



Review

Cannulated screw fixation and plate fixation for displaced intra-articular calcaneus fracture: A meta-analysis of randomized controlled trials



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HIGHLIGHTS

- Cannulated screw fixation and plate fixation has the similar fixation effectiveness and function outcomes for DIACF.
- Cannulated screw fixation is superior to plate fixation for the short duration of surgery and low rate of complications.
- More high quality RCTs are still needed to confirm the conclusion for different types of DIACF.

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ABSTRACT

Background: Displaced intra-articular calcaneus fractures (DIACFs) are the most common type of calcaneus fracture. The differences in therapeutic effectiveness between cannulated screw fixation (CSF) and plate fixation are still unclear. Thus, in this meta-analysis, we evaluated the therapeutic effectiveness of these two fixation methods.

Materials and methods: We searched for all publications on DIACFs fixated with cannulated screws or plates in the following electronic databases: Pubmed, Cochrane, Embase and CNKI. Only randomized controlled studies were included. The Cochrane Handbook for Systematic Reviews of Interventions (version 5.1.0) was applied for analysis. The primary outcomes were American Orthopedic Foot and Ankle Society score (AOFAS), improvement of Bohler's angle, improvement of Gissane's angle and the width of the calcaneus. Outcomes were reported as the standard mean difference (SMD) or relative risk (RR) with the 95% confidence interval (CI). A random effects model was used to assess the pooled data.

Results: Five randomized controlled studies met our inclusion criteria, and a total of 707 patients were involved. There was no statistically significant difference between the cannulated screw fixation group and the plate fixation group in terms of excellent and good AOFAS scores (RR = 1.01, 95%CI 0.91 to 1.13, P = 0.79), improvement of Bohler's angle (SMD = 0.12, 95%CI -0.03 to 0.28, P = 0.12), improvement of Gissane's angle (SMD = 0.09, 95%CI -0.28 to 0.26, P = 0.30), or the width of the calcaneus (SMD = -0.07, 95%CI -0.24 to 0.10, p = 0.45). Compared with plate fixation, CSF showed a significant reduction in the duration of surgery (SMD = -1.74, 95%CI, -3.35 to -0.13, P = 0.03) and rate of complications (RR = 0.25, 95%CI, 0.15 to 0.44, P < 0.00001).

Conclusions: Cannulated screw fixation and plate fixation have similar fixation effectiveness and functional outcomes in the treatment of displaced intra-articular calcaneus fractures. Due to the shorter duration of surgery and low rate of complications, cannulated screw fixation is superior to plate fixation. However, further studies are needed to evaluate cannulated screw fixation for various Sanders types of calcaneus fractures.

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1. Introduction

Calcaneal fractures account for approximately 2% of all fractures in the human body [1]. The overall incidence of calcaneus fractures

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is as high as 11.5 per 100,000 per year, and fall from height was the most common cause [2]. Approximately 75% of calcaneal fractures were displaced intra-articular calcaneus fractures [3]. DIACFs cause a change in the regular position and shape of the calcaneus and lead to synarthrophysiss, stiffness, and malunion of the subtalar joint. As a consequence, patients suffer greatly and may be unable to wear usual shoes or manage even normal weight-bearing [4]. The cost of non-surgical treatment is \$28,000 per person, whereas the cost of operative treatment is \$19,000 [5], and if there are complications, the cost increases [6]. This increases the mental or physical burden borne by calcaneal fracture patients. DIACFs are severe events that influence the quality of a person's life [7].

There are four Sanders types of DIACFs [8]: I, II, III, and IV; the four types have distinct diagnostic criteria and treatment strategies. Determining the best method to treat calcaneus fractures is challenging. Sanders type I always requires conservative treatment [9]. Recent studies reported that there is no statistically significant difference between conservative treatment and surgery in terms of functional outcomes [10,11]. Another study reported that surgery could obtain better anatomical structures and functional recovery [12]. However, recently, for types II, III and IV, there is a trend towards the use of surgical approaches. Open reduction and internal fixation (ORIF) is the most common way of achieving anatomic reduction [13,14], and ORIF has also become the gold standard fixation method, which is plate fixation [4,15]. However, lots of retrospective or randomized controlled studies have demonstrated that ORIF has a high risk of wound healing complications, which is up to 13.8%–29% [16–19]. To reduce the rate of complications, minimally invasive operation methods have been developed. There are increasing numbers of studies investigating the therapeutic effects of cannulated screw fixation. Given that cannulated screw fixation always uses a minimally invasive or percutaneous approach, the visual operative field is limited. Previous studies have reported that cannulated screw fixation may produce a less rigid fixation, such as secondary loss of reduction, compared with plate fixation [20,21]. The differences in the fixation effectiveness between cannulated screw fixation and plate fixation are still unclear.

Accumulating studies have demonstrated that the quality of the anatomic reduction and stable fixation of DIACFs leads to better functional recovery [22,23]. Thus, in this meta-analysis, we pooled evidence to compare the effectiveness of the two calcaneus fracture fixation methods. We assessed the clinical outcomes (American Orthopedic Foot and Ankle Society score), radiographic evaluation (improvement of Bohler's angle or Gissane's angle, the width of the calcaneus), durations of surgery and the incidence of complications.

2. Methods

2.1. Literature research and study selection

We searched all publications describing calcaneus fractures fixated with cannulated screws or plates until the end of March 2016, using the following electronic databases: Pubmed, Cochrane, Embase and CNKI. There was no language restriction. The following key words were used for the search: calcaneal fracture, calcaneus fracture, cannulated screw, cannulated cancellous screw, plate, calcaneal plate, calcaneal locking plate. Broad mesh terms and Boolean operators were used to maximize the search sensitivity and specificity. For Pubmed, the following search strategy was applied: ((((((calcaneal fracture) OR calcaneus fracture) AND cannulated screw) OR cannulated cancellous screw) AND plate) OR calcaneal plate) OR calcaneal locking plate. Two authors (BF, WL) assessed the title and abstract of each publication, and for equivocal publications, the full text was evaluated. A third reviewer (XZ) acted as a judge if there was any disagreement.

2.2. Eligibility criteria

Participants: Only adult patients diagnosed with displaced intra-articular calcaneal fractures, including Sanders Type II, Type III and Type IV, were included. Patients with open wounds were excluded.

Interventions: The intervention for the experimental group was cannulated screw fixation.

Comparisons: The intervention for the control group was plate fixation.

Outcomes: Width of the calcaneus, improvement of Bohler's angle, improvement of Gissane's angle, American Orthopedic Foot and Ankle Society score, duration of surgery and rate of complications.

2.3. Quality assessment

The quality assessment of the included studies was conducted by two authors (BF, XZ) according to the Cochrane Handbook for Systematic Reviews of Interventions, Version 5.1 [24]. RevMan software was used to assess the quality of the included RCTs. We assessed six specific domains: sequence generation (selection bias), allocation concealment (selection bias), blinding (performance bias), incomplete outcome data (detection bias), selective outcome reporting (reporting bias) and 'other issues'. There are three types of judgment: 'Yes' (low risk of bias), 'No' (high risk of bias), and 'Unclear' (unclear or unknown risk of bias). If there was any disagreement, a third reviewer (YR) acted as an adjudicator to arrive at the final consensus through discussion.

2.4. Data extraction

A data collection form was used to extract data from the included studies. The form included author and year, style, Sanders type, number of patients, age of patients, male/female, interventions, outcome and follow-up. Primary outcomes included width of the calcaneus, improvement of Bohler's angle and Gissane's angle, excellent and good AOFAS rating, and secondary outcomes comprise complication rate and duration of surgery. AOFAS has four degrees: excellent, good, moderate, and poor. The percent of excellent and good rating was determined as (excellent cases + good cases)/total number of cases × 100. Two reviewers (BF and YR) extracted the data from every included study. If there was any disagreement, a discussion was the first step to address the problem, and if a consensus could not be reached, the arbitration of the third author (YH) was required. For dichotomous outcomes, the numbers of the two outcomes were extracted. For continuous outcomes, mean value, standard deviation of the outcome measurements and number were extracted. If there was only a range of continuous outcomes, a special method was used to obtain the standard deviation. For a missing standard deviation, we followed the Cochrane Handbook and used the average of other studies' standard deviations [24].

2.5. Statistical analysis

Review Manager (RevMan 5.3, Nordic Cochrane Center, Copenhagen, Denmark) was used in our meta-analyses. The statistical analysis was performed according to the Cochrane Handbook for Systematic Reviews of Interventions, Version 5.1.0 [24]. For continuous variables, the standardized mean difference (SMD) and 95% confidence intervals (95% CI) were used in the analysis. The odds ratio (RR) and 95% confidence interval (CI) were assessed to analyze dichotomous outcomes. We utilized Chi-square and I-square tests to assess heterogeneity. We conducted a sensitivity or

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