

# Evaluation of Bohler Angle, SF-36, and VAS Score in Operative vs Nonoperative Treatment of Displaced Intra-articular Calcaneal Fractures: A Meta-analysis

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## ABSTRACT

**Introduction:** In the management of displaced intraarticular calcaneus fractures, there are two options available: operative or nonoperative treatment. To establish a consensus, a number of randomized and case-controlled trials have been conducted. The aim of this analysis is to utilize the most reliable clinical evidence to provide recommendations for the optimal management of these injuries.

**Method:** Using predetermined criteria, the authors conducted a search to identify relevant studies. After reaching a consensus among the authors, only prospective and randomized clinical trials were included. The methodological quality of the selected literature was evaluated using the Cochrane collaboration tool for randomized controlled trials (RCTs) and the Newcastle Ottawa Score for prospective trials. The outcome measures included the Bohler angle, the SF-36, and the score on the visual analog scale. The significance level was set to .05 and the confidence intervals (CIs) were set to 95% using the RevMan, version 5.4 software.

**Result:** Our analysis included 4 studies, in which 4 randomized controlled trials (RCTs) with a total of 662 patients were included. The results indicated that the operative group demonstrated superior clinical outcomes in

terms of VAS score, Bohler Angle, and SF-36. Nevertheless, there were no statistically significant differences between the efficacy of operative and non-operative treatments in regards to VAS score, Bohler angle, and SF-36.

**Conclusion:** The current evidence suggests that operative treatment offers an advantage over non-operative treatment. It is important for patients to be informed that the available data supports better outcomes with operative treatment. However, in the case of older patients with low activity demands, there may not be a significant difference in outcomes between operative and non-operative treatment.

**Keywords:** Operative, Non-operative, Intra-articular, Calcaneal, Fracture

**Level of evidence:** Level I, meta-analysis of RCT.

## INTRODUCTION

Calcaneal fractures, which refer to the breaking of the heel bone, account for approximately 2% of all fractures and are the most frequently occurring type of fracture in the tarsal bones. Although some calcaneal fractures may be relatively minor, many of them are considered to be severe and result from high-energy impacts. [1]

Sanders types II, III, and IV are collectively categorized as displaced intraarticular calcaneal fractures (DIACFs). [2] There has been some controversy among medical experts regarding the appropriate approach to managing DIACF (distal intra-articular fractures of the calcaneus). While certain studies have shown that operative treatment is more effective, other research has found that there is no significant difference between operative and nonoperative management.[3]

Calcaneal injuries are quite damaging as they involve not only the fracture of the entire bone but also its joint surfaces. The subtalar joint, in particular, can be significantly disrupted. Although conservative treatment may allow the fracture fragments to heal, the calcaneus remains deformed, the joint surfaces do not fit properly, and the alignment of the leg from the ankle to the heel can be compromised. [4] On the other hand, if surgery is used to manage these types of injuries, the primary goals are to fix the bone deformity, ensure the bone is stable, and allow for a prompt return to physical activity.

The 36-Item Short Form Health Survey questionnaire (SF-36) is a very popular instrument for evaluating Health-Related Quality of Life.[5] There is a meaningful association between the parameters of Böhler's angle after surgery and the patient's functional recovery, according to the findings of the study. [6] and the Visual Analogue Scale (VAS) to establish a structured approach to evaluate and collect data on foot and ankle problems, as well as to measure the results of treatment. [7]

This meta-analysis aims to provide level I and II recommendations for Intra-articular

Calcaneal fracture management based on Bohler angle, SF-36, and VAS score measurement evidence.

## MATERIAL AND METHODS

### Search Strategy

The research was carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guideline statement. A systematic search was carried out to identify studies that were potential for inclusion in this study from 2012 to 2022. The databases used are PubMed, Embase, and Google Scholar. Authors independently screened the abstracts and reference lists. Disagreements between reviewers regarding whether to include or exclude a study will be resolved by consensus, and if applicable, consultation with a third reviewer. Randomized controlled studies that compare operative and non-operative management of calcaneal fracture, uses English, and have full-text will be included in this research. The focus in this meta-analysis is to compare the clinical and functional outcome between operative and non-operative management of calcaneal fracture.

### Quality Evaluation

Each article was reviewed by the authors separately. Any disagreements were resolved through discussion until a consensus was reached. The quality of included RCTs will be evaluated by two independent reviewers based on 7 criteria from Cochrane's 'Risk of bias' assessment tool, including selection bias, performance bias, detection bias, attrition bias, reporting bias, and other types of bias. Figure 1 and 2 provide more details on these criteria

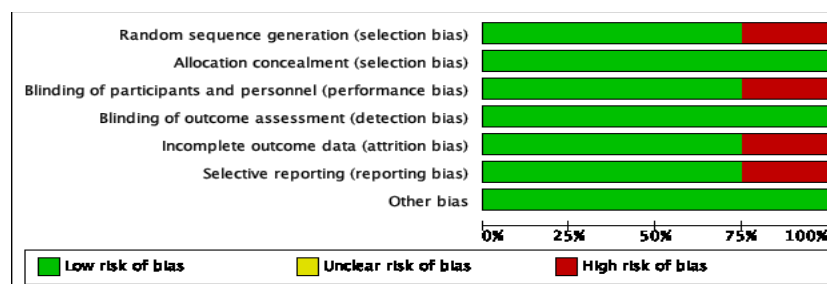


Figure 1. Risk of Bias Graph [8]

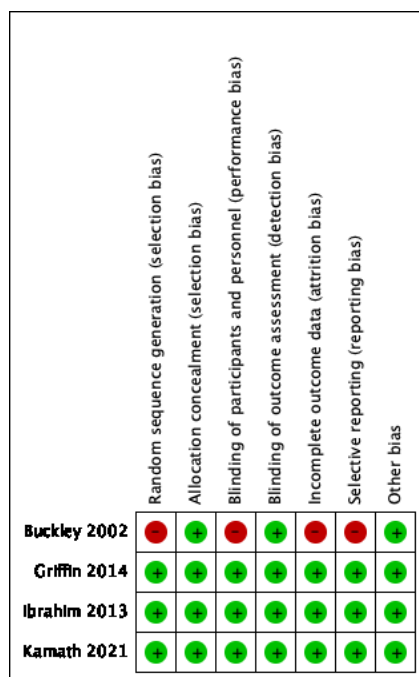


Figure 2. Risk of Bias Summary

### Inclusion Criteria

The following were the criteria for including studies:

1. Studies directly comparing nonoperative and operative Intra-articular Calcaneal fracture management
2. Levels I (RCTs) studies only
3. Studies published in 2012-2023
4. Studies in the English language only
5. Human studies only

Table 1. PICO Criteria for Inclusion Study

	Inclusion	Exclusion
Population	Patient with Intra-articular Fracture	Patient with extra-articular fracture
Intervention	Patients treated with Operative treatment	Patients treated with conservative treatment
Control	Patients treated with Non-operative treatment	Patients treated with Operative treatment
Outcome	Bohler Angle, SF-36, VAS score	Outcomes not clearly mentioned Outcome with other parameter than our inclusion criteria.
Design	Randomized controlled trials (RCT)	Case report, case series, cross-sectional study, cohort study, systematic review or meta-analyses

### Data Synthesis

The data extraction process involved gathering information on the basic characteristics and outcomes of the included studies. This data was collected using designated tables in Microsoft Excel software. When possible, quantitative analysis was performed using Review Manager software, and the results were

presented as forest plots. Mean differences for continuous outcomes and odds ratios for continuous outcomes, along with a 95% confidence interval (CI), were calculated for each study. A fixed-effects model was used when heterogeneity (I<sup>2</sup>) was less than 50%, while a random-effects model was used when heterogeneity was greater than 50%.

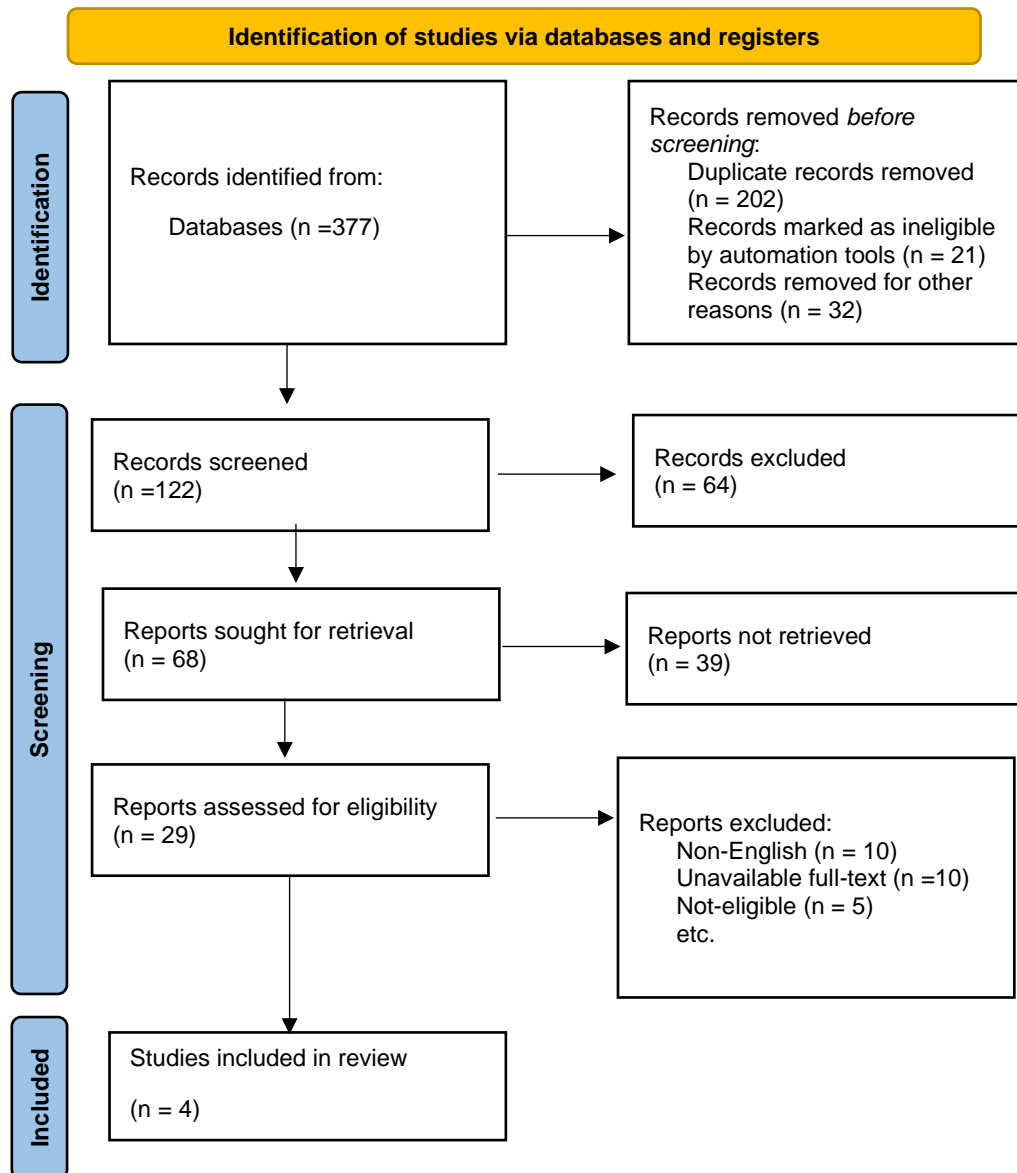


Figure 1. PRISMA flowchart for the included study [9]

## RESULTS

### Literature Search, Study Selection and Study Characteristics

The electronic research resulted in 377 records from various databases. After the process of duplication elimination, screening, and exclusion, the remaining 4 studies were included in qualitative synthesis. The remaining articles were excluded due to lack of mean and standard deviation data, non-English article,

unavailable full-text and did not meet the inclusion and exclusion criteria.

This meta-analysis included a total number of 662 patients consisting of 324 patients undergoing operative treatment and 338 patients undergoing non-operative treatment. The follow-up period was observed at 24 months postoperatively. The patient's ages ranged from 40 to 61 years old, with average age of 46.5 years old. Gender-wise, male is more dominant with 402 males and 48 females.

Table 2. Characteristic of the studies

Author	Year	Country	Cases (OP/NO)	Age, y (OP/NO)	Sex Ratio (M/F)
Buckley et al	2002	Canada	206/218	41/40	381/43
Ibrahim et al	2007	UK	15/11	61/58	21/5
Griffin et al	2014	UK	73/78	44/48	NR
Kamath et al	2021	India	30/31	40/40	NR

Table 3. Table of Outcomes

No	Reference	Outcome Measure		
		VAS	Bohler Angle	SF-36
1.	Buckley et al. (2002)[10]	OP: 6.43±3.2 NO: 6.86±2.1	-	OP: 64.7±10.5 NO: 68.7±11.2
2.	Ibrahim et al. (2013)[11]	-	OP: 10.4±3.6 NO: 16.9±5.5	OP: 53±2.3 NO: 51±2.7
3.	Griffin et al. (2014)[12]	-	OP: 25.1±4.07 NO: 20±7.06	OP: 43.7±11.1 NO: 37.0±13.1
4.	Kamath et al. (2021) [13]	OP: 3.34±1.36 NO: 4.94±0.82	-	-

### VAS Score

In 2 studies, including a total of 236 patients in the operative group and 249 patients in the Non-operative group, VAS scores were analyzed. Figure 2 demonstrates there were no significant differences between the

operative and non-operative treatment on VAS score (SMD = -0.75 95%CI -1.99, 0.49 P = 0.24). A heterogeneity (p<0.05) was found in VAS analysis. Substantial heterogeneity was evident among these studies (I<sup>2</sup> = 94%; P = <0.0001).

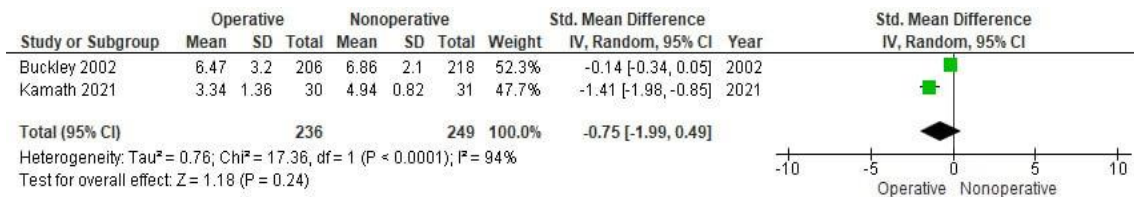


Figure 2. Forest plot analysis VAS

### Bohler Angle

In 2 studies, including a total of 88 patients in the operative group and 89 patients in the non-operative group, Bohler Angle were analyzed. Figure 5 demonstrates there were no significant differences between the

operative and non-operative treatment on Post-operative Bohler Angle (SMD = 0.23 95%CI -2.45, 2.00 P = 0.84). A heterogeneity (p<0.05) was found in Bohler angle analysis. Substantial heterogeneity was evident among these studies (I<sup>2</sup> = 98%; P = <0.0001).

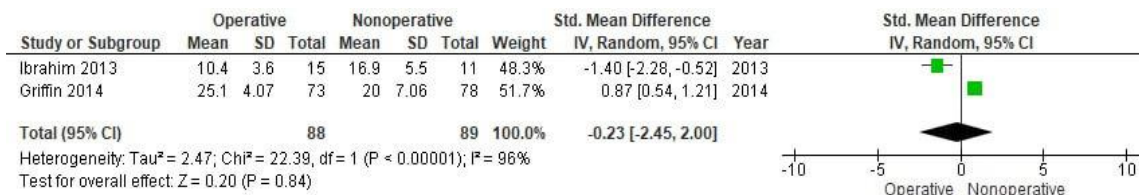


Figure 3. Forest plot analysis Bohler Angle

### SF-36 Score

In 3 studies, including a total of 294 patients in the operative group and 307 patients in the non-operative group, SF-35 were analyzed. Figure 4 demonstrates there were no significant differences between the operative

and non-operative treatment on SF-36 score (SMD = 0.27 95%CI -0.50, 1.04 P = 0.49). A heterogeneity (p<0.05) was found in the DASH score analysis. Substantial heterogeneity was evident among these studies (I<sup>2</sup> = 93%; P = <0.00001).

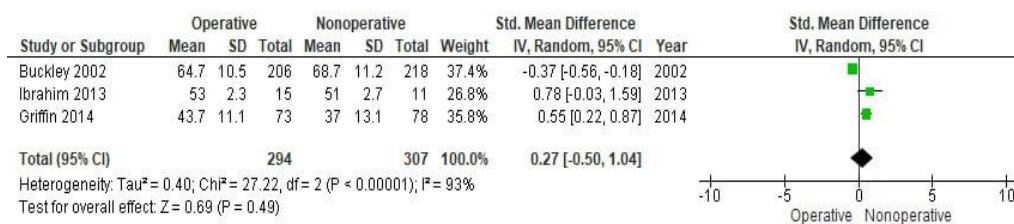


Figure 7. Forest plot analysis SF-36 Score

## DISCUSSION

The outcomes of non-operative treatment for intra-articular calcaneal fractures are similar to those of surgical treatment, and surgical treatment may even result in more serious complications. The study found that patients who underwent open reduction and internal fixation had no significant differences in outcomes compared to those who received non-operative treatment after two years. This conclusion was reinforced by the lack of significant differences in any of the secondary outcome measures, including subjective and objective measures. Although some of these measures were expected to improve with surgery, there was no difference in patient-reported general satisfaction by the measurement of VAS, Bohler angle and SF-36 measurement.

Among the various functional outcome measures that have been used to assess the outcome of calcaneal fractures, prominent have been the VAS score and SF-36 form. The residual pain at rest and during weight bearing as measured by the VAS score was reported to be similar in both groups, operative and nonoperative, by Buckley et al,<sup>16</sup> which was also confirmed later by Kamath et al<sup>15</sup> both in a RCT study. However, subsequent investigators found better VAS scores in the operative group, but that was limited to only a certain cohort of patients like those who had congruent subtalar joint reduction or those not receiving Workman's compensation.<sup>[14]</sup>

The reasons that operative treatment failed to demonstrate better results could be multifactorial. First, the cohort size could have been insufficient to demonstrate a difference in the outcome measures between the two treatments. Another possible reason involves the complex pathoanatomy of

displaced intra-articular calcaneal fractures, as the subtalar joint has a unique motion pattern in relation to the adjacent talonavicular and calcaneo-cuboid joints. Any residual displacement might lead to a disturbance of the motion pattern among these three joints with subsequent pain and walking difficulty. [15] A third possibility involves the associated joint-surface injury and soft-tissue trauma sustained at the time of injury. Aggressive exposure and osseous reduction may be required to achieve proper alignment during surgery, potentially adding new trauma to the original injury. [16]

The same contradictory findings come out when SF36 form was used for outcome assessment. In two studies, Ibrahim et al and Griffin et al have reported a higher SF-36 score after operative management of Intra-articular calcaneal fracture, whereas Buckley et al has reported otherwise. In a RCT done by Agren et al,<sup>16</sup> authors found similar SF36 scores at 1 year follow-up but higher scores at 12 years follow-up in the operated patients, although the difference was not significant (p = 0.06). An important observation made by Buckley et al is that when fractures with less comminution (Sanders type II) were operated, their SF-36 scorings were 2.74 times more likely to be above mean value. On the other hand, no such difference was noted in more comminuted fractures (Sanders type IV), whether treated operatively or conservatively. The authors have pointed out that low energy trauma fractures are easier to fix and well-reduced. [17]

Bohlers' angle restoration along with anatomical reduction of the articular surface is considered one of the benefits and aims of surgical management of Intra-articular calcaneal fracture. Anatomical

reconstruction and Bohlers' angle are given importance in calcaneus fracture treatment by some authors because it is directly related to long-term complications like subtalar osteoarthritis, peroneal impingement, pain on weight bearing, etc. [18] Our studies have reported no significance between the Bohler's angle in operative and non-operative treatment group.

In certain circumstances, a patient in their 40s with an intra-articular calcaneal fracture may benefit from non-surgical treatment. This approach involves immobilizing the foot and ankle, limiting weight-bearing activity, and providing pain relief. There are several reasons why non-operative treatment may be considered. Firstly, it is generally less invasive than surgery and carries a lower risk of complications, as it does not involve anesthesia or incisions. Secondly, the recovery time for non-operative treatment is typically shorter than for surgery, which may be beneficial for a patient with work and family responsibilities. Additionally, the severity of the fracture, as well as the patient's overall health and lifestyle, are important factors that may be considered in determining whether non-operative treatment is appropriate. Finally, the patient's preference should be taken into account, and if they are hesitant about surgery or prefer non-operative treatment, this should be respected and discussed with their physician.[19]

## CONCLUSIONS

According to present analysis, conservative management of Intra-articular Calcaneal Fracture may be equally effective as operative treatment based on VAS, Bohler Angle, and SF-36 measurement, especially in patient with 40 years older (based on the data extraction).

### Declaration by Authors

**Ethical Approval:** Not Required

**Acknowledgement:** None

**Source of Funding:** None

**Conflict of Interest:** There is no conflict of interest within this study.

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