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Case Series

Clinical, Radiological, and Functional Evaluation of Patients with Distal Third Tibia Fractures Treated with Tibial Interlocking Nails: A Case Series

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ABSTRACT

Background: The distal third tibia fracture, resulting from high-velocity trauma, is among the most prevalent long bone fractures. Its subcutaneous anteromedial surface and poor vascularity predispose it to delayed union and soft tissue complications. This study evaluates the clinical, radiological, and functional outcomes of extra-articular distal third tibia fractures managed with intramedullary tibial interlocking nailing (IMTILN).
Methods: A prospective observational case series of 21 adult patients (15 males, 6 females; mean age 41.52 ± 16.27 years; range 18–65 years) with extra-articular distal third tibia fractures treated with IMTILN at V.C.S.G, H.N.B. Base Hospital, Srinagar, between January 2024 and January 2025. Outcomes were assessed at serial follow-up intervals using the modified Johner–Wruhs criteria.
Results: Radiological and clinical union was achieved in all patients who completed follow-up, between 16 and 20 weeks. Of 20 patients available for final assessment, 14 (66.67%) achieved an Excellent outcome and 6 (28.57%) a Good outcome; 1 patient (4.76%) was lost to follow-up. No cases of non-union, deep infection, or neurovascular injury were recorded. Minor residual complications included ankle stiffness in 2 patients (9.52%), residual pain in 1 patient (4.76%), and varus/valgus deformity in 1 patient (4.76%).
Conclusion: IMTILN followed by patellar tendon bearing cast (PTB cast) for 6 weeks is a safe, effective, and minimally invasive treatment modality for extra-articular distal third tibia fractures with an excellent complication profile. The use of a minimum of two distal interlocking screws, selective adjuvant fibular fixation followed by functional brace, and meticulous soft tissue management are the principal determinants of favourable outcome.

Keywords: *Distal tibia fracture; Intramedullary interlocking nail; Tibial nailing; Johner–Wruhs criteria; Gustilo–Anderson classification; Fracture union.*

INTRODUCTION

Of all tibial fractures, distal tibia shaft fractures account for approximately 37.8%.[1] Rapid urbanisation, industrialisation, and increasing road traffic density have led to a rising incidence of high-energy injuries. The tibia is the primary weight-bearing long bone of the lower extremity; inadequately managed tibial fractures result in significant long-term morbidity, functional impairment, and socioeconomic burden, particularly among the working-age population.

Distal third tibia fractures present a distinct set of clinical challenges. The anteromedial surface of the distal tibia is subcutaneous and devoid of muscular coverage, resulting in a precarious local blood supply. This relative avascularity predisposes the distal segment to delayed union or non-union compared with more proximal tibial fractures.[1] The broad metaphyseal flare, compromised overlying soft tissues, fracture comminution, and — when a concomitant fibular fracture

occurs at the same level — attendant mechanical instability and potential syndesmotic disruption collectively render definitive management technically demanding.

The principal operative options for extra-articular distal third tibia fractures include: (i) intramedullary interlocking nailing (IMTILN), (ii) external fixator application, and (iii) minimally invasive percutaneous plate osteosynthesis (MIPPO) with locking plates. Advances in interlocking nail design have widened the indications for IMTILN, making it the preferred modality for most extra-articular distal tibial fractures.[1] External fixation is reserved for severely compromised open fractures; however, it carries a risk of restricted ankle mobility, malalignment, non-union, and pin-track infection.[2] MIPPO is suited for highly unstable fractures in close proximity to the ankle joint when soft tissue conditions are favourable; patients managed with this technique were not included in the present study.[3]

The objective of this study was to evaluate the clinical, radiological, and functional outcomes of IMTILN for extra-articular distal third tibia fractures followed by functional brace for 6 weeks, and to document union rates and complication profiles at a tertiary care centre.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective observational case series conducted at the Department of Orthopaedics, H.N.B. Base Hospital (the attached teaching hospital of VCSGGIMS&R), Srinagar, Pauri Garhwal, Uttarakhand, from January 2024 to January 2025.

Exclusion & Inclusion

Patients were included in the study if they had an extra-articular distal third tibial fracture confirmed on biplanar radiographs, were between 18 and 65 years of age, and had either a closed fracture or a Gustilo–Anderson Type I or Type II open fracture. Patients were excluded if they were younger than 18 years or older than 65 years, had fractures with intra-articular extension, pathological fractures, or Gustilo–Anderson Type IIIA, IIIB, or IIIC open fractures.

Pre-operative Assessment

Biplanar radiographs of the affected lower leg were obtained to characterise fracture morphology, degree of comminution, and concomitant fibular involvement. An above-knee posterior slab was applied as temporary immobilisation. Anti-oedema measures were instituted where required. Compound fractures were debrided under regional anaesthesia and managed with intravenous antibiotics pending definitive fixation. Routine pre-operative investigations done. Definitive surgery was deferred in patients with compromised skin condition until the appearance of the skin-wrinkle sign.

Operative Technique

Under spinal anaesthesia, the patient was positioned supine on a radiolucent table. Following sterile preparation and draping, With the knee flexed to 90°, the entry portal was established using a bone awl at a point 2 mm medial to the lateral tibial spine on the AP view and immediately anterior to the articular margin of the medial tibial plateau on the lateral view, confirmed under C-arm fluoroscopy.[4] Fracture of fibula fixed first by square nail or plate if it is at the same level to maintain length.

A guide wire was inserted and and its central position verified in AP and lateral view in distal fragment, followed by sequential reaming of the medullary canal in figure of 4 position. During reaming, distal fragment kept in correct rotation by giving slight traction on ankle and foot and counter traction at knee. The nail was advanced to the level of subchondral bone of ankle plafond.[5] Distal interlocking was performed using a minimum of two screws — mediolateral bolts routinely, with an anteroposterior bolt added where additional stability was required — based on intra-operative assessment.[6] All interlocking holes at the fracture level were filled to prevent implant fatigue.[7]

Post-operative Protocol

Limb elevation and active toe exercises commenced on post-operative day 0. Check radiographs were obtained on day 2. Intravenous antibiotics were administered for 10 days, followed by oral antibiotics. Sutures were removed on post-operative day 10, and the patient was discharged with a patellar-tendon-bearing (PTB) cast. Knee range-of-motion (ROM) exercises were initiated from post-operative day 3. The PTB cast was removed at 6 weeks and full weight-bearing commenced. Square nail is also removed at 6 weeks if callus is seen. Follow-up was conducted at 6 weeks, 3 months, 6 months, 12 months, 18 months, and 24 months. Radiological, functional and clinical outcome assessed at every follow up.

Outcome Assessment

Fracture union was defined on combined clinical criteria (absence of pain and tenderness at the fracture site on weight-bearing) and radiological criteria (bridging callus visible on at least three cortices on biplanar radiographs). Functional outcomes were assessed using the modified Johner–Wruhs criteria (Table 6), which evaluate non-union/infection, neurovascular injury, angular deformity, shortening, mobility of the knee and ankle, pain, and gait.[8]

Statistical Analysis

Data are expressed as frequency and percentage for categorical variables, and as mean ± standard deviation (SD) for continuous variables. The chi-square (χ^2) test was applied to assess significance of association between categorical variables. A p-value < 0.05 was considered statistically significant.

Figure 1. Preoperative anteroposterior (AP) and lateral radiographs demonstrating an extra-articular distal third tibial shaft fracture.

Operative Technique: Intramedullary Nailing

Figure 2. Intraoperative fluoroscopic image showing creation of the tibial nail entry point with the awl positioned approximately 2 mm medial to the lateral tibial spine.

Figure 3. Fluoroscopic image demonstrating appropriate positioning of the intramedullary tibial interlocking nail within the distal fragment following nail insertion.

Figure 4. Intraoperative fluoroscopic image showing distal interlocking screw fixation of the tibial nail using mediolateral locking screws to enhance distal fragment stability.

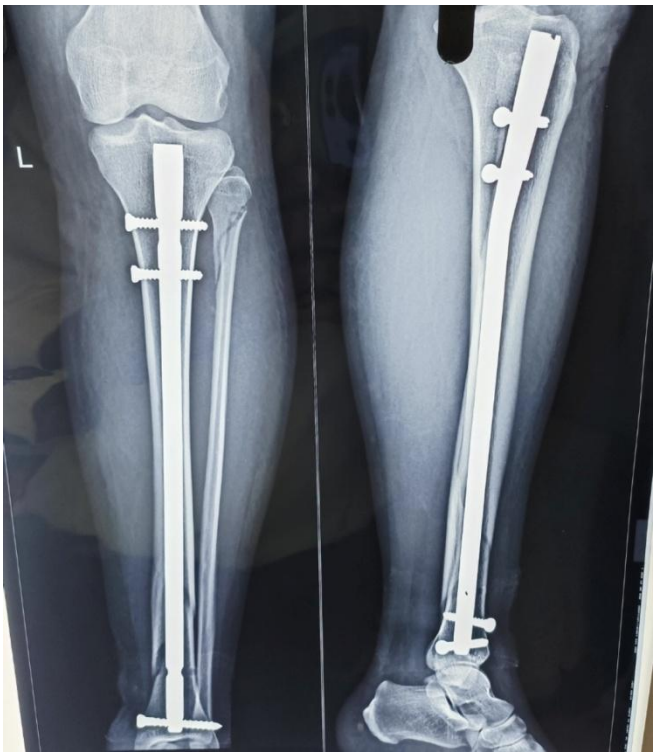

Figure 5. Postoperative day-2 AP and lateral radiographs showing satisfactory alignment of the distal tibial fracture fixed with an intramedullary interlocking nail, two proximal locking screws, and distal anteroposterior and mediolateral locking screws.

RESULTS

Twenty-one patients satisfying the inclusion criteria were enrolled over the study period. The demographic and clinical data are summarised in Tables 1–3.

Table 1: Age Distribution of the Study Population (n = 21)

Age Group (Years)	n	Percentage (%)
≤ 30 years	6	28.57
30–60 years	12	57.14
> 60 years	3	14.29
Mean ± SD (Range)	41.52 ± 16.27 years (18–65 years)	

Six patients (28.57%) were ≤30 years, 12 (57.14%) were in the 30–60 years group, and 3 (14.29%) were above 60 years. The highest proportion of cases fell within the 30–60 years age group, consistent with the peak working-age population at risk for road traffic injuries.

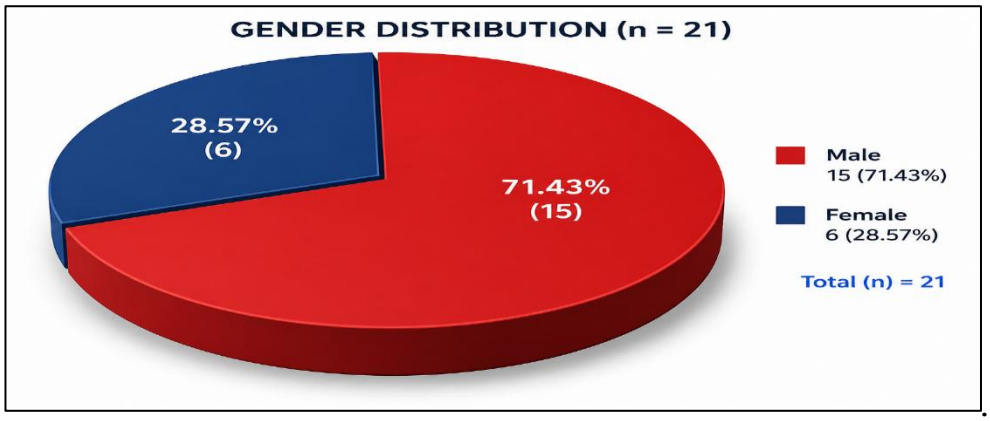

Figure 6:Gender Distribution

Male patients constituted the majority of the study population, accounting for **15 cases (71.43%)**, while females accounted for **6 cases (28.57%) (Figure 6)**.

Table 2: Duration of Presentation After Injury (n = 21)

Duration After Injury	n	Percentage (%)
< 24 hours	7	33.33
> 24 hours	14	66.67

The majority of patients (66.67%) presented after 24 hours, predominantly owing to delayed referral from peripheral health facilities.

Table 3. Fracture Characteristics of the Study Population (n = 21)

Variable	Category	n	Percentage (%)
Fracture Type	Closed	15	71.43
	Gustilo–Anderson Type I Open	3	14.29
	Gustilo–Anderson Type II Open	3	14.29
Fibular Fixation	Performed	9	42.86
	Not Performed	12	57.14
Follow-up Status	Completed	20	95.24
	Lost to Follow-up	1	4.76

Of the 21 patients included in the study, the majority of fractures were closed injuries (71.43%), while open fractures constituted 28.57% of cases, equally distributed between Gustilo–Anderson Type I and Type II categories. Fibular fixation was performed in 42.86% of patients with associated ipsilateral fibular fractures contributing to instability. Follow-up completion was excellent, with 95.24% of patients available for final outcome assessment.

Table 4: Functional Outcome by Modified Johner–Wruhs Criteria (n = 21)

Outcome Category	n	Percentage (%)
Excellent	14	66.67
Good	6	28.57
Lost to Follow-up	1	4.76

14 patients (66.67%) achieved an Excellent outcome and 6 patients (28.57%) achieved a Good outcome; 1 patient (4.76%) was lost to follow-up and excluded from functional outcome analysis.

Table 5: Complication Profile and Johner–Wruhs Sub-criterion Assessment (n = 21)

Parameter	Category	n	%
Non-union / Infection	Present	0	0.00
	Absent	21	100.00
Neurovascular Injury	Present	0	0.00
	Absent	21	100.00
Deformity	Varus / Valgus	1	4.76
	Antero-Posterior	0	0.00
	Shortening	1	4.76
Restricted Mobility	Knee	0	0.00
	Ankle	2	9.52
Residual Pain	—	1	4.76
Gait Disturbance	—	0	0.00

No cases of non-union, infection, neurovascular injury, antero-posterior deformity, knee stiffness, or gait disturbance were recorded. Minor residual findings included ankle stiffness (n=2; 9.52%), varus/valgus deformity (n=1; 4.76%), shortening (n=1; 4.76%), and residual pain (n=1; 4.76%), all within the Excellent or Good outcome categories.

Table 6: Modified Johner–Wruhs Criteria for Assessment of Outcome in Tibial Fractures

Parameter	Excellent	Good	Fair	Poor
Non-union / Infection	None	None	None	Present
Neurovascular Injury	None	None	Minimal	Relevant
Varus/Valgus Angulation	< 2°	< 5°	5–10°	> 10°
AP Angulation	< 2°	< 5°	5–10°	> 10°
Shortening	None	< 5 mm	5–10 mm	> 10 mm
Ankle Dorsiflexion	Normal	> 75%	50–75%	< 50%
Ankle Plantarflexion	Normal	> 75%	50–75%	< 50%
Knee ROM	Normal	Normal	> 90°	< 90°
Pain	None	Mild	Moderate	Severe
Gait	Normal	Normal	Antalgic	Severe

Source: Johner R, Wruhs O. Clin Orthop Relat Res. 1983;178:7–25.[8]

DISCUSSION

In the present study, the mean age of patients was 41.52 ± 16.27 years (range 18–65 years), with 57.14% belonging to the 30–60 years age group. Similar findings were reported by Goyal et al. (2021) [9] with a mean age of 39.05 years, Islam et al. (2022) [10] with 36.13 years, and Ali et al. (2021) [11] with 33 ± 11.5 years. The predominance of middle-aged adults likely reflects their greater exposure to high-energy trauma, particularly road traffic accidents, while the slightly higher mean age in the present study may be due to inclusion of patients above 60 years (14.29%). Overall, the age distribution is consistent with previous reports on distal tibial fractures.

Male patients constituted 71.43% (15/21) of the study population, while females accounted for 28.57% (6/21). Comparable findings were reported by Ringshawl et al. (2021) [12], who observed 73.3% males, Islam et al. (2022) [10], who reported 86.7% males, and Ali et al. (2021) [11], who found that 85% of patients were men. This male predominance is likely related to greater occupational exposure, outdoor activities, and involvement in road traffic accidents.

In the present study, 66.67% of patients presented more than 24 hours after injury, while 33.33% presented within 24 hours. Delayed presentation is common in developing countries because of referral pathways and limited access to trauma centres. Despite this, excellent fracture union and functional outcomes were achieved, suggesting that delayed presentation did not adversely affect final results. Similar high union rates were reported by Patel et al. (2024) [13] (95%) and Islam et al. (2025) [10] (97%) following intramedullary nailing.

The majority of fractures were closed injuries (71.43%), while 28.57% were open fractures equally distributed between Gustilo–Anderson Type I and Type II categories. These findings are comparable to Arora et al. (2023) [14] and Patel et al. (2024) [13], who also reported predominantly closed extra-articular fractures. Fibular fixation was performed in 42.86% of patients, consistent with Lokesh et al. (2024) [15], who reported improved alignment with supplementary fibular plating. However, Kumar et al. (2022) [16] found no significant difference in union or functional outcomes with fibular fixation. Follow-up was completed in 95.24% of patients, comparable to other contemporary studies.

The present study demonstrated excellent functional outcomes, with 66.67% of patients achieving Excellent and 28.57% achieving Good results according to the Modified Johner–Wruhs criteria. Similar findings were reported by Ringshawl et al. (2021) [12], who observed 66.7% excellent, 16.7% good, 13.3% fair, and 3.3% poor outcomes. Jacob Ipe et al. (2021) [17] reported 20% excellent, 55% good, and 24% fair outcomes, while Ali et al. (2021) [11] reported 60% excellent, 21.6% good, and 18.3% fair outcomes. Patel et al. (2024) [13] observed excellent outcomes in 82.5% and good outcomes in 12.5% of patients. These favourable results may be attributed to stable fixation and early mobilization.

The present study showed a low complication rate, with no cases of non-union, infection, neurovascular injury, knee stiffness, or gait abnormalities. Only one patient (4.76%) developed varus/valgus deformity, one (4.76%) had shortening, two (9.52%) experienced ankle stiffness, and one (4.76%) reported residual pain. In comparison, Islam et al. (2025) [18]

reported complications in approximately 30% of patients, while Ringshawl et al. (2021) [12] observed cases of superficial infection, delayed union, non-union, malunion, and anterior knee pain. Hadhoud et al. (2022) [19] reported primary malalignment and delayed union in 7.69% of patients each. The lower complication rate in the present study may reflect meticulous surgical technique and appropriate rehabilitation.

Overall, the findings of the present study are comparable with those reported in previous studies and demonstrate that intramedullary interlocking nailing is a safe and effective treatment modality for distal third tibial fractures, providing high rates of fracture union, excellent functional outcomes, and a low incidence of complications.

CONCLUSION

The findings of this prospective case series affirm that intramedullary tibial interlocking nailing is an excellent, minimally invasive treatment modality for extra-articular fractures of the distal third of the tibia, yielding a 100% union rate and an outstanding complication profile. Better results are due to proper central positioning of guide-wire, maintaining reduction during reaming and use of functional brace (PTB) to prevent varus/valgus and antero-posterior deformity. Early partial and full weight bearing with PTB reduces the complications and support healing than the other studies. No cases of non-union, infection, neurovascular injury, antero-posterior deformity, knee stiffness, or gait disturbance were encountered. As a load-sharing implant, IMTILN facilitates early weight-bearing rehabilitation and preserves the biology of fracture healing by protecting the periosteal blood supply and fracture haematoma — advantages not offered by plate fixation.[12] Reaming provides an autogenous internal graft that further promotes union.[14] The use of a minimum of two distal interlocking screws, selective adjuvant fibular fixation, meticulous attention to the soft tissue envelope, and careful patient selection are the principal determinants of outcome. Simple articular extension of the fracture is not a contraindication to intramedullary nailing, and functional outcomes improve progressively with follow-up.[15] These results are consistent with the best outcomes reported in the published literature and support IMTILN as the procedure of choice for extra-articular distal third tibia fractures in appropriately selected patients.

Declarations

Ethical Approval: Obtained from the Institutional Ethics Committee, VCSGGIMS&R, Srinagar (Ref. No.: IEC/Ortho/2024/____). Conducted in accordance with the Declaration of Helsinki.
Informed Consent: Written informed consent was obtained from all patients prior to enrolment.
Conflict of Interest: All authors declare no conflict of interest.
Source of Funding: No external funding was received. The study was conducted using institutional resources.
Author Contributions: Dr. Daya Krishna — Conceptualisation, supervision, surgical procedures, critical revision. Dr. Ashutosh Bhardwaj — Statistics analysis, evaluation of data and writing manuscript. Dr. Ravi Kumar Srivastav — Literature review, follow-up of patients, data collection, manuscript drafting, corresponding author. All authors approved the final manuscript.
Data Availability: Data supporting the results are available from the corresponding author (Dr. Ravi Kumar Srivastav; ravisrivastav841@gmail.com) on reasonable request.

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