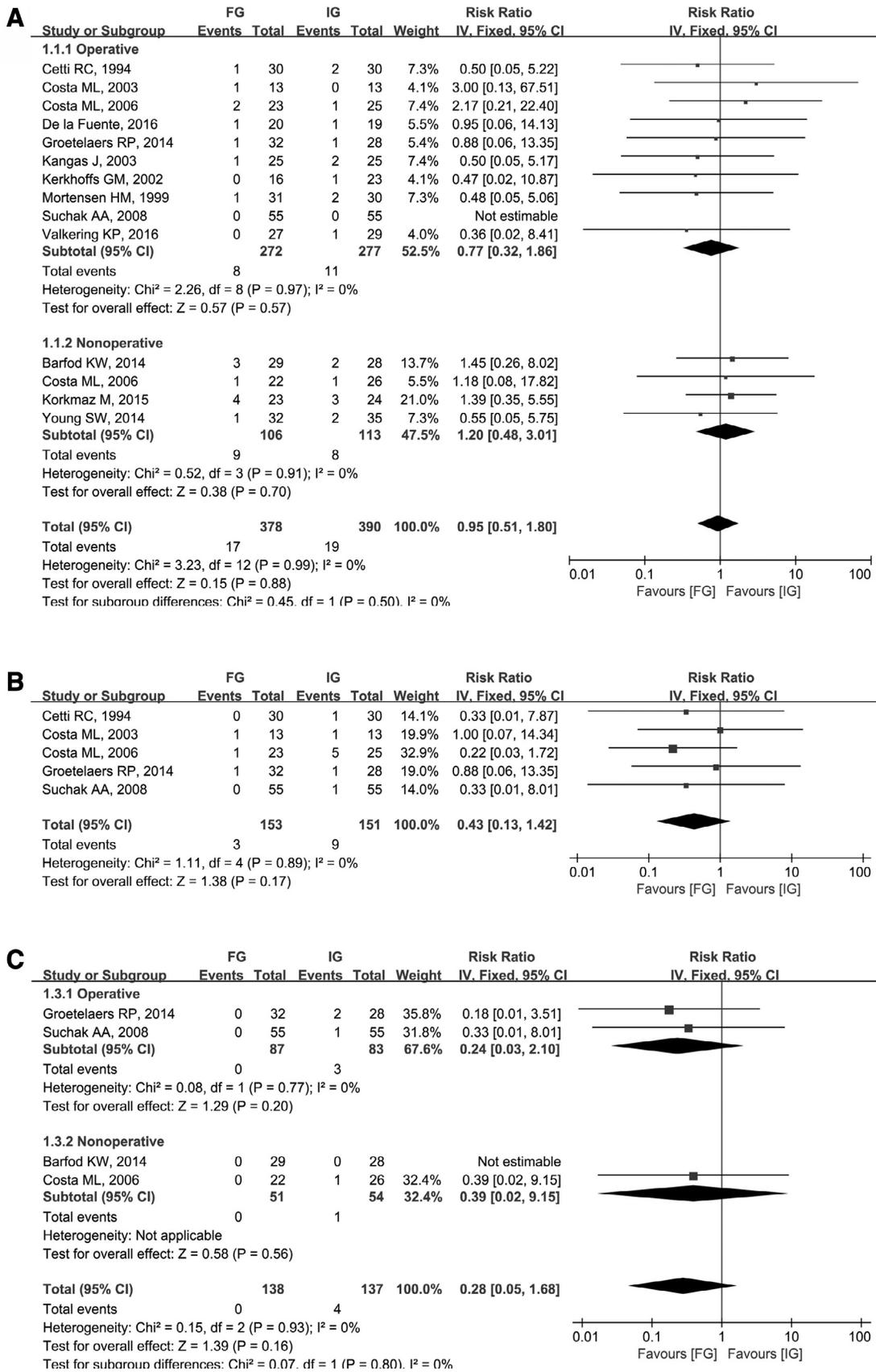
Deep venous thrombosis was an infrequent complication, occurring in <3% of the patients in both groups. There was no difference in the number of deep venous thrombosis cases between the FG ( $n = 0$ ) and IG ( $n = 4$ ) groups ( $p = .16$ ). Similar results were found in the operative subgroup ( $p = .20$ ) and nonoperative subgroup ( $p = .56$ ) (Fig. 2C).

### Rehabilitation Duration

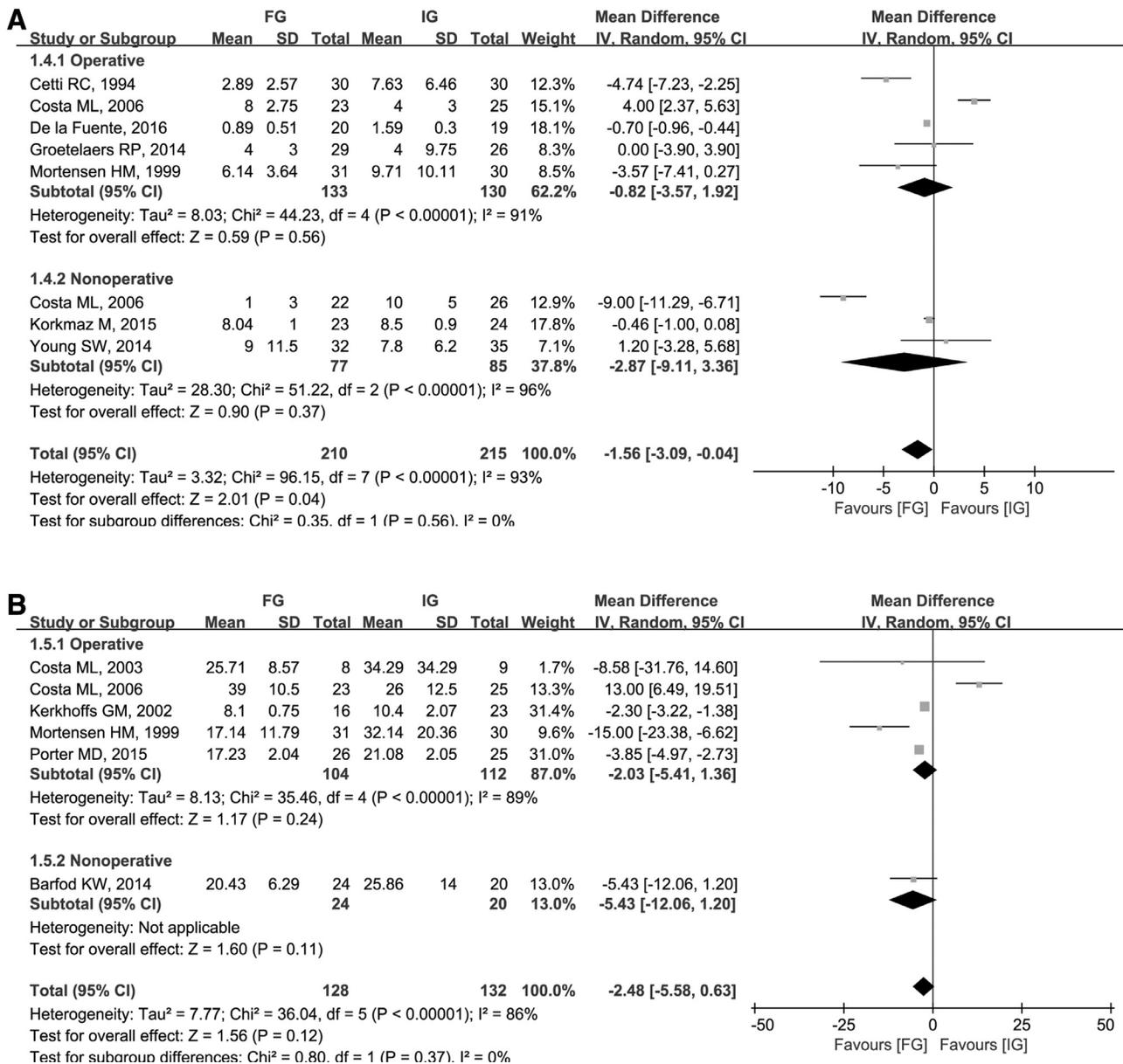
The rehabilitation duration was described as time taken to return to work and sports. Seven of the 14 included studies had time taken to return to work data; these data included 210 patients in the FG group and 215 in the IG group. The pooled results revealed a decrease in the time taken to return to work in the FG group. The pooled overall WMD was  $-1.56$  (95% CI  $-3.09$  to  $0.04$ ;  $p = .04$ ) in the random-effects model, with an evidently significant heterogeneity among the primary studies ( $I^2 = 93\%$ ,  $p$  for heterogeneity < .00001). Conversely, this effect was not evident with respect to the time taken to return to sports (WMD  $-2.48$ ; 95% CI  $-5.58$  to  $0.63$ ;  $p = .12$ ;  $I^2 = 86\%$ ,  $p$  for heterogeneity < .00001). The findings of the subgroup analysis were as follows: there was no significant difference in the time taken to return to work between the operative subgroup (WMD  $-0.82$ ; 95% CI  $-3.57$  to  $1.92$ ;  $p = .56$ ;  $I^2 = 91\%$ ,  $p$  for heterogeneity < .00001) and nonoperative subgroup (WMD  $-2.87$ , 95% CI  $-9.11$  to  $3.36$ ;  $p = .37$ ;  $I^2 = 96\%$ ,  $p$  for heterogeneity < .00001). Similar results were found in the time taken to return to sports in the operative subgroup ( $p = .24$ ) and nonoperative subgroup ( $p = .11$ ) (Fig. 3A and B).

### Total Number of Patients Returning to Work or Sports

Two trials reported data on the total number of patients returning to work; the pooled results showed no evident difference between the FG



**Fig. 2.** Comparison of the rates of complications, including (A) rerupture, (B) wound infection, and (C) deep venous thrombosis between the early functional rehabilitation group and the conventional cast immobilization group. Each comparison is presented with the name of the first author and year of publication. Risk ratios were pooled using the fixed-effect model. CI, confidence interval; IV, inverse variance.



**Fig. 3.** Comparison of the rehabilitation duration, including the time taken to return to work (A) and return to sports (B) between the early functional rehabilitation group and the conventional cast immobilization group. Weighted mean differences were pooled using the random-effect model. CI, confidence interval; IV, inverse variance; SD, standard deviation.

(45/55) and IG (38/52) groups (RR 1.10; 95% CI 0.91 to 1.34;  $p = .33$ ;  $I^2 = 0\%$ ,  $p$  for heterogeneity = .92; fixed-effect model). Similar results were found in the operative subgroup (RR 1.09; 95% CI 0.92 to 1.30;  $p = .32$ ) and nonoperative subgroup (RR 1.12; 95% CI 0.71 to 1.76;  $p = .63$ ) (Fig. 4A).

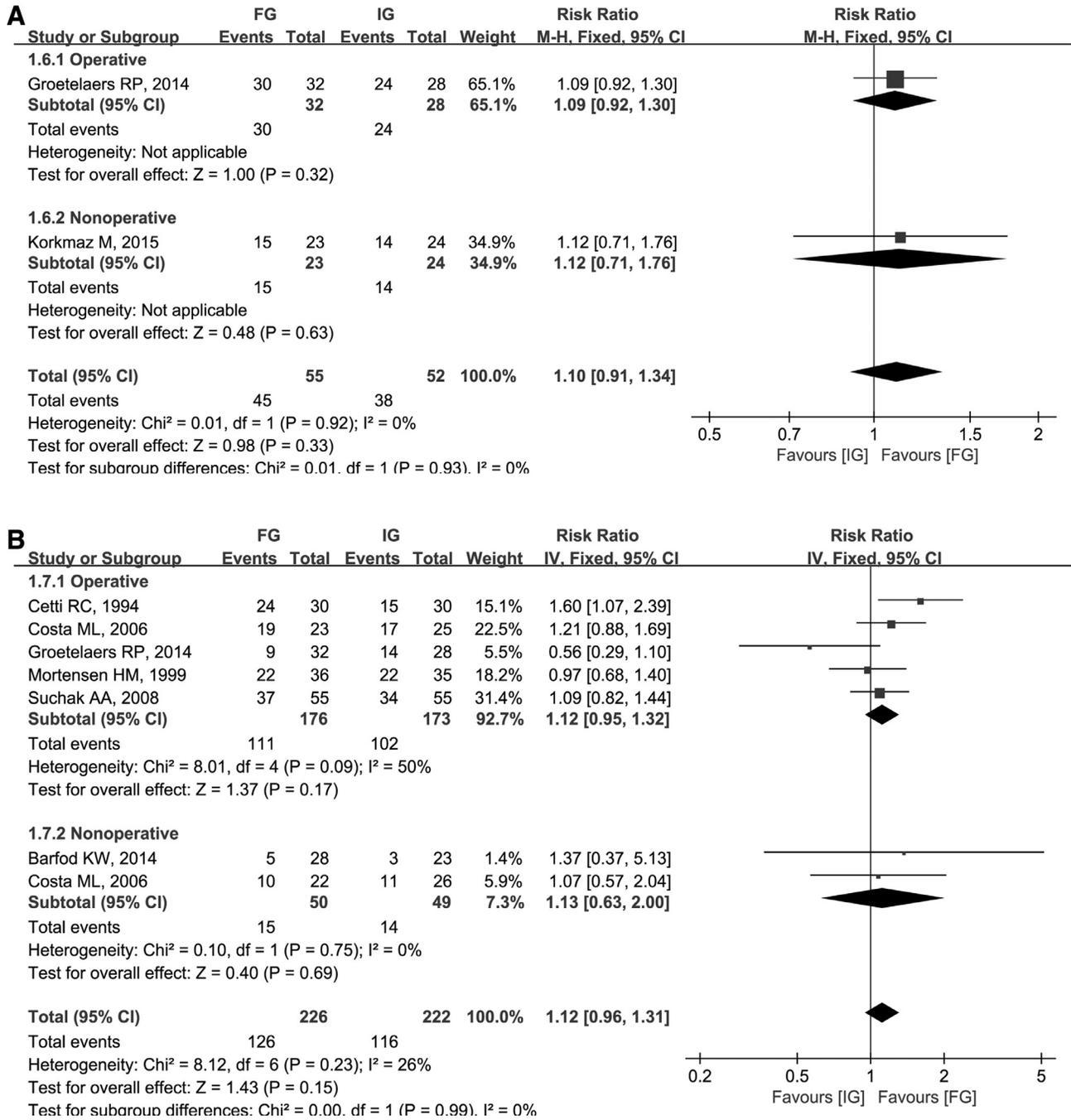
Six studies, which included 226 patients in the FG group and 222 patients in the IG group, had data on the total number of patients returning to sports. The pooled results showed no association between early functional rehabilitation and the total number of patients returning to sports. The pooled RR was 1.12 (95% CI 0.96 to 1.31;  $p = .15$ ; fixed-effect model), without significant heterogeneity ( $I^2 = 26\%$ ,  $p$  for heterogeneity = .23). Similar results were obtained when we applied the fixed-effect model in the subgroup analysis. The summary RRs for the operative subgroup and nonoperative subgroup were 1.12 (95% CI 0.95 to 1.32;  $p = .17$ ;  $I^2 = 50\%$ ,  $p$  for heterogeneity = .09) and 1.13 (95% CI 0.63 to 2.00;  $p = .69$ ;  $I^2 = 0\%$ ,  $p$  for heterogeneity = .75), respectively (Fig. 4B).

**Patient Satisfaction Rate**

When the satisfaction rates of 134 patients in the FG group and 136 patients in the IG group from 5 trials were pooled, the statistical results showed no difference between the 2 groups. The pooled overall RR was 1.06 (95% CI 0.99 to 1.13;  $p = .11$ ; fixed-effect model), without any evidently significant heterogeneity among the primary studies ( $I^2 = 0\%$ ;  $p$  for heterogeneity = .54). The subgroup analysis was also omitted because all of the patients were treated with surgery in each study providing data on the patient satisfaction rate (Fig. 5).

**Sensitivity Analysis and Publication Bias**

The pooled results of rerupture (Supplemental Table 1), wound infection (Supplemental Table 2), deep venous thrombosis (Supplemental Table 3), and satisfaction (Supplemental Table 4) after omitting each



**Fig. 4.** Comparison of the total number of patients returning to work (A) and sports (B) between the early functional rehabilitation group and the conventional cast immobilization group. Risk ratios were pooled using the fixed-effect model. CI, confidence interval; IV, inverse variance; M-H, Mantel-Haenszel.

relevant study each time did not change, which was consistent with the overall and subgroup analysis results. The pooled result for the time taken to return to work changed, however, and showed a significant difference between the FG and IG groups after omitting the studies of Young et al (29) (2014), Costa et al (3) (2006), and Groetelaers et al (28) (2014) (Supplemental Table 5). In addition, the pooled result for the time taken to return to sports was significantly reversed after only omitting the study of Costa et al (3) (2006) (Supplemental Table 6).

Publication bias was detected in this meta-analysis using the rerupture data, which were reported in most studies. The funnel plot was symmetrical, and no publication bias was found (Fig. 6).

## Discussion

The present meta-analysis of 14 RCTs including a total of 829 subjects systematically investigated whether early functional rehabilitation is a better management option than conventional cast immobilization for patients with acute AT rupture. To obtain a more reliable result, the study included RCTs only for the statistical analysis. Different from previous meta-analyses that only included studies with subjects treated with surgery, this meta-analysis included studies with subjects who received operative and nonoperative treatments. Further, the subgroup analyses were performed according to whether the patients underwent

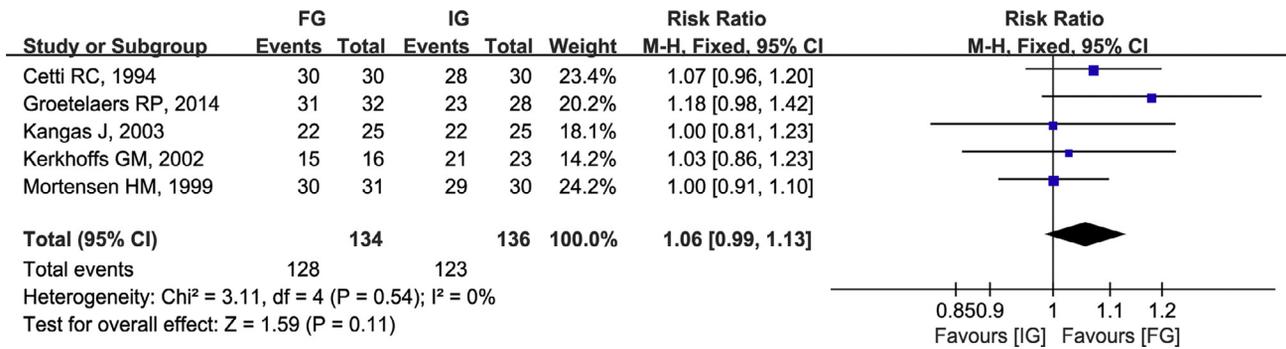


Fig. 5. Comparison of the patient satisfaction rate between the early functional rehabilitation group and the conventional cast immobilization group. Risk ratios were pooled using the fixed-effect model. CI, confidence interval; IV, inverse variance; M-H, Mantel-Haenszel.

surgery. The results indicated that although there was no evident difference in the total number of patients returning to work or sports and patient satisfaction rate between early functional rehabilitation and conventional cast immobilization, the rehabilitation duration (time taken to return to work) was significantly shorter in the patients receiving early functional rehabilitation. Moreover, the complication rates did not increase in the patients treated with early functional rehabilitation.

Regarding the time taken to return to sports between early functional rehabilitation and conventional cast immobilization, no significant differences were observed. This result was in contrast with the recommendation approving of early functional rehabilitation proposed by Porter and Shadbolt (17). Of interest, when the trial conducted by Costa et al (3) in 2006 was eliminated from the present meta-analysis, the combined results were as follows: the pooled WMD was -3.94 (95% CI -6.01 to 1.87; *p* = .0002) in the subgroup analysis, and the WMD was -3.86 (95% CI -6.10 to 1.62; *p* = .0007) in the operative subgroup (Supplemental Table 6). In the study of Costa et al (3), there was no evident difference (*p* = .341) between the groups in terms of the time taken

to return to sports. Four patients in the early FG did not return to their normal activities and were censored at 52 weeks. Moreover, the patient who was lost to follow-up before return to previous sports activities was included in the early FG; thus, several factors could be accounted for regarding the inconsistent results of the time taken to return to sports between the present study and previous studies. It may be caused by the variation in the methodologies used among the enrolled studies, basic constructs, and primary outcomes of the given treatment.

The most important result of the present study was the superior time taken to return to work after early functional rehabilitation, although this was not evident in the subgroup analysis. The studies conducted by Majewski et al (31) and Kim et al (32) also showed a shorter time taken to return to work in patients receiving early functional rehabilitation than in those receiving conventional cast immobilization. A shorter time taken to return to work (33) was also considered an important parameter for the cost efficiency of postoperative rehabilitation. Furthermore, a very recent clinical practice and treatment guideline (34) of acute AT ruptures from the American Academy of Orthopaedic

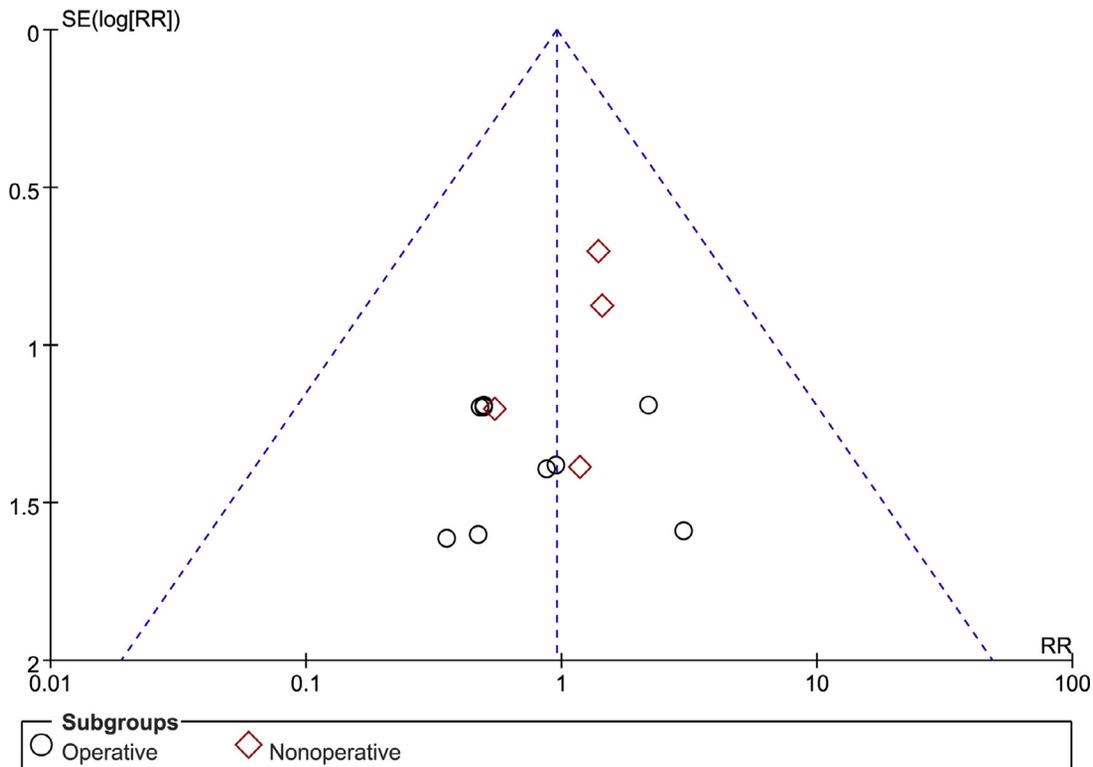


Fig. 6. Publication bias analysis in the meta-analysis. OR, odds ratio; SE, standard error.

Surgeons also provided a moderate recommendation on the application of this postoperative rehabilitation regimen; thus, early functional rehabilitation may contribute to evidence-based practice for rupture management after AT repair.

The present meta-analysis had several strengths. The meta-analysis had a relatively large sample size of 14 trials for evaluation and there was no publication bias in this study. Further, the enrolled studies were all well-designed RCTs with high quality; hence, the results of this study have greater strength than those of other systematic reviews or RCTs. There were, however, some limitations in the present meta-analysis. First, heterogeneity among the studies was significantly observed when the estimate values of the time taken to return to work and sports were pooled. The sensitivity analysis of the time taken to return to work and sports by excluding 1 relevant study each time yielded a reversal of results, suggesting instability in the combined outcomes. Second, the follow-up time in this study was inconsistent, which might introduce bias to our results. Third, the subgroup analyses showed no significance in the time taken to return to work; however, the overall result showed a significant difference, which might be induced by a small sample size. Fourth, the protocols of early functional rehabilitation adopted in each included study were inconsistent mostly because of variations in the commencement of weightbearing, range of motion allowed, and strength training. It might cause a slight difference in the curative effect of rehabilitation.

In conclusion, the present meta-analysis revealed that early functional rehabilitation appears to be related to a decrease in the time taken to return to work in patients with acute AT ruptures; it did not yield a higher complication rate than conventional cast immobilization. Although the sample size of this meta-analysis was relatively large, some outcomes are still unstable. Further studies with larger sample sizes and examinations are necessary to confirm the present findings.

## Supplementary Material

Supplementary material associated with this article can be found in the online version at <https://doi.org/10.1053/j.jfas.2018.12.014>.

## References

- Ganestam A, Kallemose T, Troelsen A, Barfod KW. Increasing incidence of acute Achilles tendon rupture and a noticeable decline in surgical treatment from 1994 to 2013. A nationwide registry study of 33,160 patients. *Knee Surg Sports Traumatol Arthrosc* 2016;24:3730–3737.
- Suchak AA, Bostick G, Reid D, Blitz S, Jomha N. The incidence of Achilles tendon ruptures in Edmonton, Canada. *Foot Ankle Int* 2005;26:932–936.
- Costa ML, Macmillan K, Halliday D, Chester R, Shepstone L, Robinson AH. Randomised controlled trials of immediate weight-bearing mobilisation for rupture of the tendo Achillis. *J Bone Joint Surg Br* 2006;88:69–77.
- Henríquez H, Muñoz R, Carcuro G, Bastías C. Is percutaneous repair better than open repair in acute Achilles tendon rupture? *Clin Orthop Relat Res* 2012;470:998–1003.
- Kołodziej L, Bohatyrewicz A, Kromuszczyńska J, Jeziński J, Biedroń M. Efficacy and complications of open and minimally invasive surgery in acute Achilles tendon rupture: a prospective randomised clinical study—preliminary report. *Int Orthop* 2013;37:625–629.
- Huri G, Biçer ÖS, Özgözen L, Uçar Y, Garbis NG, Hyun YS. A novel repair method for the treatment of acute Achilles tendon rupture with minimally invasive approach using button implant: a biomechanical study. *Foot Ankle Surg* 2013;19:261–266.
- Valkering KP, Aufwerber S, Ranuccio F, Lunini E, Edman G, Ackermann PW. Functional weight-bearing mobilization after Achilles tendon rupture enhances early healing response: a single-blinded randomized controlled trial. *Knee Surg Sports Traumatol Arthrosc* 2017;25:1807–1816.
- Barfod KW, Nielsen F, Helander KN, Mattila VM, Tingby O, Boesen A. Treatment of acute Achilles tendon rupture in Scandinavia does not adhere to evidence-based guidelines: a cross-sectional questionnaire-based study of 138 departments. *J Foot Ankle Surg* 2013;52:629–633.
- Jacob K, Paterson R. Surgical repair followed by functional rehabilitation for acute and chronic Achilles tendon injuries: excellent functional results, patient satisfaction and no reruptures. *ANZ J Surg* 2007;77:287–291.
- Huang J, Wang C, Ma X, Wang X, Zhang C, Chen L. Rehabilitation regimen after surgical treatment of acute Achilles tendon ruptures. *Am J Sports Med* 2014;43:1008–1016.
- Mark-Christensen T, Troelsen A, Kallemose T, Barfod KW. Functional rehabilitation of patients with acute Achilles tendon rupture: a meta-analysis of current evidence. *Knee Surg Sports Traumatol Arthrosc* 2016;24:1852–1859.
- Mccormack R, Bovard J. Early functional rehabilitation or cast immobilisation for the postoperative management of acute Achilles tendon rupture? A systematic review and meta-analysis of randomised controlled trials. *Br J Sports Med* 2015;49:1329–1335.
- Zhao JG, Meng XH, Liu L, Zeng XT, Kan SL. Early functional rehabilitation versus traditional immobilization for surgical Achilles tendon repair after acute rupture: a systematic review of overlapping meta-analyses. *Sci Rep* 2017;7:39871.
- Maffulli N, Tallon C, Wong J, Lim KP, Bleakney R. Early weightbearing and ankle mobilization after open repair of acute midsubstance tears of the achilles tendon. *Am J Sports Med* 2003;31:692–700.
- Maffulli N, Tallon C, Wong J, Peng LK, Bleakney R. No adverse effect of early weight bearing following open repair of acute tears of the Achilles tendon. *J Sports Med Phys Fitness* 2003;43:367–379.
- De la Fuente C, Peña YLR, Carreño G, Marambio H. Prospective randomized clinical trial of aggressive rehabilitation after acute Achilles tendon ruptures repaired with Dresden technique. *Foot* 2016;26:15–22.
- Porter MD, Shadbolt B. Randomized controlled trial of accelerated rehabilitation versus standard protocol following surgical repair of ruptured Achilles tendon. *ANZ J Surg* 2015;85:373–377.
- Moher D, Liberati A, Tetzlaff J, Altman DG. Reprint—preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Phys Ther* 2009;89:873–880.
- Higgins, Julian PT. *Cochrane Handbook for Systematic Reviews of Interventions*. Hoboken, NJ: Wiley-Blackwell; 2008:2008.
- Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ* 2003;327:557–560.
- Cetti R, Henriksen LO, Jacobsen KS. A new treatment of ruptured Achilles tendons. A prospective randomized study. *Clin Orthop Relat Res* 1994;308:155–165.
- Mortensen HM, Skov O, Jensen PE. Early motion of the ankle after operative treatment of a rupture of the Achilles tendon: a prospective, randomized clinical and radiographic study. *J Bone Joint Surg Am* 1999;81:983–990.
- Kerkhoffs GM, Struijs PA, Raaymakers EL, Marti RK. Functional treatment after surgical repair of acute Achilles tendon rupture: wrap vs. walking cast. *Arch Orthop Trauma Surg* 2002;122:102–105.
- Costa ML, Shepstone L, Darrah C, Marshall T, Donell ST. Immediate full-weight-bearing mobilisation for repaired Achilles tendon ruptures: a pilot study. *Injury* 2003;34:874–876.
- Kangas J, Pajala A, Siira P, Hämäläinen M, Leppilahti J. Early functional treatment versus early immobilization in tension of the musculotendinous unit after Achilles rupture repair: a prospective, randomized, clinical study. *J Trauma* 2003;54:1171–1180.
- Suchak A, Bostick G, Beaupré L, Durand D, Jomha N. The influence of early weight-bearing compared with non-weight-bearing after surgical repair of the Achilles tendon. *J Bone Joint Surg Am* 2008;90:1876–1883.
- Barfod KW, Bencke J, Lauridsen HB, Ban I, Ebskov L, Troelsen A. Nonoperative dynamic treatment of acute Achilles tendon rupture: the influence of early weight-bearing on clinical outcome: a blinded, randomized controlled trial. *J Bone Joint Surg Am* 2014;96:1497–1503.
- Groetelaers RP, Janssen L, van der Velden J, Wieland AW, Amendt AG, Geelen PH, Janzing HM. Functional treatment or cast immobilization after minimally invasive repair of an acute Achilles tendon rupture: prospective, randomized trial. *Foot Ankle Int* 2014;35:771–778.
- Young SW, Patel A, Zhu M, Van DS, Mcnair P, Bevan WP, Tomlinson M. Weight-bearing in the nonoperative treatment of acute Achilles tendon ruptures: a randomized controlled trial. *J Bone Joint Surg Am* 2014;96:1073–1079.
- Korkmaz M, Erkoc MF, Yolcu S, Balbaloglu O, Öztumur Z, Karaaslan F. Weight bearing the same day versus non-weight bearing for 4 weeks in Achilles tendon rupture. *J Orthop Sci* 2015;20:513–516.
- Majewski M, Schaeren S, Kohlhaas U, Ochsner PE. Postoperative rehabilitation after percutaneous Achilles tendon repair: early functional therapy versus cast immobilization. *Disabil Rehabil* 2008;30:1726–1732.
- Kim U, Choi YS, Jang GC, Choi YR. Early rehabilitation after open repair for patients with a rupture of the Achilles tendon. *Injury* 2017;43:1710–1713.
- Sorrenti SJ. Achilles tendon rupture: effect of early mobilization in rehabilitation after surgical repair. *Foot Ankle Int* 2006;27:407–410.
- Chiodo CP, Glazebrook M, Bluman EM, Cohen BE, Femino JE, Giza E, Watters WC 3rd, Goldberg MJ, Keith M, Haralson RH 3rd, Turkelson CM, Wies JL, Hitchcock K, Raymond L, Anderson S, Boyer K, Sluka P. American Academy of Orthopaedic Surgeons. American Academy of Orthopaedic Surgeons clinical practice guideline on treatment of Achilles tendon rupture. *J Bone Joint Surg Am* 2010;92:2466–2468.