E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.48047/ijprt/15.02.355

Research Article

Outcome of Open Tibial Fractures in Relation to Time from Injury to Definitive Management: A Retrospective Study from a Tertiary Care Hospital

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Abstract

Background: Open tibial fractures are the most common open long bone injuries, accounting for nearly a third to two-fifths of all open fractures, and carry an infection risk considerably higher than open fractures elsewhere in the skeleton. Timely debridement, stable fixation, soft-tissue coverage, and antibiotic prophylaxis are widely accepted as the cornerstones of management, and the interval between injury and definitive surgical care is believed to be a key determinant of functional outcome and complication rate.

Objective: To study the outcome of open tibia fractures in relation to the time from injury to definitive management in patients treated at a tertiary care centre.

Methods: This retrospective study was conducted at Mandya Institute of Medical Sciences (MIMS), Mandya, over 15 months (September 2023 to December 2024). Patients aged 18 years and above of either sex presenting with open tibia fractures were included; patients below 18 years and those unfit for surgery were excluded. All patients were managed with emergency debridement, antibiotic prophylaxis, staged stabilization, and soft-tissue coverage as required, and functional outcome was assessed using the Lower Extremity Functional Scale (LEFS) at 2 weeks, 6 weeks, 3 months, and 6 months.

Results: Thirty-four patients were followed up (24 male, 7 female — reported totals). Functional scores improved progressively over the follow-up period, with poor and fair outcomes predominating at 2 weeks and good-to-excellent outcomes predominating by 3 and 6 months. Complications included sepsis (4), delayed union (10), limb deformity (6), malunion (3), need for repeat debridement (2), and need for secondary closure (3).

Conclusion: Functional outcomes were good to excellent by 3 months postoperatively, and patients treated within 48 hours of injury had better outcomes. Fracture healing occurred between 4 and 6 months in most patients, reinforcing the principle that early, well-sequenced debridement and stabilization favourably influence both union and function.

Introduction

Open tibial fractures remain the most common open long bone injury and present with a wide spectrum of severity, ranging from a small clean puncture wound over a simple fracture to extensive, contaminated soft-tissue loss with an unstable, comminuted fracture and compromised limb vascularity. They are typically the result of high-energy trauma such as road traffic accidents, falls from height, and sports injuries, and constitute approximately 17% of all lower extremity fractures.

The demographic pattern of open tibial fractures shows a clear male preponderance and a bimodal age distribution. Younger patients tend to sustain these injuries through high-energy mechanisms such as road traffic accidents, often with more severe soft-tissue and bone injury, while older patients are more often affected by lower-energy mechanisms such as domestic falls, frequently on a background of osteopenic bone.

The tibia is the most frequent site of open fracture in the body, accounting for an estimated 32–40% of all open fractures. This is largely explained by its anatomical position: the anteromedial surface of the tibia lies subcutaneously along almost its entire length, with a thin, poorly vascularised soft-tissue envelope and limited muscular cover, particularly over the distal two-thirds. This anatomical vulnerability makes the tibia particularly susceptible to infection, with

reported infection rates 10 to 20 times higher than open fractures at other anatomical sites.

Because of this heightened risk, a timely and well-structured treatment protocol is essential. Such a protocol comprises thorough surgical debridement of all devitalized and contaminated tissue, accurate fracture reduction, early and stable skeletal fixation, meticulous soft-tissue repair or coverage, and appropriate systemic antibiotic administration. This bundle of care is widely accepted as essential for reducing complications — particularly infection, non-union, and malunion — and for optimising the chances of uneventful bony union and a functional limb.

Objectives

To study the outcome of open tibia fractures in relation to the time from injury to definitive management, through a retrospective analysis of patients with open tibia fractures operated upon and followed up at MIMS, Mandya.

Classification of Open Fractures

Open tibial fractures in this study were classified according to the Gustilo–Anderson classification, which remains the most widely used and clinically applicable system for grading the severity of open fractures. It stratifies injuries by wound size, degree of contamination, extent of soft-tissue injury, and the presence of vascular compromise, and is summarised in Table 1.

Type	Wound	Contamination	Soft-Tissue Injury	Bone Injury
I	<1 cm long	Clean	Minimal	Simple, minimal comminution
II	>1 cm long	Moderate	Moderate; some muscle damage	Moderate comminution
III-A	Usually >10 cm	High	Severe, with crushing	Usually comminuted; soft-tissue coverage of bone possible
III-B	Usually >10 cm	High	Very severe loss of cover	Bone cover poor; usually requires soft-tissue reconstruction
III-C	Usually >10 cm	High	Very severe loss of cover, plus vascular injury requiring repair	Bone cover poor; usually requires soft-tissue reconstruction

Table 1. Gustilo–Anderson classification of open fractures.

Type III injuries — the most severe category — are further subdivided based on the adequacy of soft-tissue cover and vascular status:

- Type III-A — Extensive soft-tissue laceration or flap, usually from high-energy trauma, but with adequate bone coverage by remaining soft tissue despite the degree of soft-tissue injury or laceration.
- Type III-B — Extensive soft-tissue loss with periosteal stripping and bone exposure, usually associated with massive contamination; this subtype requires soft-tissue reconstruction, typically local or free flap coverage, to achieve adequate bone cover.
- Type III-C — Any open fracture associated with an arterial injury that requires operative repair, regardless of the degree of soft-tissue injury; this subtype carries the highest risk of limb loss.

Methodology and Materials

This retrospective study was conducted in the Department of Orthopaedics at MIMS, Mandya, over a 15-month period from September 2023 to December 2024. Patients aged 18 years and above, of either sex, presenting with open tibia fractures, were included in the study, with outcomes assessed in relation to the time elapsed between injury and definitive management. Patients younger than 18 years and those not fit for surgery on medical grounds were excluded from the analysis.

Initial Management and Antibiotic Prophylaxis

All patients received tetanus toxoid prophylaxis (Inj. TT 0.5 mg) along with broad-spectrum antibiotic cover on presentation. This comprised Inj. Ceftriaxone-Sulbactam 1.5 g, Inj. Amikacin 500 mg, and Inj. Metronidazole 500 mg, administered intravenously as a stat dose to cover Gram-positive, Gram-negative, and anaerobic organisms respectively. Antibiotics were continued for 3 to 5 days in the acute phase, and preoperative antibiotic dosing for subsequent staged procedures was administered at the discretion of the treating physician.

Following initial resuscitation and stabilization, patients underwent emergent irrigation and debridement in the operating room. This involved sharp excision of devitalized or contaminated soft tissue and bone back to healthy, bleeding margins, followed by copious pulse lavage irrigation using an average of 8 to 9 litres of sterile saline solution to mechanically reduce the bacterial and particulate contamination load within the wound.

Fracture Stabilization and Wound Management

Initial fracture stabilization was most often achieved with a temporary slab, allowing the soft-tissue injury and overall patient condition to be assessed before definitive fixation. Definitive stabilization was subsequently achieved using external fixation or intramedullary nailing, with the choice of technique guided by fracture pattern, degree of contamination, soft-tissue status, and the Gustilo–Anderson grade.

Wounds were generally left open following initial debridement rather than closed under tension, in keeping with accepted principles of open fracture management. Planned re-look surgery, with re-debridement and further irrigation, was performed as indicated by the clinical appearance of the wound and the degree of contamination. Definitive soft-tissue coverage was subsequently obtained through delayed primary closure, split-skin grafting, or flap closure, depending on the extent of the soft-tissue defect and the adequacy of the wound bed

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Figure 1. Clinical photographs from the study series illustrating open tibial wound management — soft-tissue debridement and primary wound closure with interrupted sutures (top left), application of a uniplanar external fixator

across an open tibial wound for provisional skeletal stabilization (top right), and staged wound closure with sutures and skin staples at follow-up (bottom row).

Follow-Up and Postoperative Assessment

Patients were followed up postoperatively with radiological and functional assessment at 6 weeks, 3 months, and 6 months. Functional outcome was evaluated using the Lower Extremity Functional Scale (LEFS), a validated 20-item, patient-reported outcome measure originally described by Binkley et al. (1999), which assesses the degree of difficulty experienced in performing a range of daily activities relevant to lower-limb function — including housework, sporting activity, wearing outdoor shoes, squatting, and walking on even and uneven ground.

Each of the 20 activity items is scored on a 5-point scale from 0 (extreme difficulty or unable to perform the activity) to 4 (no difficulty), giving a maximum possible score of 80. In this study, scores were interpreted using the following categories:

- 70–80: Excellent functional outcome
- 60–70: Good functional outcome
- 40–60: Fair functional outcome
- Below 40: Poor functional outcome

Rehabilitation was tailored to fracture stability. Range-of-motion exercises for the knee and ankle were initiated as early as possible to minimise stiffness and optimise the eventual functional result. Weight-bearing status was guided principally by the axial stability of the fracture pattern: patients with good axial stability, as seen in non-comminuted diaphyseal fractures, were generally allowed immediate weight-bearing as tolerated, whereas those with highly comminuted fractures were kept non-weight-bearing with crutches or a walker for at least 6 weeks after discharge, and often until radiological union was evident on serial films.

Anteroposterior and lateral radiographs were obtained at each follow-up visit to assess progress of fracture healing, implant position, and the general status of the fracture site, allowing timely identification of delayed union, implant loosening, or malalignment

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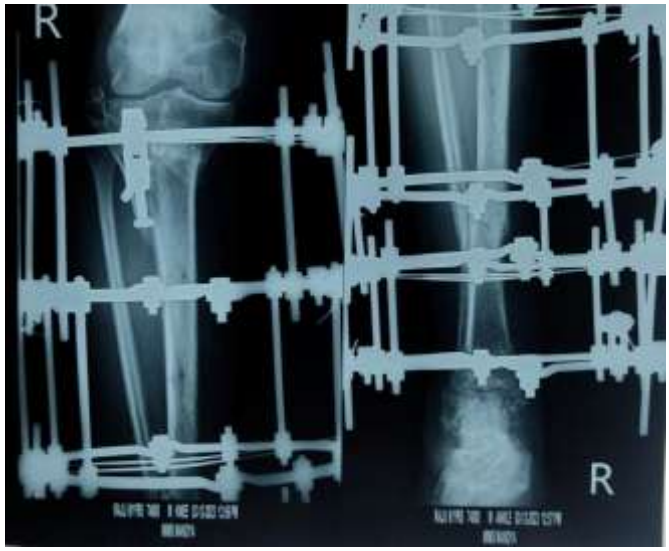

Figure 2. Serial follow-up radiographs (anteroposterior and lateral views) from the study series demonstrating skeletal stabilization with external fixation and progressive fracture healing over the follow-up period.

Results

Thirty-four patients were followed up in this series, comprising 24 male and 7 female patients (reported totals), consistent with the male preponderance typically described for high-energy open tibial fractures. Functional outcome, assessed serially using the LEFS, is summarised in Table 2.

LEFS Score Category	2 weeks	6 weeks	3 months	6 months
Poor (<40)	25	11	0	0
Fair (41–60)	16	18	0	0
Good (61–70)	6	12	10	6
Excellent (71–80)	3	8	13	10

Table 2. Distribution of patients by LEFS outcome category at each follow-up interval.

At the early 2-week assessment, the majority of patients scored in the poor (25 patients) and fair (16 patients) categories, reflecting the expected impact of the recent injury, surgery, and ongoing wound care on function. By 6 weeks, a shift toward better function was already apparent, with the poor category falling to 11 patients and the good and excellent categories rising to 12 and 8 patients respectively. By 3 months, no patients remained in the poor or fair categories, with the cohort divided between good (10) and excellent (13) outcomes. This favourable trend was sustained at 6 months, with 6 patients in the good category and 10 in the excellent category.

Complications

A range of complications were recorded over the course of treatment and follow-up:

- Sepsis — 4 patients
- Delayed union — 10 patients
- Limb deformity — 6 patients
- Malunion — 3 patients
- Need for further debridement — 2 patients
- Need for secondary closure — 3 patients

Delayed union was the most frequently observed complication, consistent with the biological impact of the initial soft-tissue injury and the higher-energy nature of open tibial fractures on the fracture healing environment. Complications such as sepsis, malunion, and limb deformity were less frequent but clinically significant, and were associated with correspondingly poorer functional scores at final follow-up.

Discussion

The findings of this study support the well-established principle that early, systematic management of open tibial fractures — encompassing prompt antibiotic administration, thorough debridement, appropriate skeletal stabilization, and timely soft-tissue coverage — favourably influences functional recovery. Patients treated within 48 hours of injury in this series achieved better functional outcomes than those with delayed definitive management, reinforcing the rationale for minimising the interval between injury and definitive surgical care wherever the patient's overall condition and available resources permit.

The progressive improvement in LEFS scores across the follow-up period — from predominantly poor and fair scores at 2 weeks to predominantly good and excellent scores by 3 and 6 months — mirrors the expected trajectory of soft-tissue healing, fracture consolidation, and rehabilitation following major lower-limb trauma. The clustering of good-to-excellent outcomes by the third postoperative visit suggests that the 3-month mark may represent a clinically meaningful milestone for functional reassessment in this patient group.

The complication profile observed — particularly the relatively high rate of delayed union — is consistent with the recognised biology of open tibial fractures, in which the same high-energy mechanism that produces the soft-tissue and bony injury also compromises the local vascularity required for uneventful healing. This underscores the importance of meticulous soft-tissue handling and staged, biologically respectful fixation strategies, alongside close radiological surveillance to detect delayed union or malalignment early enough to intervene.

Conclusion

- Lower extremity function became good to excellent from 3 months postoperatively onward (third follow-up visit).
- Patients treated within 48 hours of injury had better functional outcomes.
- Common postoperative complications included discharge from the surgical site, sepsis, delayed union, knee stiffness, malunion, and limb deformity.
- Patients who developed complications showed a significant decline in LEFS scores at final follow-up.
- Fracture healing times in this cohort ranged between 4 and 6 months.

Taken together, these findings reaffirm that a structured, time-sensitive protocol — early debridement, appropriate antibiotic cover, stable fixation, and timely soft-tissue coverage — remains central to achieving good functional outcomes after open tibial fractures, and that the interval from injury to definitive management is a meaningful, potentially modifiable determinant of that outcome.

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