

# Operative versus nonoperative treatment of displaced intra-articular calcaneal fractures

## A meta-analysis of current evidence base

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### Abstract

**Background:** The relative efficacy of operative and nonoperative treatments for the displaced intra-articular calcaneal fractures (DIACF) remains uncertain.

**Object:** We conducted a meta-analysis to compare the effectiveness of operative and nonoperative treatments in treating patients with DIACF.

**Methods:** Databases including Cochrane Library, Medline, Embase, CBM, CNKI, and Google Scholar were searched. After independent study selection by 2 authors, data were extracted and collected independently. Comparisons were performed between operative treatment group and nonoperative treatment group. The quality of included studies was assessed using the Newcastle–Ottawa Scale. RevMan 5.3 was used for data analysis. The primary outcome measures were anatomical measures (changes in Böhler angle and calcaneal height and width), functional measures (shoe problems, resuming preinjury work, and residual pain), and complications (including superficial and deep wound infection, skin flap necrosis, neurovascular injury, secondary arthrodesis, reflex sympathetic dystrophy, osteotomy, thromboembolism, and compartment syndromes).

**Results:** Eighteen trials (8 randomized controlled trials and 10 controlled clinical trials) including 1467 patients were considered. For anatomical measurements, the overall mean differences (MDs) for the mean Böhler angle, calcaneal height and width were 15.39 (95% confidence interval [CI] 9.12–21.67), 6.55 (95% CI 2.67–10.43), and 7.05 (95% CI –7.83 to –6.27), respectively. In functional measures, the overall effect MD of American Orthopedic Foot and Ankle Society was 6.23 (95% CI 5.22–17.67) and 0.38 (95% CI 0.22–0.67). The overall relative risks (RRs) of wearing shoes, resuming preinjury work, and having residual pain were 0.32 (95% CI 0.32–1.00), 0.56 (95% CI 0.40–0.77), and 0.90 (95% CI 0.68–1.20), respectively. The overall RR of the incidence of complications was 2.00 (95% CI 1.51–2.64).

**Conclusion:** Operative treatment of DIACF may lead to a higher incidence of complications but has better anatomical recovery when compared with nonoperative treatment.

**Abbreviations:** AOFAS = American Orthopedic Foot and Ankle Society, CCT = controlled clinical trial, CI = confidence interval, DIACF = displaced intra-articular calcaneal fractures, MD = mean difference, RCT = randomized controlled trial, RR = relative risk.

**Keywords:** calcaneal fractures, meta-analysis, nonoperative treatment, operative treatment

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NW, PY, and WL have contributed equally to this work.

The dataset supporting the conclusions of this article is included within the article.

WC and NW designed the study; NW and PY searched the relevant studies and abstracted the data; YZ and WC analyzed and interpreted the data; NW, WL, and YZ wrote the draft; CF and WC revised the manuscript; and WC approved the final version of the manuscript.

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## 1. Introduction

Calcaneal fractures are the most common tarsal bones, accounting for approximately 1% to 2% of all fractures in the human body<sup>[1]</sup>; approximately 75% of these fractures are intra-articular.<sup>[1,2]</sup> Intra-articular fractures are usually caused by a fall from a height with one or both heels directly hitting the ground<sup>[2–5]</sup>. This vertical violence often leads to displaced intra-articular calcaneal fractures (DIACF) and approximately 75% of calcaneal fractures affect foot function.<sup>[6]</sup> Nonoperative treatment often leads to delayed reconstruction of malunited fractures, leaving patients with a painful and stiff foot that may delay or permanently prevent patients from returning to work or engaging in previous activities. Several studies have observed that operatively treated patients had better functional outcome scores and less pain than nonoperatively treated patients.<sup>[7–10]</sup> However, other studies have reported that operative treatment was associated with a greater risk of postoperative complications, such as surgical site infections and delayed wound healing. Since few randomized controlled trials (RCTs) have examined this issue, the optimal treatment of DIACF remains controversial. Our meta-analysis aimed to resolve the aforementioned dilemma by comparing the efficacy of operative and nonoperative treatments for DIACF based on anatomical and functional measures extracted from all relevant RCTs and controlled clinical trials (CCTs).

## 2. Materials and methods

### 2.1. Literature search

Two researchers separately identified all reported RCTs and CCTs comparing operative and nonoperative treatments. Databases including the Cochrane Library (issue 12; 2016), Medline (from 1980 to December 2016), Embase (from 1980 to December 2016), CBM (from 1980 to December 2016), CNKI (from 1980 to December 2016), and Google Scholar were searched. The relevant supplement or conference abstracts were hand searched. Articles were not restricted by language of publication. The following keywords were used: displaced intra-articular calcaneal fracture, displaced intra-articular fracture of the calcaneus, operation, nonoperation, surgery, nonsurgery, conservation, RCTs, CCTs, controlled trials, and randomization.

### 2.2. Selection criteria

Only RCTs and CCTs comparing between operative and nonoperative treatments for DIACF were included. RCTs included randomized and quasi-RCTs. CCTs included trials testing 1 treatment with 2 or more groups with the same disease without randomization among the patients. Studies without effective reporting of primary results or inadequate data for meta-analysis were excluded. Participants were restricted to adult patients with fresh, closed DIACFs. Operative treatment involves open reduction with any type of internal fixation. Nonoperative treatment involved leg elevation, ice and plaster cast splints, and then gradual introduction of nonweight bearing mobilization for 6 to 8 weeks. To avoid repeatedly calculation, multiple reports of the same patient population were pooled as 1 study within the meta-analysis.

### 2.3. Study identification

Two reviewers independently screened titles from all identified articles. Abstracts for each potentially relevant study were

reviewed, and full texts were retrieved when certain information in the abstract was inadequate. Discrepancies were resolved by consensus after discussion.

### 2.4. Quality of selected studies

The methodological quality of the selected studies was assessed using the Newcastle–Ottawa Scale based on 3 main items with a maximum score of 9: the selection of study groups (0–4 points), the comparability of study groups (0–2 points), and the determination of either the exposure or outcome of interests (0–3 points).

### 2.5. Data extraction

Data were extracted by 2 reviewers independently (NW and PY) using a predefined standardized electronic data collection form without concealment of the journal name or author details. One reviewer extracted the data from the selected studies, and the other reviewer verified the extracted data. When the published data for the outcome measures were inadequate for the meta-analysis, we emailed the authors to request adequate information. The reviewers also extracted the characteristics of eligible studies including the publication date, enrollment period and location, demographic data, average follow-up period, and treatment methods. Disagreements regarding extracted data were resolved through discussion between the 2 reviewers.

### 2.6. Statistical analysis

The basic unit of analysis was the individual patient. Data analysis was performed using RevMan software, version 5.3.  $P < .05$  was considered to be statistically significant. The relative risk (RR) and 95% confidence intervals (CIs) were calculated for dichotomous outcomes, and mean differences (MDs), with 95% CIs were calculated for continuous outcomes. A fixed-effects model was used when no heterogeneity was detected; otherwise a random-effects model was used.<sup>[11]</sup> A chi-squared test was used to detect between-study heterogeneity, and the significance level was set at  $P < .10$ <sup>[11]</sup>; the degree of heterogeneity was quantified using the  $I^2$  statistic,<sup>[12]</sup> with a value  $>50\%$  representing substantial heterogeneity. To explore between-study heterogeneity, the researchers prespecified clinical characteristics for the subgroup analyses. A sensitivity analysis was performed to verify the reliability of the merged results. When the outcome measure was not suitable for pooled data analysis, it was assessed using narrative analysis. Funnel plot asymmetry was used to assess publication bias.

## 3. Results

### 3.1. Characteristics of identified studies

Figure 1 display a detailed flowchart for the article screening and selection process. Initial search identified 313 titles and abstracts from the electronic databases. After duplicates were removed, 165 abstracts were initially screened and 23 abstracts were selected for the next stage of review. After the inclusion and exclusion criteria were applied, 18 full-text articles were chosen for this meta-analysis. After a review of the titles, abstracts, and even texts, 8 published RCTs<sup>[3,13–18]</sup> and 10 CCTs<sup>[4,7,19–26]</sup> with a total of 1467 patients met all of the inclusion criteria. The 18 included studies were published between 1984 and 2016; 12 were published in English and 6 were published in Chinese. The

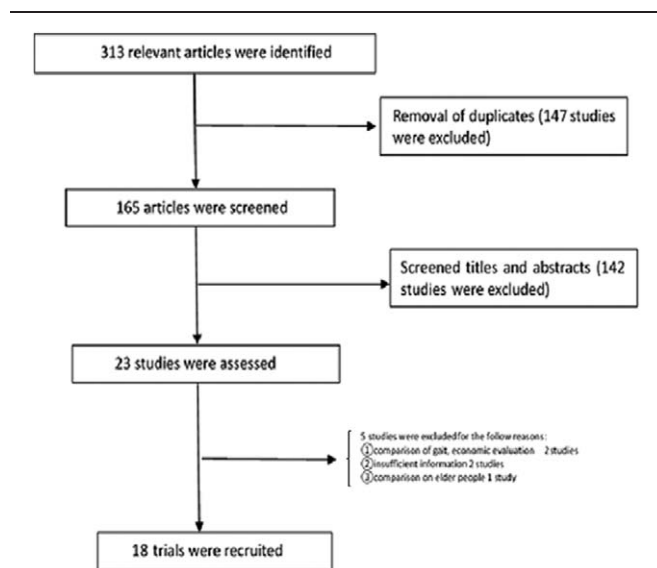


Figure 1. Flow chart of study selection.

duration of follow-up ranged from 1 to 15 years. General characteristics of the studies and participants are listed in Table 1.

### 3.2. Methodological quality assessment

The outcomes of methodological quality assessment were as follows: 2 studies<sup>[17,18]</sup> had a score of 7, 3 studies<sup>[15,19,21]</sup> had a score of 6, 5 studies<sup>[3,7,13,14,27]</sup> had a score of 5, and 7 studies<sup>[4,16,20,22–26]</sup> had a score of 3.

### 3.3. Meta-analysis

**3.3.1. Anatomical measures: Böhler angle and calcaneal height and width.** Six trials<sup>[13,19,20,22,24,26]</sup> compared the recovery of Böhler angle after operative and nonoperative treatments, and statistically significant heterogeneity was identified ( $P \leq .00001$ ,  $I^2 = 98\%$ ). A random-effects model was applied

for the meta-analysis. The results showed that patients treated nonoperatively had a significantly lower mean Böhler angle than those who were surgically treated (MD 15.39, 95% CI 9.12–21.67,  $P \leq .00001$ ) (Fig. 2).

Three<sup>[13,19,20]</sup> studies compared calcaneal height loss between the 2 groups, and statistically significant heterogeneity was identified ( $P < .0001$ ,  $I^2 = 90\%$ ). A random-effects model was applied for the meta-analysis, and the results showed that the operative group had significantly less height loss than the nonoperative group (MD 6.55, 95% CI 2.67–10.43,  $P = .0009$ ) (Fig. 3).

Two<sup>[19,20]</sup> studies reported comparisons of calcaneal width changes between the 2 groups, and there was no statistically significant heterogeneity ( $P = .66$ ,  $I^2 = 0\%$ ). A fixed-effects model was applied for the meta-analysis, and the calcaneal width was significantly more stable in operative patients than in nonoperative patients (MD  $-7.05$ , 95% CI  $-7.83$  to  $-6.27$ ,  $P < .00001$ ) (Fig. 4).

### 3.3.2. Functional measures: Shoe problems, return to work, and residual pain.

Four studies<sup>[3,13,18,27]</sup> used the American Orthopedic Foot and Ankle Society (AOFAS) scale for function assessment and provided adequate data for quantitative analyses, and these studies showed statistically significant heterogeneity ( $P = .0002$ ,  $I^2 = 85\%$ ). A random-effects model was applied for the meta-analysis, and the results showed that there were no significant differences between the 2 groups in their mean scores on the functional estimate scales (MD 6.23, 95% CI 5.22–17.67,  $P = .29$ ) (Fig. 5). This lack of significance may be due to the use of different outcome measures for functional assessment, including the visual analog scale score,<sup>[17,27,28]</sup> the short-form 36-item questionnaire,<sup>[17,18,27]</sup> the AOFAS Ankle–Hindfoot scale,<sup>[3,13,18,27]</sup> a calcaneal fracture scoring system, the foot function index questionnaire,<sup>[13]</sup> and the Kerr Atkins score.<sup>[18,28]</sup>

All included studies reported problems with wearing shoes,<sup>[3,7,14–16,27]</sup> and the incidence of shoe problems was 20.8% in the operative group and 35.7% in the conservative treatment group. The RR for problems wearing shoes in 6 included studies was 0.57 (95% CI 0.32–1.00,  $P = .05$ ), with

Table 1  
General characteristics of the included studies.

First author, year	Country	Study type	Case (S/NS)	Sex ratio (M/F)	Mean age (S/NS)	Years of follow-up (S/NS)
Leung et al 1993 <sup>[19]</sup>	Hong Kong	CCT	44/19	55/8	36.3/43.8	2.9/3.2
Ibrahim et al 2007 <sup>[13]</sup>	The United Kingdom	RCT	15/11	21/5	61.0/58	15.2/14.8
Xia et al 2010 <sup>[20]</sup>	China	CCT	62/52	107/77	40.3/38.1	2.33/2.33
O'Farrell et al 1993 <sup>[14]</sup>	Ireland	RCT	12/12	20/4	33.0/38.0	1.3/1.2
Järholm et al 1984 <sup>[4]</sup>	Sweden	CCT	20/19	32/17	46/44	5/4
Parmar et al 1993 <sup>[15]</sup>	England	RCT	25/31	48/8	48.3/48.8	2.1/1.8
Thordarson and Krieger 1996 <sup>[3]</sup>	The United States	RCT	15/11	21/5	35/36	1.4/1.2
Nouraei and Moosa 2011 <sup>[16]</sup>	Iran	RCT	31/30	NM	46/52	3/3
Buckley et al 2002 <sup>[17]</sup>	Canada	RCT	206/218	381/43	41/39	3/3
Rodríguez-Merchan and Galindo 1999 <sup>[21]</sup>	Spain	CCT	28/30	47/11	NM	3.9/4
Agren et al 2013 <sup>[27]</sup>	Sweden	RCT	39/37	NM	49/48	12/144
Zhang et al 2005 <sup>[22]</sup>	China	CCT	24/24	34/14	42.6/38.1	2.92/2.83
Liu et al 2003 <sup>[26]</sup>	China	CCT	12/12	17/7	41.7/39.1	2.5/2.17
Yang 2012 <sup>[24]</sup>	China	CCT	30/30	39/21	NM	0.83
Griffin et al 2014 <sup>[18]</sup>	The United Kingdom	RCT	73/78	NM	44.8/48.2	2
De Boer et al 2015 <sup>[7]</sup>	The Netherlands	CCT	27/33	NM	NM	4.67/7.33
Ye 2015 <sup>[25]</sup>	China	CCT	41/41	39/43	31.8/30.3	0.5/1.25
Shen et al 2007 <sup>[26]</sup>	China	CCT	37/38	NM	NM	1.5

CCT = controlled clinical trial, F = female, M = male, NM = not mention, NS = non-surgical, RCT = randomized controlled trial, S = surgery.

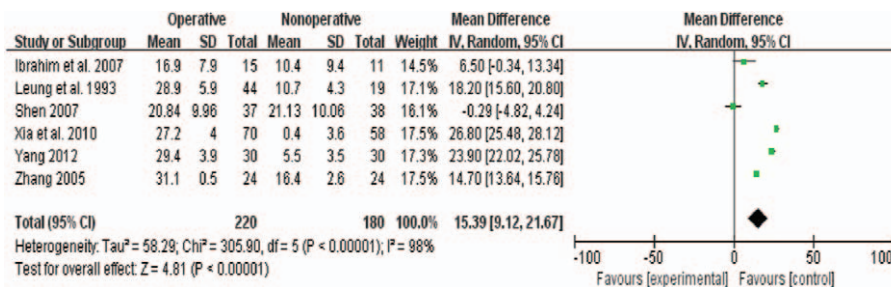


Figure 2. Recovery of Böhler angle after surgical and nonsurgical treatments.

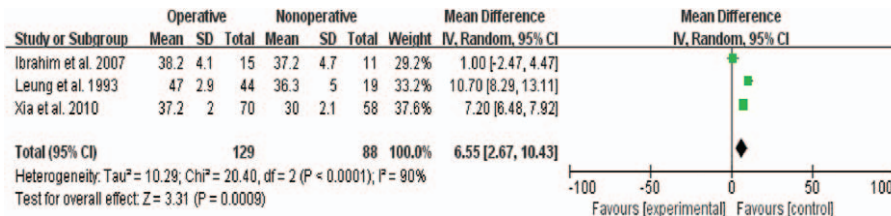


Figure 3. Changes in calcaneal height after surgical and nonsurgical treatments.

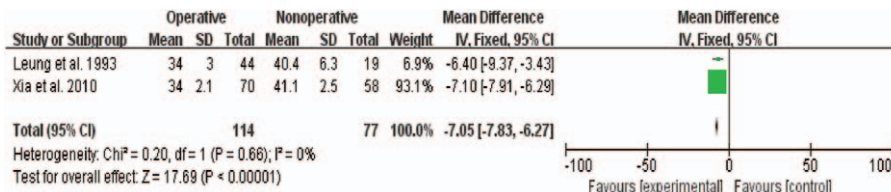


Figure 4. Changes in calcaneal width after surgical and nonsurgical treatments.

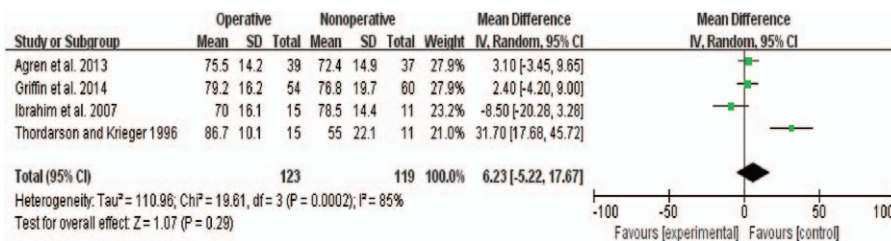


Figure 5. Scores on the American Orthopedic Foot and Ankle Society scale after surgical and nonsurgical treatments.

no significant differences between the 2 groups; this result indicates that operative treatment did not significantly decrease these shoes problems when compared with nonoperative treatment (Fig. 6).

Seven studies<sup>[3,4,7,14,15,20,21]</sup> evaluated the number of patients who failed to return to preinjury work, and no statistically significant heterogeneity was identified ( $P = .28$ ,  $I^2 = 20\%$ ). A fixed-effects model was applied for the meta-analysis, the results showed that patients who underwent operative treatment returned to work significantly more frequently than those undergoing nonoperative treatment (RR 0.56, 95% CI 0.40–0.77,  $P = .004$ ) (Fig. 7).

Of the patients included in this meta-analysis, 75 of 119 patients experienced residual pain in the operative group, 85 of 121 patients in the nonoperative group experienced residual pain during the follow-up. However, no significant difference was identified between the 2 comparison groups (RR 1.01, 95% CI 0.84–1.20,  $P = .94$ ) (Fig. 8).

**3.3.3. Incidence of complications.** Nine studies provided data on post-treatment complications.<sup>[3,4,15,17,19,21,24–26]</sup> The incidence of complications was 26.2% (117/446) in the operative group and 13.7% (60/437) in the nonoperative group (RR 2.00, 95% CI 1.51–2.64,  $P < .00001$ , fixed-effects model). This

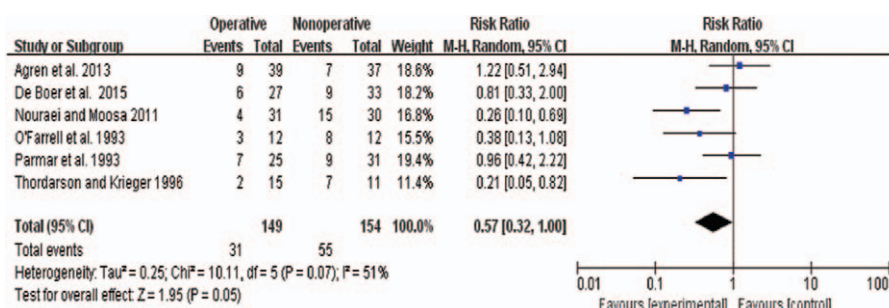


Figure 6. Problems with wearing shoes after surgical and nonsurgical treatments.

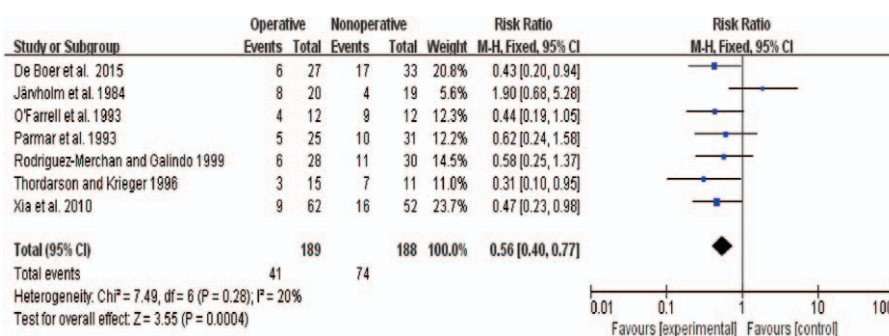


Figure 7. Number of patients failing to return to preinjury work after surgical and nonsurgical treatments.

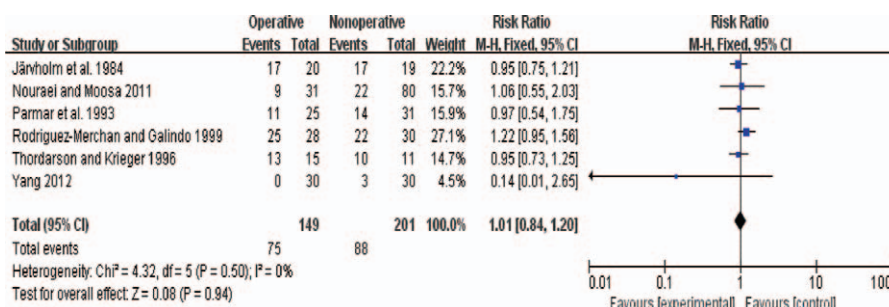


Figure 8. Number of patients who having residual pain after surgical and nonsurgical treatments.

difference indicated that the incidence of complications in the operative group was significantly higher than that observed in the nonoperative group (Fig. 9). Tolerable heterogeneity ( $I^2=39\%$ ,  $P=.11$ ) was identified and the study by Griffin et al<sup>[18]</sup> was identified as contributing the most to heterogeneity, as it reported that complications and reoperations were more common in operatively treated patients. After these data were removed, an RR of 2.0 (95% CI 1.51–2.64;  $I^2=39\%$ ,  $P=.11$ ) was identified.

**3.3.4. Sensitivity analysis.** Sensitivity analysis was performed by excluding CCTs. We did not perform meta-analyses of anatomical measurements, as there was only 1 remaining study including these measurements eligible for secondary analysis after the exclusion of CCTs. The  $I^2$ , risk ratios, 95% CIs, and  $P$  values for change in shoes size, inability to resume preinjury work, residual pain, and incidence of complications were still similar to the results obtained before the exclusion of CCTs (Table 2). Thus,

the inclusion of CCTs did not bias the results of our meta-analyses of functional recovery assessment and complication rate.

**3.4. Publication bias**

Considering the small sample size (<10) in our meta-analysis, funnel plot analysis was not applicable for the determination of publication bias.

**4. Discussion**

For the present meta-analysis, the authors observed that patients with DIACFs generally showed better functional outcomes after operation. However, different opinions, such as those of Parmar and Chrintz suggested that there were no significant differences in functional outcomes between operative and nonoperative treatments, as Parmar used K-wires and plaster cast mobilization and

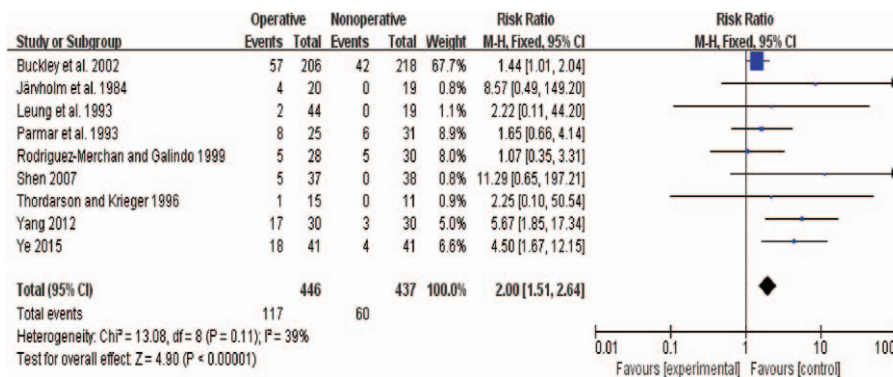


Figure 9. Incidence of complications after surgical and nonsurgical treatments.

Chrintz' study used Steinmann pin fixation for outcome analysis. The largest included trial (424 participants) found no differences in functional outcomes (the composite functional score including daily activity, walking, and other items) between treatment groups (plate or wire fixation vs. conservative treatment).<sup>[17]</sup> Ibrahim et al.<sup>[13]</sup> indicated no significant difference in the recovery of Böhler angle (MD 6.50, 95% CI -0.34 to 13.34, P=.06) or calcaneal height (MD 1.00, 95% CI -2.47 to 4.47, P=.57) at 15-year follow-up. Meena et al.<sup>[29]</sup> find that patients with operative treatment were more likely to resume preinjury work (RR=0.60, P=.04), had fewer problems when wearing shoes (RR=0.42, P=.0004), and had a higher physical component summary score of SF-36 (difference in means=6.75, P<.0001) but a higher complication rate (RR=1.74, P=.0005). Our meta-analysis confirmed significantly anatomical improvements, including restoration of Böhler angles (RR=15.39, P<.00001), calcaneal heights (RR=6.55, P=.0009), and widths (RR=-7.05, P<.00001), as well as a greater likelihood of resuming former work (RR=0.56, P=.0004). The clinical significance of these findings is that operative treatment should be recommended for DIACFs, which can restore the anatomy of the calcaneus better than nonoperative treatments, following with better functional recovery and greater likelihood of resuming former work, when compared with the nonoperative ones. This may have been observed because surgery can effectively restore the anatomical structure of the calcaneus and thus lead to better functional recovery; however, surgery was also inevitably associated with certain adverse events and delayed intervention, as suggested by higher incidence of postinjury complication (i.e., infections) in operative patients than in nonoperative patients. Jiang identified better anatomical restoration and functional recovery outcomes to be associated with surgical treatment; however, surgically treated patients had a significantly higher risk of some complications than the nonoperative patients in that study

(22.8% vs. 16.2%, P=.008).<sup>[30]</sup> Other studies, such as conducted by Parmar in 1993,<sup>[15]</sup> evaluated complication such as sural nerve symptoms and indicated that there were no statistically significant differences between conservative and surgical treatment groups. Almost one-fifth of percutaneously treated patients required secondary arthrodesis, which was not needed by any patients in the open reduction and internal fixation group. Furthermore, the secondary arthrodesis rates were found to be as high as 20% in recent studies compared with the 15% previous reported.<sup>[31]</sup>

In contrast to the mixed results for operative treatments, nonoperative treatment of calcaneal fractures was associated with certain advantages (i.e., less invasive procedures, accelerated weight bearing ability, less joint stiffness, greater patient' satisfaction).<sup>[32,33]</sup> Thus, within acceptable ranges of fixation, nonoperative treatment could still be a viable treatment modality given some patients' noncompliance with advice to ensure mobility during follow-up. Studies have reported inferior functional outcomes and a greater degree of disability in nonoperative treatment group than inoperative treatment groups based on questionnaires data, and the vast majority of late interventions in the nonoperative group were secondary arthrodesis. Therefore, in a calcaneal fracture patient undergoing nonoperative treatment, early functional exercises should be prioritized; several studies<sup>[34,35]</sup> support our view and early exercise is the best nonoperative treatment modality.

In the current study, the incidences of residual pain and shoe problems in the operative group were not significantly lower than the nonoperative group; this result differs from the findings of Nan Jiang's study.<sup>[30]</sup> We believe that our meta-analysis comprised more studies that offered more robust evidence. In addition, no previous comparisons of AOFAS scores have been done completed. However, while our study showed no significant difference between the 2 groups for this measure, extensive

Table 2

Sensitivity analysis of the merged results.

Outcome	All eligible trials (RCTs and CCTs)					Only RCTs included				
	No.	Patients	I <sup>2</sup>	RR (95% CI)	P	No.	Patients	I <sup>2</sup>	RR (95% CI)	P
Change in shoes size	6	303	51	0.57 (0.32, 1.00)	.05	5	343	58	0.52 (0.26, 1.03)	.06
Not return to work	7	377	20	0.56 (0.40, 0.77)	.0004	3	106	0	0.46 (0.23, 0.98)	.006
Residual pain	6	350	0	1.01 (0.84, 1.20)	.94	3	193	0	1.00 (0.73, 1.36)	.98
Complication	9	883	39	2.00 (1.51, 2.64)	<.00001	3	506	0	1.47 (1.67, 2.04)	.02

CCT = controlled clinical trial, CI = confidence interval, RCT = randomized controlled trial, RR = relative risk.

heterogeneity was observed; this heterogeneity was largely due to the 2007 study by Ibrahim<sup>[13]</sup> and likely associated with a large amount of incomplete and missing outcomes data (67%). Furthermore, Parmar et al<sup>[15]</sup> evaluated only the Kirschner wire as an internal fixation method, unlike the fixation method using both plate and screws evaluated in other studies.

Our study did not compare work load because this measure generally served as subindex in the included studies and could not be abstracted consistently. The results of a multicenter RCT conducted by Buckley et al<sup>[17]</sup> suggest that light or moderate workloads may lead to better recovery from DIACF, and patients with heavy workloads are unlikely to recover well regardless of treatment type. Therefore, subgroup analysis should be performed, including stratification by different workload intensities for accurate conclusions. A small study conducted in 1996 by Thordarson (30 participants) reported improved walking ability and distance and earlier mobilization in patients with plate fixation compared to patients undergoing conservative treatment.

A broad spectrum of surgical treatments was described, and drastic changes in surgical techniques were observed over time in our meta-analysis. However, for both earliest trial conducted by Chrintz in 1993 and the recent trial conducted by Buckley in 2002, the approach used was open induction and internal fixation via a lateral approach. This approach has been associated with great anatomical reduction, stable fixation, and early joint mobilization. However, other authors (i.e., Folk,<sup>[36]</sup> Yu,<sup>[37]</sup> Al-Mudhaffar,<sup>[38]</sup> and Koski<sup>[39]</sup>) have noted that the majority of postoperative complications were related to surgical incisions, such as wound infection and skin flap necrosis; these complications have been reported in as many as 13.0% to 25.0% of cases. The reasons for these complications have been well documented as relating to the relatively thin skin coverage and poor local blood supply. A study conducted by Woon et al<sup>[40]</sup> concluded that avoidance of soft tissue was the main reason for the decreased complications observed in patients with percutaneous approaches relative to those with open reduction. Subsequent studies focused on less invasive procedures with equal anatomical fixation. Percutaneous screw fixation was reported by Tomesen et al<sup>[41]</sup> as having excellent results in the treatment of DIACF. Schepers and Patka<sup>[42]</sup> indicated overall good results and an acceptable complication rate using percutaneous distraction reduction and fixation. The finding of a retrospective cohort study by DeWall et al<sup>[43]</sup> suggested that the percutaneous method minimized postoperative complications successfully.

Previous classification schemes such as the Sander, Essex-Lopresti, and Crosby and Fitzgibbons classifications have been commonly used and regarded guidance for treatment; however, the efficacy of each classification scheme has not been proven in the literature. The included patients in our meta-analysis were basically with more use of Sander classification received a vote of confidence from this study as patients with less comminution (a Sanders Type 2 fracture) were 2.74 times more likely to score above the mean on the SF-36 scoring scale when treated operatively. A recent study by Rammelt et al<sup>[44]</sup> found that percutaneous fixation was a reasonable alternative for moderately displaced Type II fractures, and the authors believed that it provided adequate control over anatomical joint reduction as subtalar arthroscopy or high-resolution (3D) fluoroscopy.

Eight of the articles were of relatively low quality and had inconsistent inclusion criteria, which, in addition to the very limited number of articles included, all contributed to the

discrepancies identified in our meta-analysis. Heterogeneity in the presentation of outcome measures and small sample sizes in the included studies reduce the credibility of our results. To further clarify the effectiveness of surgical treatment and nonsurgical treatment, prospective multicenter studies based on RCTs and CCTs with long-term follow-up are needed.

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