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Original research

Intramedullary nail versus plate treatments for distal tibial fractures: A meta-analysis

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HIGHLIGHTS

- We identified 16 studies compared efficacy of intramedullary nail (IMN) and plate.
- There were 599 IMN treatments and 541 plate treatments.
- IMN achieved a significant lower incidence of superficial infection (SI) than plate.
- IMN showed a significant higher incidence of malunion than plate.

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ABSTRACT

Introduction: Controversy remained on whether the optimal treatment for distal tibial fractures is intramedullary nail (IMN) or plate.

Methods: Databases including PubMed, Embase, Cochrane library, Wanfang and CNKI were retrieved up to May 31, 2014 for eligible studies. Quality Assessment of Diagnostic Accuracy Studies (QUADAS) tool was used to evaluate literature qualities. Q and I^2 test were applied to estimate heterogeneities. Moreover, subgroup analyses were performed and publication bias was detected. Mean difference (MD) and relative risk (RR), with their corresponding 95% confidence interval (CI) were used to calculate the pooled results.

Results: Sixteen studies were included involving 1140 participants (IMN: 599; plate: 541). There were no significant differences between IMN and plate treatments in operation time (OT), hospital time (HT), union time (UT), and incidence of deep infection (DI) and union complications (UC). However, IMN achieved a significant lower superficial infection (SI) incidence (RR, 0.41; 95% CI, 0.23 to 0.71; $P = 0.001$) and a significant higher malunion incidence (RR, 2.27; 95% CI, 1.56 to 3.31; $P < 0.001$). In subgroup analyses, IMN had significant shorter OT than plate in randomized controlled trials (RCTs) (MD, -19.04; 95% CI, -24.86 to −13.21; $P < 0.0001$), but comparable incidence of SI to plate in non-Asia countries. No obvious publication bias was indicated in UT and malunion.

Conclusion: For distal tibial fractures treatment, IMN might be advantageous over plate with lower SI incidence, and comparable UT, OT and HT. Meanwhile, IMN was related to higher risk of malunion. However, more RCTs are warranted.

1. Introduction

Tibia is characterized by an exposed bone with vulnerable soft tissue and is prone to cause local soft tissue breakdown [1]. Tibial fractures are the most common long bone fractures [2], while distal tibail fractures are even more complicated due to its proximity to ankle, and the close relationship with thin soft tissue envelope and severe comminution [3–5]. Additionally, distal tibial fractures are associated with posterior malleolus fractures [6].

A spectrum of methods have been introduced into the management of distal tibial fracture, including surgical technique such as open reduction and nonsurgical techniques such as internal fixation with screws or plates, external fixations with mono-lateral

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or circulated external fixators [7]. Although the surgical technique possesses incomparable advantages in anatomical reduction and remains the mainstay for distal tibial fracture treatment, limitations still exist. For example, surgical dissection often causes soft tissue stripping that can result in infection, wound necrosis and delayed or non-union [8]. On the contrary, several nonsurgical approaches such as plate fixation and intramedullary nail (IMN) can avoid these undesirable outcomes and are considered as two major therapeutic options for distal tibial fractures [8,9]. In the application of these two approaches, considerable studies have endeavored to investigate the optimum strategy by comparing the efficacy of IMN and plate [10–12].

Previously, a study has shown that compared with tibial IMN treatment, fibular plate fixation has the advantage of increasing initial rotational stability after distal tibial fracture [13]. Percutaneous plate osteosynthesis is also suggested to be an attractive treatment option for fractures in the distal tibia, as it could preserve soft tissues at this site [14]. A recent research provides the evidence that both medical and lateral minimally invasive plate osteosynthesis contribute to distal tibial fractures treatment [3]. On the other hand, several investigations support the superiority of IMN over the plate treatment. For instance, IMN is confirmed to be a viable alternative to plate osteosynthesis in the management of distal tibial fractures [10]. Additionally, a comparison between percutaneous locking plate and IMN demonstrates it is IMN that is more advantageous in reducing the need of secondary procedures [7]. Besides, a latest meta-analysis favored that IMN may be preferential to plate for fixation of distal tibial metaphyseal fracture with lower incidence of infection [11]. Though more preference is given to IMN, locked IMN is found closely associated with instability of the fixation and high risk of infection in the ankle joint. Besides, it could not well-aligned in the metaphysis of the tibia fracture [15]. Overall, there is not a consistent conclusion about which method is more advantageous. Therefore, we conducted this meta-analysis to provide more comprehensive and reliable evaluations of the two treatments for distal tibial fractures.

2. Methods

2.1. Search strategy

Electronic databases including PubMed, Embase, Cochrane library, Wanfang and CNKI were retrieved from their establishment to May 31, 2014, without language restriction. The key terms for searching were: “tibia fractures” OR “distal tibial fractures” OR “intramedullary nail” OR “nailing and plate”. In addition, manual search was also performed for additional literature written in paper. Reference lists from published original articles and previous reviews were scanned for more relevant studies.

2.2. Inclusion and exclusion criteria

Studies were included if the following criteria were fulfilled: (1) studies were randomized controlled trials (RCTs) or clinical controlled trails (CCTs); (2) the participants in the study were patients with distal tibial fractures; (3) the control group was treated with plate, while the case group was with IMN; (4) the assessment indexes included operation time (OT), hospital time (HT), union time (UT), wound complications including superficial infection (SI) and deep infection (DI), union complications (UC) and malunion. On the contrary, studies were excluded if they were: (1) studies with incomplete data for statistical analysis; (2) reviews, letters or comments; (3) duplicated literature.

2.3. Data extraction and quality assessment

The databases were retrieved by two independent investigators based on the above criteria. Then according to a predefined standard form, the data for the necessary information were abstracted such as the first author's name, the publication time, the test site, the age and gender composition, the type of studies, the numbers of case and control groups, the follow-up time, the numbers of loss of follow-up, the type of fractures, the internal fixation, reduction and the outcomes. Disagreements between two investigators were resolved by discussion. Methodological quality of the eligible studies were evaluated by using the modified version of the Quality Assessment of Diagnostic Accuracy Studies (QUADAS) tool proposed by the Cochrane Collaboration [16]. The evaluation system contained seven basic items including random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting and other bias, hence making the quality evaluation more objective and comprehensive.

2.4. Statistical analysis

Mean difference (MD) with the corresponding 95% confidence interval (CI) were selected to calculate the pooled results for the continuous outcomes, while relative risk (RR) with the corresponding 95% CI were applied for dichotomous outcomes. Q and I^2 test were used to estimate the heterogeneity among studies [17]. A random effects model was selected when significant heterogeneity was indicated ($P < 0.05$, $I^2 > 50\%$), whereas a fixed effects model was used for homogeneous outcomes ($P \geq 0.05$, $I^2 \leq 50\%$) [18]. The subgroup analyses stratified by study type and region were also performed. Furthermore, we tested the publication bias via funnel plot analysis. RevMan5.2 software (Cochrane Collaboration, http://ims.cochrane.org/revman) was recruited for all the statistical analyses.

3. Results

3.1. Study selection

In the preliminary screening, a total of 1291 studies were selected (272 from PubMed, 244 from Embase, 13 from Cochrane library, 328 from Wanfang and 434 from CNKI), in which 934 were remained by excluding the redundant publications. Then, 32 literature were identified after title browsing. Further, another elimination of 10 studies (2 comments, 1 letter and 7 studies without the comparison of IMN and plate) were conducted. Besides, after full text reading, 6 studies (3 reviews and 3 studies with insufficient data) were removed. No additional studies were selected under manual search. Finally, 16 eligible studies [7,10,12,15,19–30] were included for this meta-analysis. The procedure of study selection is presented as Fig. 1.

3.2. Characteristics and quality assessment of the eligible studies

Among the selected 16 studies, (11 in English [7,10,12,15,19–25] and 5 in Chinese [26–30]) there were 6 RCTs [10,12,15,19,23,24] and 10 CCTs [7,20–22,25–30], which were published from 2005 to 2014. The studies were consisted of 1140 patients, in which 599 were distributed in case group and 541 were in control group (Table 1). As indicates in Table 1, most of the eligible studies were conducted from Asia, and only 5 were from non-Asia countries (Europe and America). The evaluation of the methodological quality of the included studies is shown in Fig. 2. Due to high