RESEARCH PAPER

A Prospective Study of Functional Outcome of Distal Tibia Fracture by Minimally Invasive Percutaneous Plate Osteosynthesis Technique in A Tertiary Care Centre in Chengalpattu District

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ABSTRACT

Background: Distal third tibial fractures are challenging due to limited soft-tissue coverage and poor vascularity. Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) with locking compression plates aims to provide stable fixation while preserving fracture biology.
Aim of the Study: To evaluate the functional and radiological outcomes of distal third tibial fractures treated using the Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) technique with locking compression plates.
Methods: This prospective study included 33 adult patients with distal third tibial fractures treated using the MIPPO technique at a tertiary care centre in Chengalpattu, Tamil Nadu. Fractures were classified according to the AO/OTA classification. Patients were followed up at 6, 12, and 18 weeks. Functional outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score, and radiological union was evaluated using standard radiographs.
Results: The mean union time was 17.6 weeks. The mean AOFAS score improved from 59.3 at 6 weeks to 87.8 at 18 weeks. Most patients achieved excellent to good functional outcomes with minimal complications.
Conclusion: MIPPO is an effective technique for distal tibial fractures, providing stable fixation, satisfactory union, and good functional recovery.
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INTRODUCTION

The tibia is one of the most commonly fractured long bones in the human body, with fractures involving the distal third accounting for approximately 0.7% of all fractures and 10–13% of all tibial fractures. These injuries most commonly result from high-energy mechanisms such as road traffic accidents, falls from height, and twisting injuries, and are frequently associated with varying degrees of soft-tissue compromise. The higher incidence among individuals in the economically productive age group contributes substantially to morbidity, prolonged disability, and loss of productivity.

The distal tibia is particularly vulnerable to complications because of its subcutaneous location, limited muscular coverage, relatively poor vascularity, and close proximity

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to the ankle joint. These anatomical and biological factors predispose distal tibial fractures to delayed union, non-union, malunion, infection, wound breakdown, and ankle stiffness. Even minimal malalignment can

significantly alter ankle biomechanics, resulting in impaired gait and poor long-term functional outcomes, thereby making management of these fractures especially challenging.

To assist in treatment planning and prognostication, several classification systems have been proposed for distal tibial fractures, of which the Rüedi and Allgöwer classification and the AO/OTA classification are the most widely accepted. These systems help categorize fracture patterns based on articular involvement and severity, thereby guiding surgical decision-making and predicting outcomes.

The primary objectives in the management of distal tibial fractures are restoration of anatomical alignment, maintenance of joint stability, preservation of articular congruity, and early functional rehabilitation, while minimizing soft-tissue complications. Achieving these goals remains difficult due to the complex interplay between fracture mechanics and compromised local biology. Historically, conservative methods such as casting and functional bracing were employed for the treatment of distal tibial fractures. However, these approaches have been associated with high rates of malunion, non-union, prolonged immobilization, ankle stiffness, and delayed rehabilitation, restricting their role largely to undisplaced or minimally displaced fractures. Surgical treatment options include external fixation, intramedullary nailing, and open reduction with internal fixation. External fixation is primarily reserved for damage-control situations but is frequently complicated by pin-tract infections, joint stiffness, and delayed union. Intramedullary nailing, although effective for diaphyseal fractures, has limitations in very distal fractures due to difficulties in maintaining alignment and achieving stable distal fixation. Conventional open reduction and internal fixation allows precise anatomical reduction but necessitates extensive soft-tissue dissection and periosteal stripping, resulting in a significant incidence of wound complications such as infection and skin necrosis.

In response to these limitations, the concept of biological osteosynthesis was introduced, emphasizing preservation of the soft-tissue envelope, periosteal blood supply, and fracture hematoma. Based on these principles, minimally invasive percutaneous plate osteosynthesis (MIPPO) was developed to combine biological preservation with stable internal fixation. This technique relies on indirect fracture reduction and percutaneous insertion of a plate along the epiperiosteal plane, bridging the fracture zone while minimizing soft-tissue disruption and devascularization of fracture fragments.

The introduction of locking compression plates has further enhanced the effectiveness of this technique. Locking plates function as internal fixators by providing angular and axial stability independent of bone quality. The fixed-angle construct allows the plate to act as an internal splint, preserves periosteal circulation, reduces the risk of implant loosening, and promotes secondary bone healing through callus formation. These advantages make minimally invasive plate osteosynthesis particularly suitable for comminuted distal tibial fractures and for patients with osteoporotic bone.

Despite increasing acceptance and generally favourable outcomes reported in the literature,

concerns persist regarding the technical complexity, learning curve, risk of malalignment, and variability in functional outcomes associated with this technique. Patient-related factors such as age, comorbidities, severity of soft-tissue injury, and timing of surgery continue to influence results. Although several Indian studies have reported encouraging radiological and functional outcomes with minimally invasive plate osteosynthesis, region-specific prospective data remain limited, particularly from the Chengalpattu district. Variations in patient demographics, injury patterns, soft- tissue status, and healthcare delivery systems underscore the need for locally generated evidence. In this context, the present study employs a uniform surgical technique, a standardized postoperative protocol, and validated functional outcome assessment tools to generate reliable region-specific data on the functional and radiological outcomes of distal tibial fractures treated using minimally invasive percutaneous plate osteosynthesis.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Orthopaedics at Shri Sathya Sai Medical College and Research Institute, Ammapettai, Chengalpattu District, Tamil Nadu, over a period of three years.

A total of 33 patients with distal third tibial fractures who satisfied the inclusion criteria were included in the study. All patients admitted with distal tibial fractures during the study period were evaluated clinically and radiologically. Fractures were classified according to the AO/OTA classification system.

Inclusion Criteria

- Patients aged 18 years and above
- Patients with distal third tibial fractures
- Closed fractures and Gustilo-Anderson Type I and II open fractures
- Patients willing to participate and provide informed consent

Exclusion Criteria

- Patients below 18 years of age
- Pathological fractures
- Gustilo-Anderson Type III open fractures

- Patients with severe medical comorbidities unfit for surgery
- Patients lost to follow-up

Surgical Procedure
All patients were treated surgically using the Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) technique with a distal tibial locking compression plate. Surgery was performed under spinal or general anesthesia with the patient in the supine position on a radiolucent operating table.

Fracture reduction was achieved by indirect reduction techniques under fluoroscopic guidance. A small incision was made over the distal tibia, and a pre-contoured locking compression plate was inserted subcutaneously along the medial surface of the tibia through a minimally invasive approach. The plate was fixed with locking screws proximally and distally, maintaining fracture alignment and stability while preserving the surrounding soft tissue envelope and periosteal blood supply.

Postoperative Management
Postoperatively, patients received intravenous antibiotics and analgesics as per hospital protocol. Early ankle range-of-motion exercises were encouraged as tolerated. Partial weight-bearing was initiated depending on the radiological evidence of fracture healing, and full weight-bearing was allowed after satisfactory fracture union.

Follow-Up and Outcome Assessment
Patients were followed up at 6 weeks, 12 weeks, and 18 weeks postoperatively. At each follow-up visit, clinical and radiological assessments were performed to evaluate fracture healing, alignment, and complications.

Functional outcome was assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot scoring system, and radiological union was determined by the presence of bridging callus across the fracture site on standard radiographs.

Statistical Analysis
The collected data were entered into Microsoft Excel and analyzed using appropriate statistical methods. Descriptive statistics such as mean, standard deviation, frequency, and percentage were used to summarize the data. A p-value of less than 0.05 was considered statistically significant.

RESULTS
A total of 33 patients with distal third tibial fractures treated with Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) were included in the present study and followed up for 18 weeks. The demographic profile, fracture characteristics, functional outcome, and complications were analyzed.

Table 1: Age Distribution of Patients

Age Group (Years)	Frequency	Percentage (%)
18–30	8	24.2
30–60	15	45.5
>60	10	30.3
Total	**33**	**100**

Table 2: Gender Distribution

Gender	Frequency	Percentage (%)
Male	24	72.7
Female	9	27.3
Total	**33**	**100**

Table 3: Side of Injury

Side	Frequency	Percentage (%)
Left	14	42.4
Right	19	57.6
Total	**33**	**100**

Table 4: Mode of Injury

Mode of Injury	Frequency	Percentage (%)
Fall	8	24.2
Road Traffic Accident	21	63.6
Twisting Injury	4	12.1
Total	**33**	**100**

Table 5: AO/OTA Fracture Classification

AO/OTA Type	Frequency	Percentage (%)
43-A1	9	27.3
43-A2	14	42.4
43-A3	10	30.3
Total	**33**	**100**

Table 6: Time Between Injury and Surgery

Time Interval	Frequency	Percentage (%)
≤5 days	15	45.5
6–10 days	12	36.4
>10 days	6	18.2
Total	**33**	**100**

Table 7: Reduction Technique

Technique	Frequency	Percentage (%)
Closed Reduction	26	78.8
Assisted Reduction	7	21.2
Total	**33**	**100**

Table 8: Fracture Union at 6 Weeks

Status	Frequency	Percentage (%)
Delayed	25	75.8
United	8	24.2
Total	**33**	**100**

Table 9: Fracture Union at 12 Weeks

Status	Frequency	Percentage (%)
Delayed	10	30.3
United	23	69.7
Total	**33**	**100**

Table 10: Fracture Union at 18 Weeks

Status	Frequency	Percentage (%)
Delayed	2	6.1
United	31	93.9
Total	**33**	**100**

Table 11: Time to Mobilization and Union

Variable	Mean	Standard Deviation
Time to Mobilization (days)	3.9	1.3
Time to Union (weeks)	17.6	1.9

Table 12: Range of Motion

Variable	Mean	Standard Deviation
Dorsiflexion (degrees)	15.5	2.3
Plantarflexion (degrees)	35.8	3.1

Table 13: AOFAS Score at Follow-Up

Follow-Up	Mean	Standard Deviation	P Value
6 weeks	59.3	3.9	—
12 weeks	75.3	3.2	<0.001
18 weeks	87.8	4.7	<0.001

Table 14: Final Functional Outcome (18 Weeks)

Outcome	Frequency	Percentage (%)
Excellent	18	54.5
Good	12	36.4
Fair	3	9.1
Total	**33**	**100**

Table 15: Complications

Complication	Frequency	Percentage (%)
Infection	3	9.1
Delayed Union	2	6.1
Malunion	1	3.0
Nil	27	81.8
Total	**33**	**100**

DISCUSSION

Distal third tibial fractures represent a significant challenge to orthopaedic surgeons because of the subcutaneous location of the tibia, limited soft tissue coverage, and relatively poor vascularity in the distal region. Conventional open reduction and plating techniques may lead to complications such as infection, delayed union, and soft tissue damage due to extensive surgical exposure. The development of the Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) technique has provided an effective method of managing these fractures while preserving fracture biology and minimizing soft tissue disruption. The present study was conducted to evaluate the functional and radiological outcomes of distal tibial fractures treated with the MIPPO technique.

In the present study, the majority of patients were in the 30–60 years age group, accounting for

45.5% of the cases. This indicates that distal tibial fractures are more common in the economically productive age group, possibly due to increased exposure to high-energy trauma and occupational activities. Similar age distribution has been reported in several studies evaluating distal tibial fractures.

A clear male predominance was observed in this study, with males accounting for 72.7% of the cases. This finding may be attributed to the greater involvement of males in outdoor activities, driving, and occupations that increase the risk of trauma. The higher incidence of distal tibial fractures among males has also been reported in other orthopaedic studies.

With regard to the mode of injury, road traffic accidents were the most common cause, accounting for 63.6% of the cases, followed by falls and twisting injuries. The predominance of road traffic accidents reflects the increasing incidence of high-velocity trauma in developing countries and highlights the importance of effective management strategies for these injuries.

According to the AO/OTA fracture classification, the most common fracture pattern observed in this study was type 43-A2, followed by type 43-A3 and type 43-A1 fractures. Most of the fractures included in this study were extra-articular distal tibial fractures, which are suitable for treatment using minimally invasive plating techniques.

In this study, closed reduction was achieved in the majority of patients, while a smaller proportion required assisted reduction techniques. The ability to achieve satisfactory reduction with minimal surgical exposure demonstrates the effectiveness of the MIPPO technique in maintaining fracture alignment while preserving the surrounding soft tissue structures and periosteal blood supply.

Fracture union was achieved in the majority of patients by 18 weeks, with a mean union time of 17.6 weeks. The high union rate observed in this study can be attributed to the biological fixation principles of the MIPPO technique, which preserves the fracture hematoma and promotes early callus formation.

Functional outcome was assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score. The mean AOFAS score improved progressively during follow-up, increasing from 59.3 at 6 weeks to 75.3 at 12 weeks and 87.8 at 18 weeks. This progressive improvement indicates satisfactory recovery of ankle function and mobility following surgical treatment.

At the final follow-up, the majority of patients achieved excellent to good functional outcomes, with only a small percentage showing fair results. These findings suggest that the MIPPO technique

provides effective stabilization of distal tibial fractures while allowing early mobilization and functional recovery.

The complication rate observed in this study was relatively low. A small number of patients developed complications such as infection, delayed union, and malunion, while the majority had no complications. The low complication rate may be attributed to the minimally invasive nature of the MIPPO technique, which reduces soft tissue damage and preserves vascularity around the fracture site.

Overall, the results of this study suggest that Minimally Invasive Percutaneous Plate Osteosynthesis is an effective and reliable technique for the management of distal third tibial fractures, providing stable fixation, good functional outcomes, and a low complication rate.

CONCLUSION

The present study was conducted to evaluate the functional and radiological outcomes of distal third tibial fractures treated using the Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) technique. Based on the findings of this study, it can be concluded that the MIPPO technique is an effective method for the management of distal tibial fractures. The technique allows stable fixation while preserving the fracture biology and minimizing soft tissue damage. In the present study, the majority of patients achieved fracture union within an acceptable time period, with a mean union time of approximately 17.6 weeks. Functional outcomes assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score showed significant improvement during follow-up, and most patients achieved excellent to good functional results. The complication rate observed in this study was relatively low, indicating that the MIPPO technique is a safe and reliable treatment option for distal tibial fractures. Overall, the results of this study suggest that minimally invasive plating provides satisfactory fracture healing, good functional recovery, and a low incidence of complications in patients with distal tibial fractures.

REFERENCES

1) Annals of International Medical and Dental Research E-ISSN: 2395-2822 | P-ISSN: 2395-2814 Vol-7, Issue-5 | September-October 2021 Page no- 165-173 | Section- Research Article (Orthopaedics)

2) Donimath VS, Chandan AE, Sandeep SR, Battur M. A prospective study on functional outcome of distal tibia fractures treated with minimally invasive percutaneous plate osteosynthesis. International J Orthopaedics Sciences. 2018;4(1):585-9.

3) Supe AC, Kinge KV, Badole CM, Wandile KN, Patond KR. Minimally invasive percutaneous plate osteosynthesis in distal tibial fracture: A series of 32 cases. Int J Orthop Sci. 2016;2(1):06-9.

4) Neinaa HA, Hannout YS, Wahab AA. Evaluation of treatment of distal tibial fractures using the minimally invasive percutaneous plate osteosynthesis technique. Menoufia Medical Journal. 2016 Jul 1;29(3):691

5. Gupta RK, Rohilla RK, Sangwan K, Singh V, Walia S. Locking plate fixation in distal metaphyseal tibial fractures: series of 79 patients. Int Orthop.2010;34(8):1285-90. doi: 10.1007/s00264-009-0880-4.

6. Leung FK, Law TW. Application of minimally invasive locking compression plate in treatment of distal tibia fractures. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2009;23(11):1323-5.

7. 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):975-82.doi: 10.1007/s11999-009-0991-7.

8. Bahari S, Lenehan B, Khan H, McElwain JP.Minimally invasive percutaneous plate fixation of distal tibia fractures. Acta Orthop Belg.2007;73(5):635-40.

9. Zha G, Chen Z, Qi X. Minimally invasivepercutaneous locking compression plate internal fixation in the treatment of tibial fractures.Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi.2008;22(12):1448-50.

10. Collinge C, Protzman R. Outcomes of minimally invasive plate osteosynthesis for metaphyseal distal tibia fractures. J Orthop Trauma. 2010;24(1):24-9. doi: 10.1097/BOT.0b013e3181ac3426.