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Original article

External fixation versus open reduction and internal fixation for tibial pilon fractures: A meta-analysis based on observational studies

Yi-Chen Meng, Xu-Hui Zhou*

Department of Orthopedics, Changzheng Hospital, Second Affiliated Hospital of Second Military Medical University, Shanghai, China

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ABSTRACT

Purpose: Tibial pilon fractures remain challenging for an orthopaedic surgeon to repair. External fixation (ExFix) and open reduction and internal fixation (ORIF) are two widely used methods for repairing tibial pilon fractures. However, conclusions of comparative studies regarding which method is superior are controversial. Our aim is to compare ORIF and ExFix and clarify which method is better in terms of reduction and union results and major complications.

Methods: A computerized research of MEDLINE, EMBASE, Springer, and Cochrane Library (before December 2014) for studies of any design comparing ORIF and ExFix was conducted. Weighted mean difference (*WMD*), risk ratio (*RR*) and corresponding 95% confidence intervals (*CI*) were used for estimating the effects of the two methods. Statistical analyses were done using Review Manager Version 5.2.

Results: Ten cohort studies and one randomized clinical trial were included in our ultimate analysis. And the analysis found no significant difference between the two methods in deep infection ($p = 0.13$), reduction ($p = 0.11$), clinical evaluation ($p = 0.82$), post-traumatic arthrosis ($p = 0.87$), and union time ($p = 0.35$). Besides, ExFix group was found to have a higher rate of superficial infection ($p = 0.001$), malunion ($p = 0.01$) and nonunion ($p = 0.02$), but have a lower risk of unplanned hardware removal ($p = 0.0002$).

Conclusions: We suggest that ORIF has a relatively lower incidence rate of superficial infection, malunion and nonunion, but a higher rate of unplanned hardware removal. No difference was found in deep infection, reduction, clinical evaluation, post-traumatic arthrosis and union time.

Introduction

The incidence of tibial pilon fractures is increasing following the rise of the incidence of road traffic accidents.[1,2] Repairing pilon fractures remain challenging for orthopedic surgeons. Over the past years, a wide variety of treatment strategies for these fractures emerged and developed, which include nonoperative management, open reduction and internal fixation (ORIF), external fixation (ExFix), and minimally invasive treatments.[3,4] ORIF and ExFix are two methods frequently reported in the literature. ORIF can restore the anatomic structure of the bone, but it cannot avoid dissecting soft tissues which associate with recovery.[5] On the other hand, ExFix allows indirect reduction but causes less soft tissues damage. However, a few studies conclude that ExFix is associated with high rates of malunion and nonunion.[6,7] Different authors have compared ORIF and ExFix from different aspects, but the clinical outcomes are still controversial. We searched for all the non-randomized prospective or retrospective studies or randomized clinical trials comparing the clinical outcomes between ORIF and ExFix for tibial pilon fractures. The aim of this systematic review and meta-analysis is to compare ORIF and ExFix and clarify which method is better in terms of reduction score and major complications, including infection, malunion, nonunion and arthrosis.

Materials and methods

Search strategy

We searched MEDLINE, EMBASE, Springer, Cochrane Library to retrieve related studies published before December 2013 with

* Corresponding author. Tel.: +86 21 81886999; fax: +86 21 63520020.
E-mail address: myc910429@163.com (X.-H. Zhou).

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combinations of keywords “tibia pylon/plafond”, “fracture?”, “ExFix”, “internal fixation”, “ORIF” and “comparative study”. The language was restricted to English. We also scanned the citation lists of the identified articles for additional relevant studies.

Eligibility

Studies were included if they met the following criteria: (1) randomized, quasi-randomized, prospective and retrospective cohort and case-control studies; (2) patients with tibial pilon fractures of type 43A, 43B, 43C according to the AO/OTA classification; (3) patients aged 18 years or older; (4) comparison of ORIF and ExFix for treatment; (5) outcomes of interest adequately reported for meta-analysis.

Data extraction and study quality assessment

Full texts were read and relevant data were extracted from each included study by the two authors independently using a data extraction form. The information extracted from each study included the first author, year, country, research type, patients' number. Outcomes of interest we extracted included the incidence of complications, the union time and unplanned hardware removal. After the first extraction, the data were rechecked by the two authors.

The quality of the included studies was assessed by the two independent observers, using the Downs and Black checklist for both randomized and nonrandomized studies.[8] For the Downs and Black checklist, 27 questions were raised to assess reporting, external validity, internal validity-bias, internal validity-confounding, and power. This checklist is considered a reliable and valid tool to assess the methodological quality of studies, which has a total score of 31. Scores above 20 were considered high methodological quality; 11–20 moderate quality; and below 11 poor quality.

Statistical analysis

Statistical analyses were done using Review Manager Version 5.2 (Cochrane Collaboration, Software Update, Oxford). We analyzed the risk ratio (*RR*) with 95% confidence intervals (*CI*) for dichotomous variables and the weighted mean difference (*WMD*) with the *95% CI* for continuous variables. *I*-squared (I^2) statistic was used to assess statistical heterogeneity among studies and $I^2 > 50\%$ reflects high heterogeneity.[9] Both fixed-effects and random-effects models were used to pool the data. The random-effects model was used only when heterogeneity was significant. *p*-values less than 0.05 are considered statistically significant.

Results

A total of eleven studies,[7,10–19] compared ORIF and ExFix for tibial pilon fractures and published between 1993 and 2013, fulfilled our inclusion criteria. Fig. 1 provides a flow diagram of the search results. These studies included 502 participants, of which 238 (47.4%) underwent ExFix and 264 (52.6%) underwent ORIF. The study consisted of ten retrospective or prospective non-randomized studies and one randomized clinical trial. Results of quality assessment with the Downs and Black checklist are shown in Table 1. Total scores were on average 16.3 points. Ten of eleven studies were of moderate methodological quality, while one of poor quality. All eleven studies were of low power due to small intervention group sizes. A summary of meta-analysis results is shown in Table 2.

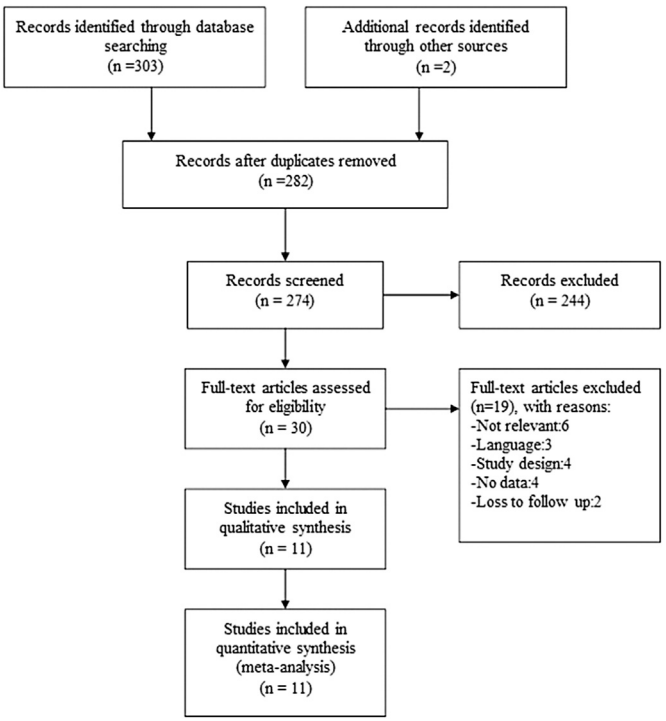

Fig. 1. Flow chart of screening studies comparing ORIF and ExFix.

Postoperative complications

Infection

Eleven studies[7,10–19] reported the incidence of wound infections, with only two of them individually showing a statistically significant difference between the ExFix group and the ORIF group. One study did not give the detailed data and was excluded from analysis. Rate of total infection was 43 of 225 in the ExFix group and 35 of 250 in the ORIF group. Subgroup analysis showed a higher risk of incidence of superficial infection in the ExFix group ($RR = 2.71$, *95% CI* = 1.48 to 4.97, $Chi^2 = 5.65$, $p = 0.001$) with no significant heterogeneity ($I^2 = 0\%$), while for deep infection there was no difference between the two groups ($RR = 0.65$, *95% CI* = 0.37 to 1.14, $Chi^2 = 12.99$, $p = 0.13$) with an acceptable heterogeneity ($I^2 = 31\%$). The forest plot is presented in Fig. 2.

Post-traumatic arthrosis

Arthrosis was a major complication reported by seven studies.[10,12,15–19] Rate of arthrosis was higher in the ORIF group (57 of 144) than that of the ExFix group (55 of 159). Meta-analysis showed no significant difference in the incidence of arthrosis between the ExFix group and the ORIF group. The result was $RR = 0.98$, *95% CI* = 0.79 to 1.23, $Chi^2 = 6.88$, $I^2 = 13\%$, $p = 0.87$.

Malunion

Malunion was defined as >5° of angulation in the coronal plane, >10° in the sagittal plane, or >2 mm of articular step-off as seen on postoperative radiographs. Six studies[7,14–17,19] reported the incidence of malunion, none of which individually showed a statistically significant difference between the ExFix group and the ORIF group. The meta-analysis of these studies showed a significantly reduced incidence of malunion with ORIF as compared with ExFix ($RR = 2.85$, *95% CI* = 1.23 to 6.60, $Chi^2 = 1.32$, $p = 0.01$) with no significant heterogeneity ($I^2 = 33\%$).

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