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Review

Minimally invasive percutaneous plates versus conventional fixation techniques for distal tibial fractures: A meta-analysis

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HIGHLIGHTS

- MIPO had longer operating time, longer radiation time and higher incidence rate of soft tissue irritation symptoms.
- No significant difference existed between MIPO and CFT the in postoperative complications except for soft tissue irritation symptoms.
- Advantage of limited soft tissue dissection and minimal hardware application in MIPO was not found.

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ABSTRACT

Objective: This meta-analysis was performed to determine the effects of minimally invasive percutaneous plate osteosynthesis (MIPO) versus conventional fixation techniques (CFT) for treating distal tibial fractures.

Methods: A literature search was performed in EMBASE, Medline, the Cochrane Library, and Web of Science. The trials searched were evaluated for eligibility. The Cochrane Collaboration's Review Manager software was used to perform meta-analyses.

Results: Eight studies were enrolled, including five randomized controlled trials, one control-matched trial and two retrospective cohort trials. The meta-analysis revealed that MIPO has a longer operating time, longer radiation time and higher incidence rate of soft tissue irritation symptoms than those of CFT. There was no significant difference between the two techniques with regard to union time, the American Orthopedic Foot and Ankle Society (AOFAS), infection rate and various other complications.

Conclusions: The present meta-analysis showed that MIPO did not have obvious advantages over CFT in the treatment of distal tibia fracture. However, more rigorous randomized controlled trials are required in the future.

1. Introduction

Distal tibia fractures are primarily caused by high-energy bending and rotational forces. Such fractures are inherently unstable and are commonly associated with potentially catastrophic soft tissue injuries. Management of these fractures was shown to involve many complications, including malunion, delayed union, nonunion, and wound infection [1]. At present, the distal tibial fracture is one of the most problematic fractures.

Despite continuous improvements in surgical treatment of distal tibia fractures, determining the optimal surgery technique remains controversial. Plates, intramedullary nails and external fixations are three conventionally used and effective surgical methods. No single method is appropriate for all types of distal tibia fractures [2]. Open reduction and internal fixation (ORIF) with plates for low-energy traumas has been successful, especially in good soft tissue conditions [3]. With regard to serious open tibial fracture associated with vascular or nerve injury, infections, wound complications and implant prominence are frequently reported after plating surgeries. An increased number of subsequent

Abbreviations: MIPO, Minimally invasive percutaneous plates; CFT, conventional fixation techniques; AOFAS, the American Orthopedic Foot and Ankle Society; ORIF, open reduction and plate fixation; IMN, tibial intramedullary nail; NOS, the Newcastle–Ottawa Scale; RCTs, randomized controlled trials.

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operations and prolonged hospital stay are inevitable [4]. Tibial intramedullary nailing (IMN) is another alternative for the distal tibial fracture. IMN allows minimally invasive, dynamic fracture fixation and avoids further soft tissue trauma by adhering to the concept of biological osteosynthesis [4]. It has the advantages of stable fixation, early mobilization and soft tissue preservation with easier patient care, particularly with multiple injuries [5,6]. On the other hand, a higher incidence of malunion and anterior knee pain has been common complaints after antegrade tibial nailing in many studies [4,7,8].

The end result of ORIF in distal leg fractures is jeopardized by relevant soft tissue complications. Minimally invasive plate osteosynthesis (MIPO) takes care of the soft tissue, further reduces the surgical trauma and provides an alternative for managing these lesions [9]. MIPO is technically feasible and advantageous because it minimizes devascularization of the fracture fragments as well as soft tissue damage. The MIPO technique has been confirmed and applied by many groups [9–11] and appears to be superior to conventional fixation techniques (CFT). As a result, the technique has gained popularity in recent years and has become the preferred choice for some groups.

Many studies comparing MIPO with CFT have recently been conducted. The objective of this meta-analysis was to determine the effects of MIPO versus CFT for treating distal tibial fractures.

2. Methods

2.1. Literature search

The following electronic databases were extensively searched independently by two investigators from the inception of the database through October 2016: EMBASE, Medline, the Cochrane Library, and Web of Science. The search strategy was based on a combination of two concepts adjusted to each database as necessary. Concept One included all of the terms for distal tibial shaft fractures; Concept Two included all of the terms for MIPO. In addition, the bibliographies of the included studies and dissertations were searched for additional publications. The searches were initially limited to English publications of relevant trials in humans.

2.2. Inclusion and exclusion criteria

To be included in this analysis, trials had to fulfill the following inclusion criteria: (1) randomized and nonrandomized comparative study; (2) skeletally mature patients (>18 years of age); and (3) MIPO versus CFT for distal tibial fractures. The exclusion criteria included the following: (1) pathologically or metabolically induced fractures; (2) case reports, editorials, experimental studies, conference articles, non-English studies and other studies that failed to report on the outcome of interest; and (3) repeated studies and data.

2.3. Data extraction

After removing duplicates and completing the study selection process, two reviewers independently extracted the relevant data by adapting the predetermined standardized procedure. All data were checked for internal consistency, and controversies were settled by consensus or discussion with a third author. When inadequate information existed in the studies, it was essential to contact the first authors to obtain and clarify the relevant data, as specified by the standardized protocol.

2.4. Assessment of study quality

The methodological quality assessment of included RCTs was independently performed by two reviewers based on Cochrane collaboration's tool [12]. The risk of bias was classified as low risk, unclear risk, or high risk. The quality of included cohorts and case–control studies was assessed according to the Newcastle–Ottawa Scale (NOS) [13]. The NOS ranges from zero to nine stars; trials scoring more than 5 were considered to be high-quality.

3. Statistical analysis

The Cochrane Collaboration's Review Manager software (RevMan Version 5.2, The Cochrane Collaboration, Copenhagen, 2014) was used to perform meta-analyses. For dichotomous variables, we listed individual and pooled statistics as an odds ratio with 95% confidence intervals. For continuous data as time to union, we pooled the weighted mean time to union with associated 95% confidence intervals, and listed the individual means and standard deviations. Heterogeneity was evaluated with the χ^2 distribution test and Higgins I^2 index [14], and considerable heterogeneity was determined when the Cochrane's Q test result resulted in $p < 0.10$ and I^2 above 75% [15]. In the absence of considerable heterogeneity, studies were pooled using a fixed-effect model. If considerable heterogeneity was observed, a random-effect model was used [16]. If appropriate, the heterogeneity was identified and explained using a subgroup analysis or sensitivity analysis.

4. Results

4.1. Literature search

Fig. 1 presents a flowchart describing the process by which we screened and selected trials. The initial literature search yielded a total of 242 articles. Manual searching of relevant references did not yield any additional studies. After both duplicate checking and title and abstract screening, 202 publications were excluded. The remaining 40 publications met the inclusion criteria, and the full texts of all 40 articles were available. Ultimately, five randomized controlled trials, one case-matched trial and two retrospective cohort trials were included in the meta-analysis.

4.2. Characteristics of the trials

Detailed baseline characteristics of the eight trials are listed in Table 1. A total of 439 participants (233 MIPO, 206 CFT) divided into 16 groups (8MIPO, 8 CFT) were recruited in the final analysis. Five trials were conducted in China, two trials were conducted in Turkey, and one trial was performed in America. Four papers [17–20]compared MIPO with IMN, and three papers [21–23] compared MIPO with plates. Another trial was conducted to compare MIPO with combined titanium elastic nails and external fixation [24]. Postoperative ankle function was assessed with the American Orthopedic Foot and Ankle Society (AOFAS) scoring system in four studies [17,18,21,24] and was assessed with the Mazur ankle score in two studies [19,23]. All of the fractures included were classified according to the Orthopedic Trauma Association classification. One hundred and eight patients with distal tibia metadiaphyseal fractures (AO 43) were included in two studies [18,21] and the remaining 331 patients recruited in the other studies had distal tibia shaft fractures (AO 42).

4.3. Risk of bias assessment

Based on the Cochrane Collaboration recommendations, the