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Review

Intramedullary nailing versus plating for extra-articular distal tibial metaphyseal fracture: A systematic review and meta-analysis

Xing-He Xue [1], Shi-Gui Yan, Xun-Zi Cai *, Ming-Min Shi, Tiao Lin

Department of Orthopaedic Surgery, Second Affiliated Hospital, School of Medicine, Zhejiang University, No. 88 Jiefang Road, Hangzhou 310009, PR China

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ABSTRACT

Introduction: With development in the techniques of reduction and fixation, there has been a controversy in comparison between intramedullary nailing (IMN) and plating for the treatment of distal tibial metaphyseal fracture (DTF). The study aimed to investigate: (1) which fixation, IMN or plating, was better in the clinical outcomes and in the complications for the treatment of DTF and (2) which modifying variables affected the comparative results between the two modalities.

Methods: PubMed, EMBASE, OVID, Scopus, ISI Web of Science, the Cochrane Library, Google Scholar and specific orthopaedic journals were searched from inception to July 2013, using the search strategy of '('Fracture Fixation, Intramedullary' [MeSH]) AND ('Tibial Fractures' [MeSH]) AND (plate OR plating)'. All prospective and retrospective controlled trials comparing function, pain, bone union and complications between IMN and plating for DTF were identified. Our analysis had no limitation of the language or the publication year. The primary outcome measurements were complication rate, union time, operation time and hospital stays, while the secondary outcome measurements were functional score and pain score.

Result: Fourteen of 6620 studies with 842 patients were included. IMN was probably preferential to plating for DTF given its higher functional score ($p = 0.01$), lower risk of infection ($p = 0.02$) and comparable pain score ($p = 0.33$), total complication rate ($p = 0.53$) and time to union ($p = 0.86$). However, plating had a lower malunion rate than IMN ($p < 0.0001$). All the results were based on the Grading of Recommendations Assessment, Development and Evaluation (GRADE) evidence of moderate quality.

Conclusions: With a satisfying alignment obtained, IMN may be preferential to plating for fixation of DTF with better function and lower risk of infection. However, IMN showed higher malunion rate for fixation of DTF. With the biases in our meta-analysis, it will ultimately require a rigorous and adequately powered randomised controlled trial (RCT) to prove.

Level of evidence: Level III, therapeutic study (systematic review).

Contents

* Corresponding author. Tel.: +86 571 13750838226; fax: +86 571 86806079.
E-mail addresses: qq524689473@163.com (X.-H. Xue), emilcai@hotmail.com (X.-Z. Cai).
[1] Tel.: +86 571 15088681606; fax: +86 571 86806079.

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Introduction

Tibial metaphyseal fractures (TMFs) contain both distal tibial metaphyseal fractures (DTFs, Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) type 43 or distal 42) and proximal metaphyseal tibial fractures (PTFs, AO/OTA type 41 or proximal 42) [1], which account for 3–10% and 5–11% of total tibial fractures, respectively [2,3]. With the severe damage of soft tissue and the extreme instability, TMFs have a high risk of unsatisfactory function, severe pain, delayed union, malunion and infection [2,4]. The established treatments include intramedullary nailing (IMN) and plating.

Plating has been accepted as the first choice for DTF [5], which ensures accurate reduction and rigid fixation. Unfortunately, extensive dissection of the host bone and the soft tissue is mandatory. It inevitably raises the risk of infection and nonunion. Furthermore, the complaint about hardware irritation makes it prone to be removed [5]. IMN is the gold standard for tibial diaphyseal fractures. It has a small influence on the blood supply of the host tissue, which would contribute to a low rate of nonunion and infection [4,5]. Initially, the extreme high malunion rate and the poor function prevented orthopaedic surgeons from using IMN for DTF [5]. Biomechanical experiments showed that even the reamed IMN could not fit with the lenient medullary canal of the tibia metaphysis [6]. Of the two fracture ends, the short part lacked the cortical friction with implants and the adequate purchase of locking screws so that the tibial alignment could be neither obtained nor maintained [6]. Given these inherent defects, IMNs were limited or even relatively contradicted for DTF.

With the emerging shortened and multidirectional interlocking IMN, for example, the distal locking nail (DLN) [2], and the evolving reduction techniques, for example, the blocking screw (BS) and other percutaneous reduction techniques (PRTs) [2], the interest in applying IMN to TMFs has been renewed. The claimed improvement in the alignment and the stability has been confirmed both in the laboratory and in the clinical follow-up [2,3,6]. Meanwhile, the novel technique of minimally invasive plating osteosynthesis (MIPO) has been developed to further alleviate the local damage of plating [3].

At present, there has been a great controversy on the ideal surgical option for DTF. A large amount of studies compared IMN with plating [7–20]. Limited by the sample size, they failed to show a clear superiority of one modality over the other. To address this, the present systematic review and meta-analysis is aimed to cover all the comparative evidence with the purpose of determining: (1) which fixation, IMN or plating, was better in the clinical outcomes and in the complications for the treatment of DTF and (2) which modifying variables affected the comparative results between two modalities.

Materials and methods

Three reviewers (XHX, XZC and MMS) searched PubMed (1966 to July 2013), EMBASE (1974 to July 2013), Ovid (1966 to July 2013), Scopus (1966 to July 2013), ISI Web of Science (1945 to July 2013), Cochrane Library, Clinical Trial Grade Center and Google Scholar (1966 to July 2013), Chinese VIP Database (1986 to July 2013) and Chinese Wan-Fang Database (1992 to July 2013) using the search strategy of '('Fracture Fixation, Intramedullary' [MeSH]) AND ('Tibial Fractures' [MeSH]) AND (plate OR plating)', plus 'clinical trial' AND 'comparative study' with no limitation of publication year or language. The reference lists of all the selected articles and the related orthopaedic journals were hand searched for any additional trials. In addition, we searched the Clinical Trial Registry, the Current Controlled Trials, the Trials Central and the Center Watch for grey literature. We defined the criteria of inclusion and exclusion before searching. We only included studies where: (1) DTF (AO/OTA type 43 or distal 42) was involved, (2) the age was $\geq$18, (3) both IMN and plating were adopted, (4) functional score, pain score or complication rate was assessed and (5) the design was comparative either prospectively or retrospectively. Exclusion criteria included studies where: (1) tibial isthmal fractures or AO type 43-C with serious intra-articular damages were involved, (2) neither of the outcomes was available, (3) the follow-up was $<$1 year and (4) no control data were provided. All the redundant publications were excluded. The abstracts of the rest of the publications were reviewed for relevance. Excluding the redundant publications and the unsatisfactory publications, the full texts of the rest of the publications were acquired and read in detail. We included the publications that satisfied our inclusion criteria.

We contacted the corresponding authors of the eligible trials if necessary to verify the accuracy of the data abstraction as well as the methodological assessment. We also tried to get any further data or unpublished data which were useful for our data analysis.

Methodological quality

Three reviewers (XHX, SGY and MMS) assessed the methodological quality of the literature according to the 12-item scale [21]. The 12-item scale contained: randomised adequately, allocation concealed, similar baseline, patient blinded, care provider blinded, outcome assessor blinded, avoided selective reporting, similar or avoided cofactor, patient compliance, acceptable drop-out rate, similar timing and intention-to-treat (ITT) analysis. The inconsistent opinions were judged by another author (XZC). The disagreements were evaluated by the means of a kappa (κ) test and resolved by discussion. According to the 12-item standard (Table 1), five studies [8–12] explicitly described the randomisation and the concealment of the allocation assignment, six studies [8,9,11,14,15,17] described the proper blinding and only one study [9] described ITT analysis. The weighted kappa for the agreement on the trial quality between the reviewers was 0.85 (95% confidence interval (CI), 0.77–0.93).

Analysis of the data

Three reviewers (XHX, TL and MMS) extracted the relevant data and checked the accuracy (Table 2). Study design, sample size, age, gender, loss to follow-up, AO and Gustilo classification of DTFs, reduction technique, implants, fibular fixation, protocol of weight