



## Review

## The management of segmental tibial shaft fractures: A systematic review



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## ARTICLE INFO

## Article history:

Accepted 15 November 2015

## Keywords:

Tibial fracture  
Segmental  
Systematic review  
External fixation  
Intramedullary nailing  
Open reduction and internal fixation  
Comparison

## ABSTRACT

**Introduction:** Segmental tibial fractures are complex injuries associated with significant soft tissue damage that are difficult to treat. This study aimed to identify the most effective method of treating segmental tibial fractures.

**Method:** A PRISMA compliant systematic review was conducted. Studies investigating the management of segmental tibial fractures with intramedullary nail fixation (IMN), open reduction and internal fixation (ORIF) or circular external fixation (CEF) were included for review. The primary outcome measure was time to fracture union. Secondary outcomes were complications and functional outcome. A narrative analysis was undertaken as meta-analysis was inappropriate due to heterogeneity of the data. **Results:** Thirteen studies were eligible and included. No randomised controlled trials were identified. Fixation with an intramedullary nail provided the fastest time to union, followed by open reduction and internal fixation and then CEF. The rate of deep infection was highest after IMN (5/162 [3%]), followed by open reduction and internal fixation (2/78 [2.5%]) and CEF (1/54 [2%]). However, some studies reported particularly high rates of infection following IMN for open segmental tibial fractures. There was limited reporting of postoperative deformities. From the studies that did include such data, there was a higher rate of deformity following ORIF (8/53 [15%]), compared to IMN (13/138 [9%]), and CEF (4/44 [9%]). Three studies, not including IMN, described patient reported outcome measures with results ranging from 'excellent' to 'fair'.

**Discussion:** The available evidence was of poor quality, dominated by retrospective case series. This prevented statistical analysis, and precludes firm conclusions being drawn from the results available.

**Conclusion:** IMN has the fastest time to fracture union, however there are concerns regarding an increased deep infection rate in open segmental tibial fractures. In this subgroup, the data suggests CEF provides the most satisfactory results. However, the available literature does not provide sufficient detail to make this statement with certainty. We recommend a randomised controlled study to further investigate this challenging problem.

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## Introduction

A segmental fracture is characterised by distinct fractures at two or more levels, creating one or more completely separate intercalary fragments of tubular bone [1]. In the tibia, segmental fractures are assigned the AO classification 42C2. Segmental tibial fractures are rare, accounting for between three and 12% of all tibial shaft fractures. They often result from high energy mechanisms of injury [2]. Complications are more common in comparison to simple tibial shaft fractures, particularly in terms of non-union and infection [3].

There is a wide zone of injury associated with these fractures and the soft tissue component requires specific management considerations. Compartment syndrome occurs in up to half of all cases, and over 50% of segmental tibial fractures present as open fractures [1]. The high rate of complications is thought to relate to the severe nature of the soft tissue injury, both in open and closed fractures [4]. In all cases, there is periosteal stripping and disruption of the blood supply, particularly to the intercalary fragment, which disturbs fracture healing.

Non-operative treatment is generally not indicated for these fractures as the outcome is poor [5]. Surgical options include open reduction and internal fixation (ORIF), locked intramedullary nailing (IMN) and circular frame external fixation (CEF). However, there is currently clinical equipoise with no consensus on the best method [4]. To address this uncertainty, we systematically analysed the current evidence to determine what is the optimal fracture fixation method for segmental tibial fractures.

## Materials and methods

A PRISMA compliant systematic review was conducted to determine which method of fixation resulted in the shortest time to union and the fewest complications [6].

### Search strategy

We performed a systematic literature search on the 30th April 2015 to identify relevant articles. The electronic databases MEDLINE, Embase, CINAHL, Pubmed and AMED were searched through the Ovid platform from their inception to the 30th April 2015. The unpublished literature was searched from the electronic databases OpenGrey, British Library Integrated catalogue, Current Controlled Trials and the Cochrane Central Register of Controlled Trials from inception to the 30th April 2015. The MEDLINE search

strategy is presented in Supplementary Table 1. This was modified for the other electronic searches.

### Study eligibility

We aimed to identify randomised controlled trials (RCTs) and non-randomised studies reporting the surgical management of segmental tibial fractures. A broad search allowed inclusion of population characteristics, medical co-morbidities and coincidental injuries, surgical interventions and the origin of the study. Studies published in any language were included and papers were eligible irrespective of date of publication. We excluded animal or biomechanical (cadaveric or saw bone) studies.

### Study identification

Two reviewers (Z.L., S.M.) independently reviewed the title and abstract of each study. Full text papers were ordered for those studies which met the eligibility criteria. Two reviewers (Z.L., S.M.) then independently reviewed each full text paper against the eligibility criteria and included pertinent studies in the review. If disagreements arose between the reviewers in respect to study eligibility, data extraction or critical appraisal score, this was resolved with discussion between the two reviewers until a consensus was reached.

### Data extraction

Data was collected from each included paper by one reviewer (Z.L.), and verified by a second reviewer (S.M.). Data extracted from each paper included cohort age, gender, clinical presentation, mechanism of injury, management, complications, outcome measures and follow-up period.

### Outcome measures

The primary outcome measure was time to fracture union. Secondary outcome measures were complications and functional outcome.

### Critical appraisal

The Critical Appraisal Skills Programme (CASP) critical appraisal tool for cohort studies was used to assess the methodological quality of the included studies as this was the study design of the subsequently eligible papers [7]. Each included paper was

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