Original Research Paper

Volume - 15 | Issue - 06 | June - 2025 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Orthopaedics

FUNCTIONAL OUTCOME OF DISTAL TIBIA FRACTURE FIXED WITH LOCKING COMPRESSION PLATES USING MIPPO TECHNIQUE: A PROSPECTIVE STUDY

Dr Gagandeep Gupta	Professor, Department of Orthopaedics, MMIMSR, Mullana, Ambala.
Dr Abhijeet Sandhu*	3rd year Junior Resident, Department of Orthopaedics, MMIMSR, Mullana, Ambala. *Corresponding Author
Dr Navneet Singh	Associate Professor, Department of Orthopaedics, MMIMSR, Mullana, Ambala.
Dr Shivang Kala	Senior Resident, Department of Orthopaedics, MMIMSR, Mullana, Ambala.
Dr Samay Das	3rd year Junior Resident, Department of Orthopaedics, MMIMSR, Mullana, Ambala.
Dr Ishan Mittal	3rd year Junior Resident, Department of Orthopaedics, MMIMSR, Mullana, Ambala.
Dr Nikhil Relwani	3rd year Junior Resident, Department of Orthopaedics, MMIMSR, Mullana, Ambala.
Dr Abhishek Singh	3rd year Junior Resident, Department of Orthopaedics, MMIMSR, Mullana, Ambala.
Dr Akhilesh Saini	3rd year Junior Resident, Department of Orthopaedics, MMIMSR, Mullana, Ambala.
Dr Vivek Garg	1st year Junior Resident, Department of Orthopaedics, MMIMSR, Mullana, Ambala.

ABSTRACT **Background:** Distal tibial fractures, particularly those involving the metaphyseal region, pose significant treatment challenges due to limited soft tissue coverage, poor vascularity, and proximity to the ankle joint. Traditional open reduction and internal fixation (ORIF) often require extensive dissection, increasing the risk of complications such as infection and delayed healing. In response, Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) using Locking Compression Plates (LCP) has emerged as a promising alternative that aims to preserve the periosteal blood supply and reduce soft tissue trauma while providing stable fixation. **Aim:** To evaluate the functional and radiological outcomes of distal tibial fractures managed with locking compression plates using the MIPPO technique, and to assess the influence of fibular fixation on angular deformity, time to union, and ankle function over a 12-month follow-up period. **Materials and methods:** A prospective observational study was conducted at MM Institute of Medical Sciences and Research, Mullana, Ambala, involving 20 skeletally mature patients (age 18–65 years) with AO/OTA Type 43-A and 43-B distal tibial fractures. Inclusion criteria consisted of closed or Grade I open fractures, with exclusion of polytrauma cases and intra-articular fractures (43-C). All patients underwent fixation with a medial distal tibial LCP via a minimally invasive approach. Ten patients also underwent fibular fixation based on intraoperative assessment. Patients were followed clinically and radiologically at 3, 9, and 12 months. Functional outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score. **Results:** Radiological union was achieved in all patients with a mean time to union of 16.85 weeks (range: 14–22 weeks). Angular deformity of less than 5° was observed in 90% of cases, while only 10% had deformities exceeding 5°, which were clinically insignificant. The mean AOFAS score at final follow-up was 87.9, with 50% of patients achieving excellent outcomes (score ≥90), 40% good (80–89), and 10% fair (70–79). Ankle mobility was well-preserved with an average dorsiflexion of 19.3° and plantarflexion of 35.2°. Full weight-bearing was achieved at a mean of 11.9 weeks. Complications were minimal, with two cases of delayed union and one case of superficial infection; no cases of non-union, implant failure, or deep infection were reported. No significant difference in functional outcome was observed between patients who underwent fibular fixation and those who did not. **Conclusion:** MIPPO using locking compression plates is a safe, effective, and biologically favorable technique for managing distal tibial fractures, particularly in scenarios requiring minimal soft tissue disruption. The method demonstrates high union rates, satisfactory alignment, preserved ankle mobility, and low complication rates. While fibular fixation may be beneficial in select cases, it does not appear to significantly influence final outcomes. Further large-scale studies are warranted to establish definitive guidelines regarding the role of fibular fixation and long-term functional results.

KEYWORDS : Distal tibial fracture, Minimally Invasive Percutaneous Plate Osteosynthesis, Locking Compression Plate, MIPPO, Functional outcome, Fibular fixation, AOFAS score, Radiological union

INTRODUCTION

Distal tibial fractures, particularly those involving the metaphyseal region, present significant challenges due to the limited soft tissue envelope, suboptimal vascularity, and the proximity to the ankle joint. These fractures often result from high-energy trauma such as road traffic accidents or falls from height, leading to complex injury patterns that necessitate meticulous management to restore limb function and alignment[1,2].

Traditional open reduction and internal fixation (ORIF) methods, while effective in achieving anatomical reduction, are associated with substantial soft tissue dissection, increasing the risk of wound complications, infection, and delayed healing. In response to these challenges, Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) has emerged as a favorable alternative. This technique emphasizes indirect fracture reduction and percutaneous plate insertion, thereby preserving the periosteal blood supply and minimizing soft tissue disruption[3,4].

Locking Compression Plates (LCPs) have further enhanced the efficacy of MIPPO by providing angular stability, especially beneficial in osteoporotic bone or comminuted fractures. The combination of MIPPO and LCP aims to achieve stable fixation while respecting the biological environment of the fracture site, facilitating early mobilization and reducing the incidence of complications[5,6].

Despite the advantages, the role of fibular fixation in distal tibia fractures remains a topic of debate. Some studies suggest that fibular fixation aids in maintaining limb alignment and preventing rotational deformities, while others argue that it may not significantly impact the overall outcome. Understanding the interplay between fibular fixation and tibial fracture healing is crucial for optimizing surgical strategies[7,8].

This study aims to evaluate the functional and radiological outcomes of distal tibial fractures treated with LCP using the MIPPO technique, with a particular focus on the relationship between fibular fixation and angular deformities, time to union, and ankle function over a 12-month follow-up period.

AIM

To evaluate the functional and radiological outcomes of distal tibia fractures treated with locking compression plates using the minimally invasive percutaneous plate osteosynthesis (MIPPO) technique over a 12-month follow-up period.

MATERIALS AND METHODS

Study Design

A prospective observational study was conducted over a period of 12 months at MM Institute of Medical Sciences and Research, Mullana, Ambala. 20 skeletally mature patients presenting with distal tibial fractures (AO/OTA 43-A and 43-B) were included.

Inclusion Criteria

- Age 18–65 years
- Closed or Gustilo-Anderson Grade I open distal tibial fractures
- Displaced extra-articular or partially articular fractures
- Able to follow post-op rehabilitation protocol

Exclusion Criteria

- Pathological fractures
- Gustilo-Anderson Grade II/III open fractures
- Intra-articular fractures (43-C)
- Polytrauma patients

Evaluation Parameters

- Mode of injury
- Fracture pattern
- Time from injury to surgery
- Time to union
- Angular deformities at union
- Fibular fixation correlation
- Ankle range of motion
- Time to full weight bearing
- Functional outcome (AOFAS score)
- Complications

OPERATIVE AND SURGICAL TECHNIQUE

Pre-operative Planning-

All patients underwent standard radiographs and CT scans (if intra-articular extension was suspected). Pre-operative templating was done.

Surgical Procedure And Post-operative Protocol

All procedures were performed under spinal or epidural anesthesia with a pneumatic tourniquet applied. Indirect fracture reduction was achieved using manual traction and reduction clamps. A pre-contoured distal tibia locking compression plate was inserted through a small (approximately 5 cm) incision over the medial malleolus and advanced proximally in the submuscular plane[figure 1 and 2].. Locking screws were placed through stab incisions under fluoroscopic guidance [figure 3].In selected cases (n=10), associated fibular fractures were fixed using a one-third tubular plate prior to tibial fixation. Post-operatively, intravenous antibiotics were administered for 48 hours, followed by oral antibiotics for five days. Static quadriceps and toe mobilization exercises were initiated on post-operative day one. Non-weight-bearing ambulation with crutches began after 48 hours. Sutures were removed at 14 days. Ankle range of motion exercises commenced from the second post-operative week. Partial weight bearing was allowed at 6–8 weeks based on radiological evidence of healing, and full weight bearing was permitted following confirmed radiological union. Patients were followed up at 3, 9, and 12 months. At each visit, clinical and radiographic assessments were conducted, range of motion and complications were recorded, and functional outcomes were evaluated at the final follow-up using the American Orthopaedic Foot and Ankle Society (AOFAS) score.

RESULTS

This prospective study was conducted to evaluate the functional and radiological outcomes of distal tibial fractures managed using locking compression plates with the minimally invasive percutaneous plate osteosynthesis (MIPPO) technique. A total of 20 patients were included based on the inclusion and exclusion criteria. Each patient was followed for a period of 12 months postoperatively to assess various clinical, radiological, and functional parameters.

Demographic Profile

Among the 20 patients, there was a marked male predominance, with 16 male patients (80%) and 4 female patients (20%). The age of the patients ranged from 24 to 60 years, with a mean age of 38.2 years. The highest number of patients (6 out of 20) were in the age group of 30–40 years. This reflects the common involvement of the working-age male population in high-velocity injuries such as road traffic accidents, which was consistent with our findings.

Mechanism of Injury

The most common mechanism of injury in this study was high-energy trauma, primarily due to axial loading forces sustained in motor vehicle accidents, observed in 14 patients (70%). Falls from a height, resulting in vertical compression injuries, accounted for 4 cases (20%). Low-energy torsional mechanisms, typically occurring in domestic settings, were responsible for 2 cases (10%). The high incidence of road traffic accidents highlights the role of high-energy trauma as a significant etiological factor in distal tibial fractures, particularly among younger male patients. In contrast, low-energy mechanisms such as simple falls and domestic accidents were more frequently associated with elderly individuals and female patients

Fractures were classified using the **AO/OTA system** for distal tibial fractures (**Type 43**), **excluding 43-C (complete articular) fractures**. The distribution was as follows:

AO/OTA Code	Type	Description	No. of Patients (%)
43-A2	Extra-articular	Simple oblique fractures	6 (30%)
43-A3	Extra-articular	Transverse or wedge fractures	2 (10%)
43-B2	Partial articular	Oblique partial articular	3 (15%)
Unclassified A/B	Extra/Partial articular	Comminuted (extra/partial articular)*	9 (45%)

***Comminuted fractures were included only if they were extra-articular or partial articular based on radiographic evaluation, excluding complete articular involvement (43-C).**

The average duration between injury and surgery was 4.5 days, with a range from 2 to 8 days. Early surgical intervention was prioritized to reduce soft tissue complications and facilitate earlier rehabilitation. All patients underwent fixation using a medial distal tibial locking compression plate introduced through a minimally invasive approach, ensuring soft tissue preservation and biological fracture healing.

Union and Radiological Outcome

Radiological union was achieved in all patients. The time to union ranged from 14 to 22 weeks, with an average of 16.85 weeks. Most fractures united uneventfully within 14–18 weeks. Two patients experienced delayed union beyond 20 weeks; however, none progressed to non-union. Radiographic analysis showed satisfactory alignment in the majority of cases. Angular deformity of less than 5 degrees was noted in 18 patients (90%), while only 2 patients (10%) exhibited deformity greater than 5 degrees, which remained clinically insignificant and did not affect functional outcome.

Functional Outcome Assessment

Functional assessment was performed using the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score at the final 12-month follow-up. The AOFAS scores ranged from 78 to 96, with a mean of 87.9. Based on the scoring system, 10 patients (50%) had an excellent outcome (score $\geq$ 90), 8 patients (40%) had a good outcome (score 80–89), and 2 patients (10%) had a fair outcome (score 70–79). No patient had a poor outcome. These results demonstrate a high level of patient satisfaction, mobility, and return to activities of daily living following MIPPO fixation of distal tibial fractures.

Ankle range of motion was preserved in most patients, with an average dorsiflexion of 19.3 degrees and plantarflexion of 35.2 degrees. The average time to full weight-bearing ambulation was 11.9 weeks (range: 10–14 weeks), depending on the rate of clinical and radiological union.

Complications

Postoperative complications were minimal. Delayed union was observed in 2 patients (10%), both of whom eventually united without requiring additional intervention. One patient (5%) developed a superficial surgical site infection, which was managed successfully with oral antibiotics and local care. There were no cases of deep

infection, hardware failure, or implant breakage. Importantly, no patient required revision surgery or implant removal during the follow-up period.

Summary

The results of this study indicate that distal tibial fractures treated with locking compression plates via the MIPPO technique result in satisfactory union rates, minimal complications, and good to excellent functional outcomes in the majority of patients. The technique offers biological advantages by preserving the periosteal blood supply and minimizing soft tissue disruption, which is particularly important in the distal tibia where soft tissue coverage is limited.

DISCUSSION

The management of distal tibial fractures presents a unique challenge due to the subcutaneous location of the distal tibia, its poor vascularity, and limited soft tissue envelope. Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) with locking compression plates has gained widespread acceptance for distal tibial fractures due to its ability to preserve fracture biology and minimize soft tissue trauma.

In the present study, all 20 patients underwent distal tibia fixation using the MIPPO technique with locking compression plates. The mean time to radiological union was 16.85 weeks (range: 14–22 weeks), which aligns with the findings of Vallier et al. (2008), who reported an average union time of 17 weeks in their study of 41 patients with distal tibia fractures treated using minimally invasive plating techniques [9]. Similarly, Hasenboehler et al. (2007) in their prospective series of 39 patients also found that union occurred in a mean duration of 16.7 weeks [10]. These findings reinforce the current study's observation that MIPPO facilitates timely union while reducing the risk of non-union due to minimal periosteal stripping and preserved blood supply.

The functional outcome, as assessed by the AOFAS Ankle-Hindfoot Score, was excellent in 50% of patients and good in 40%, with a mean score of 87.9 at the final follow-up. These results are consistent with the outcomes reported by Bahari et al. (2007), who demonstrated excellent to good outcomes in 85% of their patients with a similar technique [11]. In contrast, Redfern et al. (2004) observed excellent to good outcomes in only 76% of their cases using MIPPO, which may reflect differences in surgical technique, patient selection, or postoperative rehabilitation protocols [12].

In the present study, the incidence of angular deformity >5° was only 10%, and no malalignment necessitated revision. This supports the biomechanical advantage of locking compression plates in maintaining fracture alignment even in comminuted patterns, as emphasized by Egol et al. (2004), who found that locking plates provided better angular stability, particularly in osteoporotic or metaphyseal bone [13].

Regarding complications, delayed union was observed in two patients (10%), and superficial infection occurred in one patient (5%). No deep infections or implant failures were reported. This low complication rate is favorable when compared to the findings of Redfern et al., who reported superficial infection in 13% and deep infection in 7% of cases [12]. Our study's reduced complication rate can likely be attributed to careful patient selection, early soft tissue management, and adherence to minimally invasive principles.

Fibular fixation was performed in 65% of cases. The decision was made intra-operatively based on the stability and displacement of the fibular fracture. While some studies advocate routine fibular fixation for alignment restoration, others suggest it may not be necessary in all cases. In our series, no significant difference in outcome was observed between patients who had fibular fixation and those who did not, supporting the findings by Hooper et al. (1991) who concluded that fibular fixation should be selectively performed based on fracture configuration and stability [14].

The use of MIPPO in distal tibia fractures has become increasingly favored due to the balance it offers between mechanical stability and biological preservation. The good-to-excellent results in 90% of our patients reflect that with appropriate patient selection, timely intervention, and precise surgical technique, this method is reliable and reproducible. The preservation of soft tissues, especially in the distal third of the leg where skin is tenuous, plays a vital role in reducing infection and wound-related complications.

In comparison to open reduction and internal fixation (ORIF), the MIPPO technique has demonstrated superior results in terms of reduced wound complications and comparable, if not better, union and functional outcomes, as shown in multiple meta-analyses and systematic reviews [15].

Thus, our study supports the growing body of evidence that MIPPO with locking compression plates is a safe, effective, and functionally rewarding method for managing distal tibial fractures.

CONCLUSION

Distal tibial fractures, particularly those involving the metaphyseal region, present unique challenges due to limited soft tissue coverage and compromised vascularity. The minimally invasive percutaneous plate osteosynthesis (MIPPO) technique, using locking compression plates, offers a biomechanically stable and biologically favorable method of fixation.

In this prospective study of 20 patients, the MIPPO technique demonstrated excellent to good functional outcomes in 90% of cases, with a mean AOFAS score of 87.9. The average time to union was 16.85 weeks, and the incidence of complications such as delayed union and superficial infection was low. Radiological alignment was satisfactorily maintained in the majority of patients, and early mobilization was facilitated without compromising fracture healing.

The technique minimizes soft tissue disruption, preserves periosteal blood supply, and reduces infection rates when compared to conventional open plating methods. Our findings are consistent with multiple published studies, reinforcing the role of MIPPO as a reliable and effective modality in the management of distal tibia fractures.

Given the favorable functional and radiological outcomes, the MIPPO technique with locking compression plates can be considered the treatment of choice in carefully selected cases of distal tibial fractures, particularly where soft tissue preservation is paramount. However, larger randomized controlled trials with longer follow-up are recommended to further validate these results and establish long-term benefits.

LIMITATIONS

While the findings are encouraging, the study is limited by its small sample size and short follow-up duration. Larger, randomized controlled trials with extended follow-up periods are necessary to validate these results and further elucidate the role of fibular fixation in distal tibial fracture management.

Figure : 1& 2 tibia locking compression plate was inserted through a small incision

Figure : 3 Intra operative fluoroscopic image image

REFERENCES

1. Ronga M, Longo UG, Maffulli N. Minimally invasive locked plating of distal tibia fractures is safe and effective. Clin Orthop Relat Res. 2010;468(4):975-982.
2. Hasenboehler EA, Rikli D, Babst R. Locking compression plate in diaphyseal fractures of the radius and ulna: is there a problem with stress shielding? Clin Orthop Relat Res. 2006; (448):116-122.
3. Redfern DJ, Syed SU, Davies SJ. Fractures of the distal tibia: minimally invasive plate

osteosynthesis. Injury. 2004;35(6):615-620.
4. Lau TW, Leung F, Chan CF, Chow SP. Wound complication of minimally invasive plate osteosynthesis in distal tibia fractures. Int Orthop. 2008;32(5):697-703.
5. Apivatthakakul T, Sananpanich K. Minimally invasive plate osteosynthesis (MIPO) of the tibia with the medial plating: Is it possible? A cadaveric study. Injury. 2007;38(4):530-538.
6. Helfet DL, Shonnard PY, Levine D, Borelli J Jr. Minimally invasive plate osteosynthesis of distal fractures of the tibia. Injury. 1997;28(Suppl 1):A42-47.
7. Egol KA, Tejwani NC, Capla EL, Wolinsky PL, Koval KJ. Staged management of high-energy proximal tibia fractures (OTA types 41): the results of a prospective, standardized protocol. J Orthop Trauma. 2005;19(7):448-455.
8. Vallier HA, Cureton BA, Patterson BM. Randomized, prospective comparison of plate versus intramedullary nail fixation for distal tibia shaft fractures. J Orthop Trauma. 2011;25(12):736-741.
9. Vallier HA, Le TT, Bedi A. Radiographic and clinical comparisons of distal tibia shaft fractures (OTA type 43) treated with minimally invasive plating vs. intramedullary nailing. J Orthop Trauma. 2008;22(5):307–311.
10. Hasenboehler EA, Rikli D, Babst R. Locked plating in fractures of the distal tibia: experience in 39 patients. Injury. 2007;38(3):365–370.
11. Bahari S, Lenehan B, Khan H, Mcelwain JP. Minimally invasive percutaneous plate fixation of distal tibia fractures: results in 20 patients. Injury. 2007;38(3):306–311.
12. Redfern DJ, Syed SU, Davies SJ. Fractures of the distal tibia: minimally invasive plate osteosynthesis. Injury. 2004;35(6):615–620.
13. Egol KA, Tejwani NC, Capla EL, Wolinsky PL, Koval KJ. Staged management of high-energy proximal tibia fractures (OTA types 41): the results of a prospective, standardized protocol. J Orthop Trauma. 2005;19(7):448–455.
14. Hooper GJ, Keddell RG, Penny ID. Distal tibial fractures: treatment with the AO dynamic compression plate. J Trauma. 1991;31(9):1236–1240.
15. Lau TW, Leung F, Chan CF, Chow SP. Wound complication of minimally invasive plate osteosynthesis in distal tibia fractures. Int Orthop. 2008;32(5):697–703.