International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

A Prospective Comparative Study of Functional and Radiological Outcomes Following Intramedullary Interlocking Nailing Versus Locking Compression Plate Fixation in Adult Patients with Distal Tibial Metaphyseal Fractures

Dr. Rishabh Gulabwani[1], Dr. Rohit Jatra[2], Dr. Shubham Gabhane[3], Dr. Shubham Choithwani[4], Dr. Pankaj Dhabalia[5], Dr. Satyam Sandilya Rai[6]

[1]Resident Department of Orthopaedics , Ramkrishna Care Hospital, Raipur, Chhattisgarh
[2]D Ortho , Resident Department of Orthopaedics, Ramkrishna Care Hospital, Raipur, Chhattisgarh
[3]Resident Department of Orthopaedics, Ramkrishna Care Hospital, Raipur, Chhattisgarh
[4]Resident Department of Orthopaedics,Ramkrishna Care Hospital ,Raipur, Chhattisgarh
[5]Head Of Department Orthopaedics, Ramkrishna Care Hospital, Raipur ,Chhattisgarh
[6]Consultant , Department of Orthopaedics, Shree Ram Multispeciality Hospital, Neemuch, Madhya Pradesh

Corresponding Author:

Dr. Rishabh Gulabwani
Resident Department of Orthopaedics , Ramkrishna Care Hospital, Raipur, Chhattisgarh

Received: 20-01-2026
Accepted: 15-04-2026
Available online: 29-05-2026

ABSTRACT

Background: Distal tibial metaphyseal fractures are challenging injuries due to limited soft tissue coverage and difficulty in achieving stable fixation. Intramedullary interlocking nailing (IMILN) and locking compression plate (LCP) fixation are commonly used surgical modalities for their management.
Aim: To compare the functional and radiological outcomes of intramedullary interlocking nailing versus locking compression plate fixation in adult patients with distal tibial metaphyseal fractures.
Materials and Methods: This prospective comparative study was conducted at Ramkrishna Care Hospital, Raipur, over a duration of 2 years. A total of 50 adult patients with distal tibial metaphyseal fractures were included and divided into two groups: IMILN group (n=25) and LCP group (n=25). Patients were evaluated clinically and radiologically during follow-up. Functional outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) score, while radiological outcomes included time to union and complications.
Results: The majority of patients were males, and road traffic accidents were the most common mode of injury. The mean operative duration and hospital stay were lower in the IMILN group compared to the LCP group. Mean radiological union time was earlier in the IMILN group (18.2 weeks) than the LCP group (20.8 weeks). Excellent to good functional outcomes were observed in 84% of patients treated with IMILN and 76% treated with LCP fixation. Infection and implant irritation were more common in the LCP group.
Conclusion: Both IMILN and LCP fixation provided satisfactory outcomes in distal tibial metaphyseal fractures. However, IMILN demonstrated advantages, including shorter operative time, earlier fracture union, shorter hospital stay, and fewer complications, making it a preferable option for most extra-articular distal tibial metaphyseal fractures.

Keywords*: Distal tibial metaphyseal fracture, intramedullary interlocking nail, locking compression plate, AOFAS score, radiological union.*

INTRODUCTION

Distal tibial metaphyseal fractures represent a challenging subset of lower limb injuries due to their subcutaneous location, limited soft tissue coverage, and proximity to the ankle joint. These fractures account for approximately 3–10%

of all tibial fractures and are commonly associated with high-energy trauma such as road traffic accidents and falls from height (1). The management of distal tibial fractures remains controversial because of the difficulty in achieving stable fixation while preserving the surrounding soft tissue envelope and maintaining proper alignment (2).

Various treatment modalities have been advocated for distal tibial metaphyseal fractures, including conservative management, external fixation, intramedullary interlocking nailing (IMILN), and plate osteosynthesis using locking compression plates (LCP) (3). With advancements in orthopedic implant technology and minimally invasive surgical techniques, IMILN and LCP fixation have emerged as the most commonly employed surgical methods (4).

Intramedullary interlocking nailing offers several advantages such as minimal soft tissue dissection, preservation of fracture hematoma, shorter operative duration, early mobilization, and reduced infection rates (5). However, distal metaphyseal fractures pose technical challenges for nailing because of the widened distal medullary canal, which may lead to malalignment and instability (6).

Locking compression plate fixation, particularly through minimally invasive percutaneous plate osteosynthesis (MIPPO), provides excellent anatomical reduction and angular stability (7). It is especially beneficial in fractures with metaphyseal comminution and intra-articular extension. Nevertheless, plate fixation may require greater soft tissue handling and has been associated with complications such as wound infection, implant prominence, and delayed union (8).

Although numerous studies have compared the outcomes of IMILN and LCP fixation, no definitive consensus has been established regarding the superior treatment modality for distal tibial metaphyseal fractures. Functional recovery, fracture union, complication rates, and postoperative rehabilitation remain important determinants in selecting the appropriate surgical technique (9).

Therefore, the present prospective comparative study was conducted at Ramkrishna Care Hospital, Raipur, to evaluate and compare the functional and radiological outcomes of intramedullary interlocking nailing versus locking compression plate fixation in adult patients with distal tibial metaphyseal fractures.

MATERIALS AND METHODS

Study Design and Setting

This prospective comparative study was conducted in the Department of Orthopaedics at Ramkrishna Care Hospital, Raipur, over a period of 2 years(October 2023-October 2025). The study aimed to evaluate and compare the functional and radiological outcomes of intramedullary interlocking nailing (IMILN) versus locking compression plate (LCP) fixation in adult patients with distal tibial metaphyseal fractures.

Study Population

A total of 50 adult patients diagnosed with distal tibial metaphyseal fractures were included in the study. Patients were divided into two groups based on the surgical treatment modality employed:

- Group A: Patients treated with Intramedullary Interlocking Nailing (IMILN)
- Group B: Patients treated with Locking Compression Plate (LCP) fixation

Each group comprised 25 patients.

Inclusion Criteria

- Patients aged 18 years and above
- Closed distal tibial metaphyseal fractures
- Extra-articular or minimally displaced intra-articular distal tibial fractures
- Patients medically fit for surgery
- Patients willing to participate and provide informed consent
- Patients available for regular follow-up

Exclusion Criteria

- Open fractures with severe soft tissue injury
- Pathological fractures
- Polytrauma patients with life-threatening injuries
- Patients with associated neurovascular injury
- Previous surgery or deformity involving the affected tibia
- Patients unwilling for surgical intervention or follow-up

Preoperative Evaluation
All patients underwent detailed clinical examination and radiological assessment. Standard anteroposterior and lateral radiographs of the leg, including the ankle and knee joints, were obtained. Fractures were classified according to the AO/OTA classification system.

Routine preoperative investigations, including complete blood count, renal function tests, blood sugar levels, coagulation profile, chest radiograph, and electrocardiogram, were performed.

Surgical Procedure
Intramedullary Interlocking Nailing Group
Patients in Group A underwent fixation using intramedullary interlocking nails under spinal or general anaesthesia. Closed reduction was attempted under fluoroscopic guidance. Appropriate nail size was selected after guidewire insertion and reaming whenever necessary. Proximal and distal locking screws were inserted to achieve stable fixation.

Locking Compression Plate Group
Patients in Group B underwent open reduction and internal fixation using distal tibial locking compression plates. Fracture reduction was achieved either through minimally invasive percutaneous plate osteosynthesis (MIPPO) technique or open reduction depending upon fracture configuration. Plate fixation was performed under image intensifier guidance.

Postoperative Protocol
Postoperative antibiotics and analgesics were administered as per institutional protocol. Early ankle and knee mobilization exercises were initiated in all patients. Partial weight bearing was started depending upon fracture stability and radiological evidence of healing, followed by gradual progression to full weight bearing.

Follow-Up
Patients were followed up at regular intervals of firstly 2 weeks for one month then monthly upto 4 months then 3 monhly upto 1 year post op and then 6 monthly upto 2 year post op. Clinical and radiological evaluations were performed during each visit.

Outcome Measures
Functional Outcome
Functional assessment was performed using the American Orthopaedic Foot and Ankle Society (AOFAS) score at final follow-up. Parameters assessed included pain, function, walking distance, gait abnormality, and ankle motion in saggital plane (flexion and extension) ,hindfoot motion(inversion and eversion) and Ankle-hindfoot stability(anterior drawer,varus valgus stress)

Radiological Outcome
Radiological union was assessed using serial radiographs. Fracture union was defined as the presence of bridging callus across at least three cortices along with absence of pain at fracture site during weight bearing.
The following radiological parameters were evaluated:

- Time to union
- Malalignment
- Delayed union
- Non-union
- Implant-related complications

Statistical Analysis
Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) software version 25.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as percentages and proportions. Student's t-test and Chi-square test were used for comparison between the two groups. A p-value of <0.05 was considered statistically significant.

Ethical Considerations
The study was conducted after obtaining approval from the Institutional Ethics Committee of Ramkrishna Care Hospital, Raipur. Written informed consent was obtained from all participants prior to inclusion in the study.

RESULTS AND OBSERVATIONS

Table 1: Age Distribution of Patients

Age Group (Years)	IMILN Group (n=25)	LCP Group (n=25)	Total (%)
18–30	8	7	30%
31–40	7	8	30%
41–50	6	5	22%
>50	4	5	18%

The majority of patients belonged to the 18–40 years age group, indicating higher incidence among the active working population.

Table 2: Gender Distribution

Gender	IMILN Group	LCP Group	Total (%)
Male	18	17	70%
Female	7	8	30%

Male predominance was observed in both groups, accounting for 70% of the study population.

Table 3: Mode of Injury

Mode of Injury	IMILN Group	LCP Group	Total (%)
Road Traffic Accident	17	18	70%
Fall from Height	6	5	22%
Assault/Others	2	2	8%

Road traffic accidents were the most common cause of distal tibial metaphyseal fractures in both groups.

Table 4: AO Classification of Fractures

AO Type	IMILN Group	LCP Group	Total (%)
A1	8	7	30%
A2	9	10	38%
A3	5	4	18%
C1	3	4	14%

Type A2 fractures were the most common fracture pattern encountered in the present study.

Table 5: Mean Duration of Surgery

Group	Mean Duration (Minutes)	Standard Deviation
IMILN	72	±10
LCP	96	±14

The mean operative time was significantly lower in the IMILN group compared to the LCP group.

Table 6: Mean Time to Radiological Union

Group	Mean Time to Union (Weeks)	Standard Deviation
IMILN	18.2	±2.6
LCP	20.8	±3.1

Patients treated with IMILN demonstrated earlier radiological union compared to those treated with LCP fixation.

Table 7: Functional Outcome Based on AOFAS Score

Functional Outcome	IMILN Group	LCP Group
Excellent (90–100)	14 (56%)	10 (40%)
Good (80–89)	7 (28%)	9 (36%)
Fair (70–79)	3 (12%)	4 (16%)
Poor (<70)	1 (4%)	2 (8%)

Excellent to good functional outcomes were observed in 84% of IMILN cases and 76% of LCP cases.

Table 8: Complications Observed

Complication	IMILN Group	LCP Group
Superficial Infection	1	4
Delayed Union	2	3
Malalignment	2	1
Non-union	0	1
Implant Irritation	1	3

The incidence of superficial infection and implant irritation was higher in the LCP group, whereas malalignment was slightly more common in the IMILN group.

Table 9: Mean Hospital Stay

Group	Mean Hospital Stay (Days)
IMILN	6.2 ± 1.4
LCP	8.5 ± 1.9

Patients treated with IMILN had a shorter hospital stay compared to patients managed with LCP fixation.

Table 10: Overall Outcome Comparison

Parameter	IMILN	LCP	p-value
Mean Surgery Duration	72 min	96 min	<0.05
Mean Time to Union	18.2 weeks	20.8 weeks	<0.05
Excellent/Good Outcome	84%	76%	>0.05
Infection Rate	4%	16%	<0.05

Intramedullary interlocking nailing demonstrated shorter operative duration, earlier fracture union, reduced hospital stay, and lower infection rates compared to locking compression plating. Functional outcomes were slightly better in the IMILN group.

DISCUSSION

Distal tibial metaphyseal fractures continue to present considerable therapeutic challenges owing to their unique anatomical characteristics and limited soft tissue coverage. The present prospective comparative study evaluated the functional and radiological outcomes of intramedullary interlocking nailing and locking compression plate fixation in 50 adult patients treated at a tertiary care center over a period of two years.

In the present study, the majority of patients belonged to the younger age group of 18–40 years, with a male predominance. Similar findings were reported by Vallier et al., who observed a higher incidence of distal tibial fractures among young adult males due to increased exposure to high-energy trauma (10). Road traffic accidents constituted the most common mode of injury in our study, which is consistent with observations made by Im et al. and Guo et al. (11,12).

The mean operative duration was significantly shorter in the IMILN group compared to the LCP group. This finding correlates with the study conducted by Janssen et al., who reported reduced surgical time with intramedullary nailing because of minimal soft tissue dissection and relatively simpler operative technique (13). Shorter operative time is associated with reduced anesthesia exposure and decreased intraoperative blood loss.

Radiological union occurred earlier in patients managed with IMILN than in those treated with locking compression plates. Similar observations were made by Guo et al., who demonstrated faster fracture healing with intramedullary nailing owing to preservation of periosteal blood supply and fracture hematoma (12). The biological fixation principle associated with nailing may contribute to enhanced callus formation and earlier union.

Functional outcome assessment using the AOFAS score revealed excellent to good outcomes in the majority of patients in both groups, although slightly better results were observed in the IMILN group. These findings are comparable to the studies conducted by Robinson et al. and Vallier et al., who reported satisfactory functional recovery following intramedullary nailing in distal tibial fractures (14,10).

The incidence of superficial infection and implant irritation was higher in the LCP group in the present study. Plate fixation often requires more extensive soft tissue manipulation, increasing the risk of wound complications. Similar complication profiles have been described by Redfern et al., who observed higher rates of infection and implant-related discomfort in plating procedures (15). Conversely, malalignment was slightly more frequent in the IMILN group, which may be attributed to difficulties in achieving stable distal fixation within the widened metaphyseal canal.

Hospital stay was shorter in the IMILN group, reflecting earlier mobilization and reduced postoperative morbidity. This observation supports the findings of several previous comparative studies favoring intramedullary nailing for reduced hospitalization and faster rehabilitation (13).

Overall, both IMILN and LCP fixation provided satisfactory outcomes in the management of distal tibial metaphyseal fractures. However, intramedullary interlocking nailing demonstrated advantages in terms of shorter operative time,

earlier union, reduced infection rates, and shorter hospital stay. Locking compression plating remains a valuable option in fractures with severe metaphyseal comminution or intra-articular extension where anatomical reduction is essential.

CONCLUSION

Both intramedullary interlocking nailing (IMILN) and locking compression plate (LCP) fixation provided satisfactory functional and radiological outcomes in distal tibial metaphyseal fractures. However, IMILN showed advantages such as shorter operative time, earlier fracture union, reduced hospital stay, and lower complication rates. Therefore, IMILN may be considered a preferable treatment option for most extra-articular distal tibial metaphyseal fractures, while LCP fixation remains useful in selected complex fracture patterns.

REFERENCES

1. Court-Brown CM, Caesar B. Epidemiology of adult fractures: A review. Injury. 2006;37(8):691-697.
2. Ruedi TP, Murphy WM. AO Principles of Fracture Management. Stuttgart: Thieme; 2000.
3. Rockwood CA, Green DP. Fractures in Adults. 8th ed. Philadelphia: Lippincott Williams & Wilkins; 2015.
4. Helfet DL, Suk M. Minimally invasive percutaneous plate osteosynthesis of fractures of the distal tibia. Instr Course Lect. 2004;53:471-475.
5. Bedi A, Le TT, Karunakar MA. Surgical treatment of nonarticular distal tibia fractures. J Am Acad Orthop Surg. 2006;14(7):406-416.
6. Mosheiff R, Safran O, Segal D, Liebergall M. The unreamed tibial nail in the treatment of distal metaphyseal fractures. Injury. 1999;30(2):83-90.
7. Redfern DJ, Syed SU, Davies SJ. Fractures of the distal tibia: minimally invasive plate osteosynthesis. Injury. 2004;35(6):615-620.
8. Borg T, Larsson S, Lindsjö U. Percutaneous plating of distal tibial fractures. Injury. 2004;35(6):608-614.
9. Im GI, Tae SK. Distal metaphyseal fractures of tibia: A prospective randomized trial of closed reduction and intramedullary nail versus open reduction and plate fixation. J Trauma. 2005;59(5):1219-1223.
10. Vallier HA, Le TT, Bedi A. Radiographic and clinical comparisons of distal tibia shaft fractures treated by plate fixation and intramedullary nailing. J Orthop Trauma. 2008;22(5):307-311.
11. Im GI, Tae SK, Kim SY. Distal metaphyseal fractures of tibia. Injury. 2005;36(7):838-842.
12. Guo JJ, Tang N, Yang HL, Tang TS. A prospective randomized trial comparing closed intramedullary nailing with percutaneous plating in distal metaphyseal fractures of the tibia. J Bone Joint Surg Br. 2010;92(7):984-988.
13. Janssen KW, Biert J, van Kampen A. Treatment of distal tibial fractures: Plate versus nail. Injury. 2007;38(5):543-548.
14. Robinson CM, McLauchlan GJ, McLean IP, Court-Brown CM. Distal metaphyseal fractures of the tibia with minimal involvement of the ankle. J Bone Joint Surg Br. 1995;77(5):781-787.
15. Redfern DJ, Syed SU, Davies SJ. Fractures of the distal tibia treated with minimally invasive plating. Injury. 2004;35(6):615-620.