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Operative Versus Nonoperative Treatment for Displaced Intra-Articular Calcaneal Fractures: A Meta-Analysis of Randomized Controlled Trials

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ABSTRACT

The purpose of the present study was to perform an updated meta-analysis of the operative versus nonoperative treatment of displaced intra-articular calcaneal fractures in adults. We searched the Cochrane Library, MEDLINE, EMBASE, and Google Scholar for eligible studies. All published randomized controlled trials comparing operative with nonoperative treatment for displaced intra-articular calcaneal fractures were eligible. The meta-analysis was performed using RevMan, version 5.0, software. Seven studies assessing 824 patients were eligible for the meta-analysis. The pooled results indicated no significant differences between the 2 groups with regard to the functional results. The incidence of complications was 25.0% (80 of 319) in the operative group and 16.6% (55 of 330) in the nonoperative group (relative risk 1.53, 95% confidence interval 1.13 to 2.08; $p = .006$) with a significant difference. The rate of subtalar arthrodesis was significantly lower in the operative group than in the nonoperative group. The current evidence is still insufficient to ascertain whether operative treatment is superior to nonoperative treatment for displaced intra-articular calcaneal fractures. Operative treatment can reduce the risk of late subtalar arthrodesis but is associated with a greater risk of complications. The small sample size and the great heterogeneity of the included studies made it difficult to draw conclusions regarding some of the combined results. Furthermore, more high-quality, randomized controlled trials with long-term follow-up data on this issue are required to provide evidence for surgeons to make an informed decision.

The calcaneal fracture is the most common tarsal fracture, and approximately 75% of them are intra-articular (1,2). The treatment results of displaced intra-articular calcaneal fractures have often been unsatisfactory. Controversy exists concerning whether operative treatment is superior to nonoperative treatment for displaced intra-articular calcaneal fractures (DIACF) in the published data (3,4). Some retrospective studies have recommended operative treatment for DIACF, because they observed that operatively treated patients had better functional outcome scores and had less pain than the nonoperatively treated patients (5–8). Nevertheless, many orthopedic surgeons have expressed concern that the benefits achieved from surgery will be offset by wound complications.

Several randomized controlled (RCTs) comparing operative with nonoperative treatment for DIACF had been published. However, these published randomized trials provided inconsistent results. Most of these RCTs were limited by a small sample size, with little statistical power to detect a difference between the compared groups. In the past few years, 4 systematic reviews and 2 meta-analyses on this issue were performed (3,9–13). Some reviewers concluded that the evidence was insufficient to establish whether surgical treatment is superior to nonoperative treatment for DIACF (3,9,10). In contrast, others reported a trend for operatively treated patients to have better outcomes (11–13). Therefore, whether to recommend operative treatment as the preferred method for DIACF remains uncertain. Because a few of new RCTs on this issue were published in recent years, it is unclear whether combining them with previous RCTs would produce meaningful results. The purpose of the present study was to perform an updated meta-analysis on the operative versus nonoperative treatment of displaced intra-articular calcaneal fractures in adults.

Materials and Methods

Criteria for Considering Studies for Our Meta-Analysis

All RCTs comparing operative and nonoperative treatment for DIACF were eligible. The participants were limited to adult patients with fresh, closed displaced intra-

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articular calcaneal fractures. Patients undergoing open reduction with any type of internal fixation method were considered for the present study. To avoid repeated calculations, multiple reports of the same patient population were pooled as 1 study.

Search Methods for Identification of Studies

Two reviewers (She. H., Q.L.) independently searched the Cochrane Central Register of controlled trials (Cochrane Library, issue 9; 2014), MEDLINE (from 1980 to September 2014), EMBASE (from 1980 to September 2014), and Google Scholar for eligible trials and then screened the titles of all the identified reports and reviewed the abstracts of the studies that were relevant to the topic. The reviewers also traced the reference lists of all retrieved trials, including reviews and meta-analysis to search for additional studies. No restriction to language was applied. Only RCTs comparing operative and nonoperative treatment for DIACF were included. Disagreement on whether 1 study was eligible for inclusion was resolved by discussion.

Outcome Measures

The primary outcomes of interest were chronic pain and function. The secondary outcomes of interest were complications, problems with wearing shoes, subtalar arthrodesis, and radiologic assessment. The complications included superficial and deep wound infection, skin flap necrosis, neurovascular injury, secondary late arthrodesis, reflex sympathetic dystrophy, ostectomy, thromboembolism, and compartment syndromes.

Data Extraction

Data on the outcomes were extracted by 2 reviewers (X.L., Shu. H.) using a predefined standardized electronic data collection form without concealing the journal name or author details. One reviewer extracted the data from the included studies, and the other checked the extracted data. When the published data of the outcome measures was not adequate for meta-analysis, we sent electronic letters to the authors for more information. The characteristics of the eligible studies were also extracted, and included publication date, enrollment period and location, demographic data, average follow-up time, and treatment methods. Disagreement of extracted data was resolved through discussion between the two review authors.

Assessment of Risk of Bias in Included Studies

Two reviewers (X.L., Q.L.) independently assessed risk of bias in included studies using the Risk of Bias Tool recommended by the Cochrane Collaboration. This comprises a description and a judgement for each entry in a "risk of bias" tabular format, in which each entry addresses a specific feature of the study. The judgement for each entry involved answering a question, with "yes" indicating low risk of bias, "no" a high risk of bias, and "unclear" either a lack of information or uncertainty regarding the potential for bias (14).

Data Synthesis and Analysis

The individual patient was the unit of the analysis. The meta-analysis was performed using RevMan, version 5.0, software, and $p < .05$ was considered to indicate statistical significance. The relative risk (RR) and 95% confidence intervals (CIs) were calculated for dichotomous outcomes, and the mean differences, with 95% CI, were calculated for continuous outcomes (14). When no heterogeneity was detected, a fixed-effect model (15) was used in the meta-analysis, and if large heterogeneity was found between studies, a random-effect model was used. A chi-square test was used to detect the between-study heterogeneity, and the significance level was set at $p < .10$ (15); its extent was quantified using the I^2 statistic (16), with a value >50% representing substantial heterogeneity. To explore the between-study heterogeneity, the clinical characteristics were prespecified in the protocol for the subgroup analyses. A sensitivity

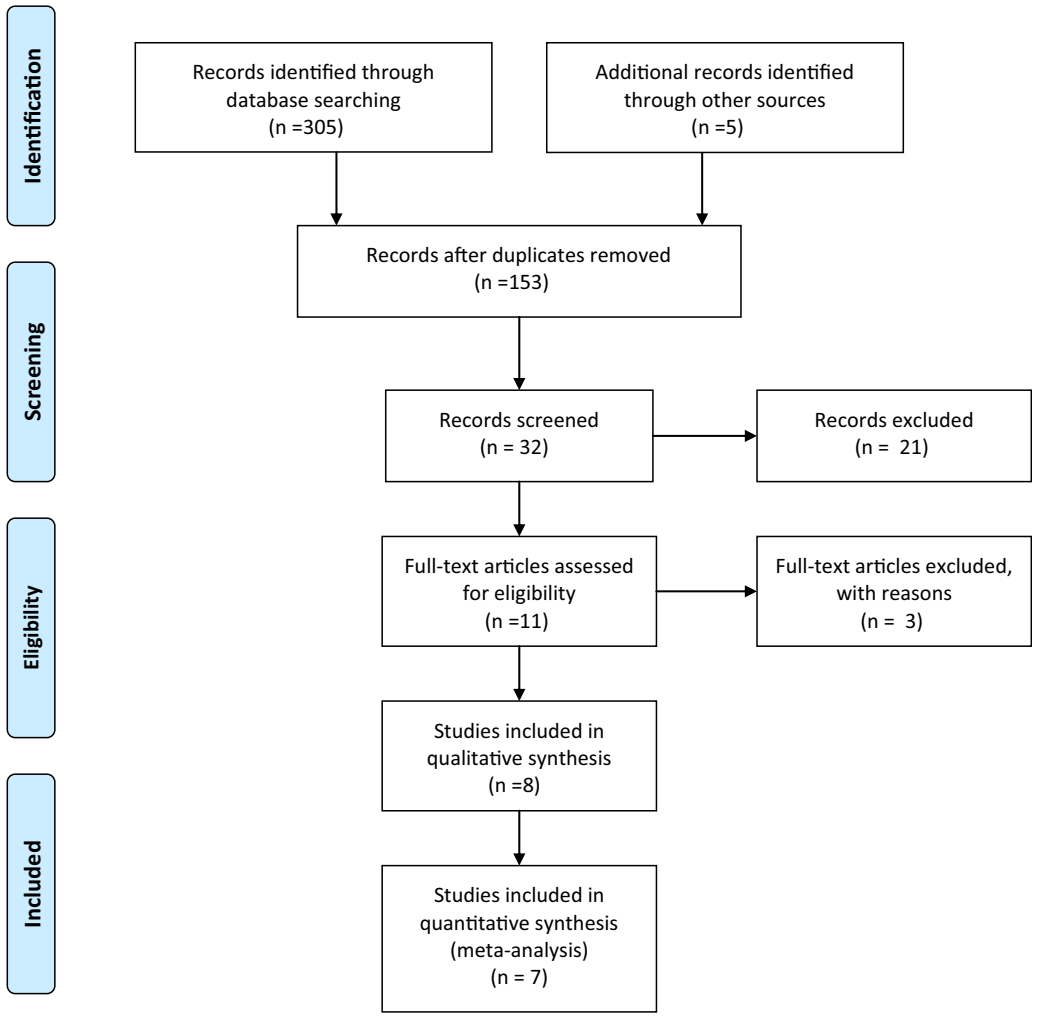

Fig. 1. Flowchart of searches for studies (created using Preferred Reporting Items for Systematic Reviews and Meta-Analyses [PRISMA] 2009 Flow Diagram, version 2.1.3).