

**Original Article**

## Our Experience of Fixation of Diaphyseal Tibia Fractures with Interlocking Intramedullary Nail at a Tertiary Care Center—A Prospective Study

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### ABSTRACT

**Background:** Diaphyseal fractures of the tibia are common injuries encountered in orthopaedic practice and are frequently associated with complications due to limited soft tissue cover and compromised blood supply. Interlocking intramedullary nailing has become the preferred method of fixation for these fractures, as it provides stable fixation and allows early mobilization.

**Objectives:** To evaluate the clinical, radiological, and functional outcomes of diaphyseal tibial fractures treated with interlocking intramedullary nailing at a tertiary care centre.

**Materials and Methods:** This was a prospective observational study conducted at Government Medical College, Kathua, from April 2022 to March 2024. A total of 25 adult patients with diaphyseal fractures of the tibia were included. Both closed fractures and open fractures up to Gustilo-Anderson Grade II were studied. Patients were treated with interlocking intramedullary tibial nailing and followed up clinically and radiologically. Outcomes assessed included time to union, union status, complications, and functional outcome. Statistical analysis was performed, and a p-value of <0.05 was considered significant.

**Results:** The mean age of patients was approximately 37 years, with a male predominance. Road traffic accidents were the most common mode of injury. Union was achieved in 19 patients (76%), while delayed union and non-union were observed in 4 (16%) and 2 (8%) patients, respectively. The mean time to union was 21.4 weeks. Open fractures showed a significantly longer time to union compared to closed fractures ( $p = 0.00005$ ) and had a higher complication rate ( $p = 0.00013$ ). Functional outcomes were excellent in 40%, good in 28%, fair in 16%, and poor in 16% of patients. A statistically significant association was observed between fracture union status and functional outcome ( $p = 0.001$ ).

**Conclusion:** Interlocking intramedullary nailing is an effective and reliable method for the management of diaphyseal tibial fractures. It provides satisfactory union rates and good functional outcomes, particularly in closed fractures. When performed in a tertiary care setting, interlocking intramedullary nailing offers favourable clinical outcomes.

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**Keywords:** Diaphyseal tibial fractures, Interlocking intramedullary nailing, Fracture union, Functional outcome, Complications.

### INTRODUCTION

Fractures of the tibial diaphysis are commonly encountered in orthopaedic practice. These fractures are often associated with significant soft tissue injury and have a higher risk of complications when compared to other long bone fractures. The limited soft tissue cover and relatively poor blood supply increase the risk of infection, delayed union, and non-union<sup>1</sup>. The goals of treatment include achieving fracture union, restoring limb alignment and length, and allowing early mobilization of the patient.

Several treatment methods have been described for tibial diaphyseal fractures. These include conservative treatment with plaster casting, functional bracing, external fixation, plate fixation, and intramedullary nailing. External fixation has been widely used, especially in open fractures and in polytrauma patients, where it may serve as a primary or definitive method of stabilization <sup>2,3</sup>. Thoresen et al. demonstrated good outcomes with interlocking intramedullary nailing in femoral shaft fractures, which led to its wider application in tibial fractures as well<sup>4</sup>.

At present, interlocking intramedullary nailing is considered the treatment of choice for most displaced tibial diaphyseal fractures. It is a minimally invasive procedure and preserves the fracture biology. Closed reduction helps maintain the fracture hematoma, which plays an important role in bone healing. Despite these advantages, complications are still reported. Coles and Gross highlighted issues such as delayed union, non-union, infection, and anterior knee pain following tibial shaft fracture management <sup>1</sup>. Foulke et al. reviewed fracture healing in older patients and noted that healing can be satisfactory with appropriate management <sup>5</sup>. Taormina et al. further reported that increasing age does not necessarily lead to poorer functional outcomes when fractures are managed properly <sup>6</sup>.

The present study was undertaken to evaluate the clinical, radiological, and functional outcomes of diaphyseal fractures of the tibia treated with interlocking intramedullary nailing at a tertiary care centre. The study aims to assess fracture union, functional recovery, and complications associated with this method of treatment.

## AIM

To clinically evaluate the outcomes of fixation of diaphyseal fractures of the tibia using interlocking intramedullary nailing in adult patients treated at a tertiary care center.

## OBJECTIVES

1. To assess the time to clinical and radiological union in diaphyseal tibial fractures managed with interlocking intramedullary nailing.
2. To evaluate the functional outcome of patients following interlocking intramedullary nailing of tibial shaft fractures.
3. To study the complications associated with interlocking intramedullary nailing, including infection, delayed union, and non-union.

## MATERIALS AND METHODS

### Study Design

This was a prospective observational study conducted to evaluate the clinical and functional outcomes of fixation of diaphyseal fractures of the tibia using interlocking intramedullary nailing.

### Study Period

The study was carried out over a period of two years, from April 2022 to March 2024.

### Study Place

The study was conducted at the Department of Orthopaedics, Government Medical College (GMC), Kathua, a tertiary care center.

### Study Population

A total of 25 adult patients with diaphyseal fractures of the tibia who met the inclusion criteria were included in the study.

### Inclusion Criteria

1. Adult patients aged 18 years and above
2. Patients with diaphyseal fractures of the tibia
3. Both closed fractures and open fractures (Gustilo-Anderson Grade I, II)
4. Patients willing to give informed written consent
5. Patients fit for surgical management.

### Exclusion Criteria

1. Patients aged below 18 years
2. Fractures involving proximal or distal metaphysis of the tibia
3. Pathological fractures
4. Gustilo-Anderson Grade III open fractures
5. Patients with associated neurovascular injury
6. Patients medically unfit for surgery.

## Preoperative Evaluation

A detailed history was taken regarding mode of injury, time since injury, and associated injuries. Clinical examination included assessment of soft tissue condition, neurovascular status, and associated injuries. Radiological evaluation was done using anteroposterior and lateral radiographs of the leg, including knee and ankle joints. Routine preoperative investigations were carried out as per hospital protocol.

## Surgical Technique

All patients were operated under spinal or general anesthesia. Fracture fixation was performed using an interlocking intramedullary tibial nail through a standard patellar tendon-splitting or parapatellar approach.

Closed reduction was attempted in all cases. Open reduction was performed when closed reduction was unsuccessful. Proximal and distal locking was done under image intensifier guidance. Wound closure was done in layers, and a sterile dressing was applied.

## Postoperative Management

- Analgesics and Intravenous antibiotics were administered.
- Limb elevation and pain management were advised
- Early knee and ankle mobilization exercises were started
- Partial weight bearing was initiated depending on fracture stability and progression of union
- Full weight bearing was allowed after evidence of radiological union

## Showing Preop and post op X rays



## Follow-Up Protocol

Patients were followed up at 6 weeks, 12 weeks, 18 weeks, and 24 weeks, and thereafter as required. At each follow-up, patients were assessed clinically and radiologically for:

- Pain and tenderness at fracture site
- Range of motion of knee and ankle
- Radiological signs of union
- Any complications

## Outcome Measures

- Time to clinical and radiological union
- Functional outcome, assessed using standard functional scoring criteria
- Complications, such as infection, delayed union, and non-union

## Operational Definitions

For the purpose of this study, the following operational definitions were used:

- Union:**  
Union was defined as the presence of clinical stability with the absence of pain or tenderness at the fracture site on weight bearing, along with radiological evidence of bridging callus across at least three cortices on anteroposterior and lateral radiographs.
- Delayed Union:**

Delayed union was defined as failure of the fracture to show clinical and radiological signs of union by 24 weeks postoperatively, but with continued progression towards union without the need for secondary surgical intervention.

- Non-Union:

Non-union was defined as the absence of clinical and radiological evidence of fracture union after 9 months following surgery, with no progression of healing over a minimum period of 3 consecutive months, and requiring further surgical intervention.

### Statistical Analysis

Data collected were entered into a Microsoft Excel sheet and analyzed using appropriate statistical methods. Descriptive statistics were used to summarize patient demographics, fracture characteristics, and outcomes.

### Ethical Considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee vide letter no. IEC/GMCK/127/Pharma dated 25/08/2021. Informed written consent was obtained from all patients prior to inclusion in the study.

## RESULTS

### 1. Demographic and Injury Profile

A total of 25 patients with diaphyseal fractures of the tibia were included in the study.

The age of patients ranged from 26 to 55 years, with a mean age of approximately 37 years. The majority of patients belonged to the young and middle-aged adult group, reflecting the active population commonly involved in high-energy trauma.

There was a male predominance in the study. Out of 25 patients, 16 were males and 9 were females.

With respect to the mode of injury, road traffic accidents were the most common cause, accounting for the majority of cases. This was followed by falls, while a smaller number of patients sustained injury due to assault or sports-related trauma.

Regarding the side of involvement, fractures of the right tibia were more common than the left.

Based on fracture type, closed fractures constituted the majority of cases, while open fractures formed a smaller proportion. Among the open fractures, Gustilo-Anderson Grade I and II injuries were more frequent, with a few Grade IIIA fractures included in the study.

**Table 1:** Demographic characteristics and injury profile of the patients.

Variable	Number of Patients	Percentage (%)
<b>Age (years)</b>		
20–30	6	24
31–40	9	36
41–50	7	28
>50	3	12
<b>Sex</b>		
Male	16	64
Female	9	36
<b>Mode of Injury</b>		
Road traffic accident	14	56
Fall	7	28
Assault	2	8
Sports injury	2	8
<b>Side Involved</b>		
Right	14	56
Left	11	44
<b>Type of Fracture</b>		
Closed	17	68
Open	8	32
Grade I	3	12
Grade II	3	12

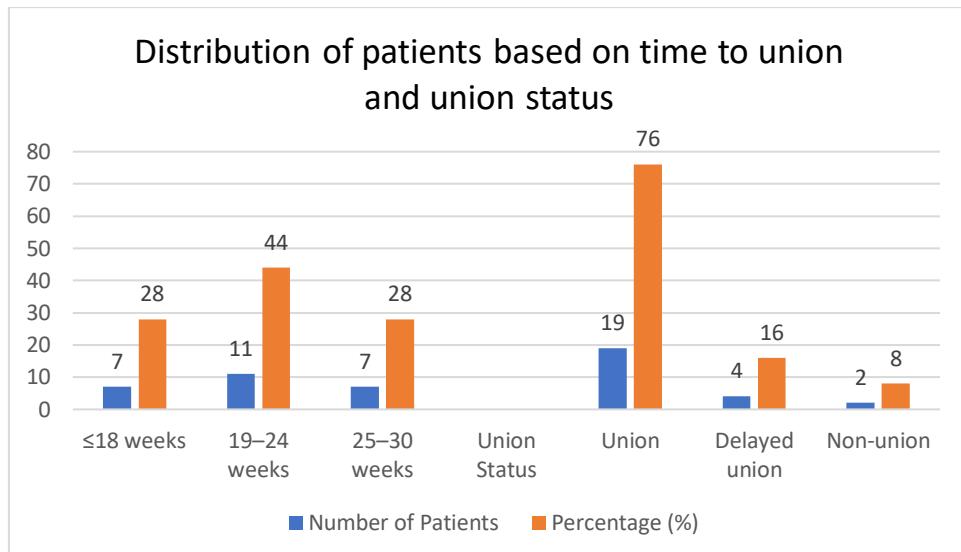
### 2. Fracture Union

All patients were followed up until fracture union or till a diagnosis of delayed union or non-union was made.

The time to radiological union ranged from 17 to 30 weeks, with a mean union time of approximately 21.4 weeks. The majority of fractures united between 18 and 24 weeks.

Based on the predefined operational criteria, union was achieved in most patients. A smaller number of patients showed delayed union, while non-union was observed in a few cases.

Closed fractures showed a shorter mean time to union when compared to open fractures. Open fractures, particularly higher-grade injuries, required a longer duration for fracture healing as shown in the figure1.



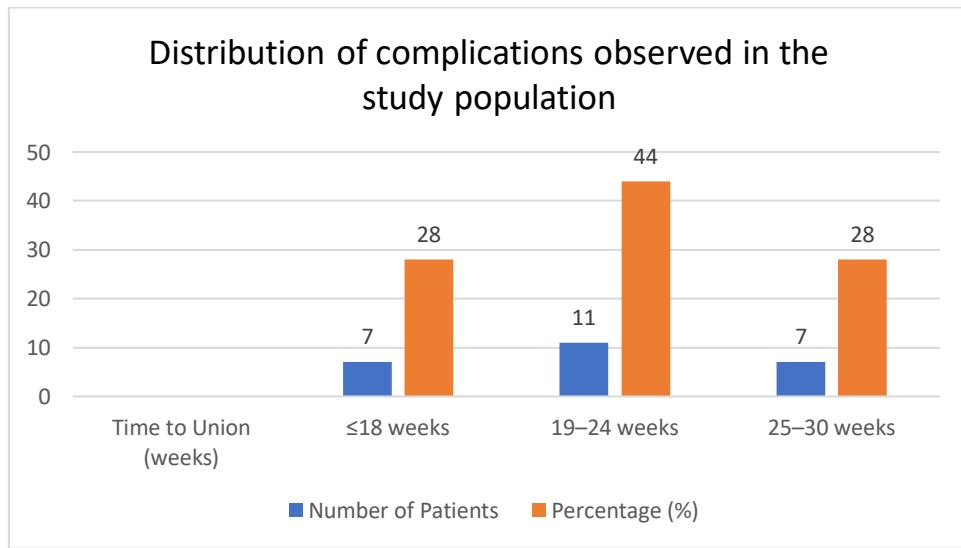
**Figure 1. Distribution of patients based on time to union and union status**

### 3. Complications

The most common complication noted was delayed union, followed by superficial infection. Non-union was observed in a small number of patients. No cases of implant failure or neurovascular complications were recorded in this study. Complications were more frequently observed in patients with open fractures when compared to closed fractures. The difference in complication rates between open and closed fractures was found to be statistically significant ( $p = 0.00013$ ).

**Table 2: Shows the distribution of complications observed in the study population.**

Complication	Number of Patients	Percentage (%)
None	18	72
Delayed union	4	16
Infection	3	12
Non-union	2	8



**Figure 2: Distribution of complications observed in the study population.**

#### 4. Functional Outcome

The majority of patients had a favourable functional outcome following interlocking intramedullary nailing of tibial diaphyseal fractures. Most patients were able to return to their daily activities with minimal or no functional limitation. Patients with uncomplicated fracture healing generally demonstrated better functional outcomes, whereas those with delayed union, non-union, or infection showed poorer functional recovery.

**Table 3:** Distribution of patients based on functional outcome.

Functional Outcome	Number of Patients	Percentage (%)
Excellent	10	40
Good	7	28
Fair	4	16
Poor	4	16

#### Correlation Between Fracture Union and Functional Outcome

To evaluate the association between fracture union and functional outcome, patients were grouped based on union status and final functional outcome. Functional outcome was categorized as Excellent/Good and Fair/Poor. Statistical analysis was performed using Fisher's Exact test.

**Table 4: Correlation Between Union Status and Functional Outcome (n = 25)**

Union Status	Excellent / Good	Fair / Poor	Total
Union	17	2	19
Delayed union / Non-union	0	6	6
<b>Total</b>	<b>17</b>	<b>8</b>	<b>25</b>

Statistical test: Fisher's Exact test (two-tailed)

p-value: 0.001

A statistically significant association was observed between fracture union status and functional outcome. Patients who achieved fracture union had predominantly excellent to good outcomes, whereas patients with delayed union or non-union had poorer functional outcomes (p = 0.001).

#### DISCUSSION

In the present study, the majority of patients were young to middle-aged adults, with a clear male predominance. Road traffic accidents were the most common mechanism of injury. This demographic pattern is consistent with the epidemiological observations reported by McBirnie, who analyzed 523 tibial fractures and demonstrated that high-energy trauma, particularly road traffic accidents, accounted for the majority of diaphyseal tibial injuries. He also noted that severe fracture patterns were relatively uncommon, a finding that aligns with the predominance of closed and low-grade open fractures observed in the present study.<sup>7</sup>

In the present study, fracture union was achieved in 76% of patients, with a mean time to union of approximately 21 weeks. Delayed union and non-union were observed in 16% and 8% of cases, respectively. These results are comparable with previously published literature. Panti et al. reported radiographic union rates of 68.8% in patients treated with solid SIGN nails and 80% in those treated with cannulated interlocking nails for femoral shaft fractures, with 100% clinical union in both groups. Although their study focused on femoral fractures, the union rates reported are comparable to those observed in the present study and support the effectiveness of interlocking intramedullary fixation in long bone fractures.<sup>8</sup>

A statistically significant difference in time to union was observed between open and closed fractures in the present study, with open fractures demonstrating a longer time to union and a higher incidence of delayed union and non-union. This finding is well supported by existing literature. McBirnie demonstrated an association between fracture morphology, degree of soft tissue injury, and outcome.<sup>7</sup> Similarly, Tay et al. reported that delayed union and non-union were significantly more common in open fractures and in patients with higher injury severity. In their study of 423 femoral and tibial shaft fractures, 138 fractures, representing approximately one-third of cases, progressed to delayed union or non-union.<sup>10</sup> These findings highlight that impaired fracture healing remains a clinically relevant problem despite advances in fixation techniques.<sup>18</sup>

In the present study, fracture union was assessed using a combination of clinical and radiological criteria. This approach is in agreement with the recommendations outlined by Morshed, who emphasized that no single modality is sufficient to determine fracture healing and that clinical assessment should be combined with radiographic evaluation.<sup>9</sup> The use of combined criteria in the present study therefore reflects practical and clinically relevant decision-making.

Complications were observed in 28% of patients in the present study, with delayed union and infection being the most common. Open fractures demonstrated a significantly higher complication rate compared to closed fractures. Tay et al. reported that patients with delayed union or non-union had persistently poorer health outcomes, with SF-12 physical component scores remaining below 50 at both six and twelve months.<sup>10</sup> They also demonstrated that delayed union and non-union were associated with prolonged pain and delayed return to work. These findings are consistent with the present study, where patients with delayed union or non-union were more likely to have inferior functional outcomes.

The relationship between fracture union and functional outcome was clearly demonstrated in the present study. A statistically significant association was observed between union status and functional outcome, with patients achieving timely union showing predominantly excellent to good outcomes. In contrast, patients with delayed union or non-union were more likely to have fair or poor functional outcomes. Similar observations have been reported in the literature, where delayed union and non-union are associated with persistent disability and reduced quality of life.<sup>10</sup>

Early mobilization plays an important role in functional recovery following fracture fixation. Patel et al. demonstrated that early initiation of range-of-motion exercises resulted in earlier return to full activity and reduced rates of stiffness. Patients who initiated rehabilitation within four weeks returned to full activity in a mean of 103 days, compared to 215 days in those with delayed mobilization.<sup>14</sup> Although their study involved pediatric tibial eminence fractures, the principle of early mobilization remains relevant. In the present study, early knee and ankle mobilization was encouraged, which may have contributed to the favorable functional outcomes observed in patients with uncomplicated fracture healing.

Non-union is a complex problem with a multifactorial etiology. Mills et al. demonstrated that 69% of non-union cases had more than one contributing factor, with mechanical instability, host factors, and infection frequently coexisting. They also reported unexpected infection in 5% of cases initially believed to be aseptic.<sup>12</sup> Although the number of non-unions in the present study was small, the poorer outcomes observed in these patients emphasize the importance of early identification and management of contributing factors.

Management of infected non-unions has shown encouraging results when treated in specialized centres. Bauer et al. reported successful outcomes in 89% of patients with infected femoral and tibial non-unions following standardized staged management, with a mean time to union of nine months.<sup>13</sup> These findings demonstrate that satisfactory outcomes can be achieved even in complex cases, although often with prolonged treatment duration and multiple surgical procedures.

Alternative fixation methods, such as the Ilizarov technique, have also been used successfully in complex tibial fractures. Tucker et al. reported good to excellent outcomes in the majority of patients treated with the Ilizarov method, though pin-tract infections and prolonged treatment duration were common.<sup>11</sup> These techniques remain valuable in selected cases but are associated with higher patient burden when compared to intramedullary nailing.

Finally, outcomes following fracture management are influenced by the quality of trauma care available. Noordin et al. demonstrated a reduction in mortality from 9.7% to 5.7% following the establishment of structured trauma care systems at a tertiary care hospital, despite similar injury severity scores.<sup>15,16,17</sup> Although mortality was not assessed in the present study, the acceptable union rates, manageable complication profile, and favorable functional outcomes observed reflect the benefits of treatment within a structured tertiary care trauma setup.

### Limitations of the Study

1. The sample size was small, which may limit the generalizability of the results.
2. This was a single-center study, and outcomes may vary in different clinical settings.
3. Patient-reported outcome measures were not included in the functional assessment.

### CONCLUSION

Interlocking intramedullary nailing is an effective and reliable method for the management of diaphyseal fractures of the tibia. In the present study, the majority of fractures achieved union within an acceptable time frame, with a high proportion of patients attaining good to excellent functional outcomes. Early mobilization and standardized postoperative care contributed to satisfactory functional recovery. Overall, interlocking intramedullary nailing provides stable fixation, allows early rehabilitation, and offers favourable clinical and functional outcomes.

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