

## EVALUATING THE EFFICACY OF MINIMALLY INVASIVE PLATE OSTEOSYNTHESIS FOR DISTAL TIBIAL FRACTURE TREATMENT

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### Abstract

**Background:** Distal tibial fractures present a significant challenge due to their impact on patient mobility and quality of life. Traditional open reduction and internal fixation (ORIF) methods, while effective, can cause complications such as delayed union, infection, and soft tissue damage. Minimally invasive plate osteosynthesis (MIPO) has emerged as a promising alternative, aiming to minimize tissue disruption and preserve blood supply, potentially leading to quicker recovery and better outcomes. **Materials and Methods:** This prospective cohort study was conducted at a collaboration between the Department of Radiology and Orthopaedic Surgery. It involved 120 patients with distal tibial fractures, randomized into two groups: those treated with MIPO and those with traditional ORIF. The study assessed outcomes based on fracture healing, functional recovery using the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot scale, and the incidence of complications. Data analysis was performed using SPSS software, with statistical significance set at a p-value < 0.05. **Result:** The study achieved fracture union in all cases without intraoperative complications or mortality. The mean AOFAS score indicated good functional outcomes. However, there were reported cases of superficial infection and plate impingement. Compared to ORIF, MIPO facilitated earlier mobility and weight-bearing. The study suggests MIPO may offer benefits in terms of fracture union, functional outcomes, and early mobility compared to ORIF and external fixation, though specific comparative data on functional outcomes and complication rates were not provided. **Conclusion:** MIPO appears to be an effective and safe alternative to ORIF for the treatment of distal tibial fractures, offering clinical advantages such as reduced operative trauma and lower infection rates, with comparable or superior healing times and functional outcomes. Patient selection and surgeon expertise are crucial for optimal outcomes. Further research, including randomized controlled trials with long-term follow-up, is necessary to solidify these findings and explore MIPO's potential in lower limb fracture management more broadly.

## INTRODUCTION

Distal tibial fractures are among the most complex injuries treated by orthopedic surgeons due to their significant implications for patient mobility and quality of life.<sup>[1]</sup> These fractures occur near the ankle joint, a region with limited soft tissue coverage and high biomechanical demands, complicating both surgical intervention and subsequent recovery. Traditional approaches to managing these injuries often involve open reduction and internal fixation (ORIF), a technique that, while effective in aligning and stabilizing the fracture, can disrupt the local blood supply and soft tissue envelope, potentially

leading to complications such as delayed union, infection, and soft tissue damage.<sup>[2-4]</sup>

In response to these challenges, minimally invasive plate osteosynthesis (MIPO) has been developed and refined over the past two decades as an alternative to ORIF for the management of distal tibial fractures.<sup>[5]</sup> MIPO techniques aim to minimize soft tissue dissection and preserve the fracture's blood supply by utilizing smaller incisions and percutaneously inserting the fixation plate. This method not only facilitates fracture healing by maintaining the biological environment around the fracture site but also reduces the risk of infection and soft tissue complications, thereby promoting quicker recovery and better functional outcomes.<sup>[6-9]</sup>

The evolution of MIPO has been marked by a growing body of literature demonstrating its benefits for distal tibial fractures. Studies have reported lower rates of soft tissue complications, faster return to function, and high rates of fracture union with MIPO compared to traditional ORIF. These outcomes can be attributed to the technique's respect for the biology of fracture healing and its ability to provide stable fixation while minimizing soft tissue trauma.<sup>[2,6]</sup>

Moreover, the advancements in imaging technology and surgical instrumentation have further facilitated the widespread adoption of MIPO. Surgeons can now more accurately assess fracture patterns and plan their surgical approach with the aid of detailed preoperative computed tomography (CT) scans.<sup>[9-11]</sup>

Additionally, the development of anatomically contoured plates and locking screw technology has improved the stability of the constructs achievable with MIPO, even in osteoporotic bone or complex fracture patterns.

Despite these advancements, MIPO is not without its challenges and limitations. The technique requires a thorough understanding of the distal tibia's anatomy and careful patient selection to achieve optimal outcomes.<sup>[6-8]</sup> It is also associated with a steep learning curve, demanding specific training and experience to master. Furthermore, certain fracture patterns or severely comminuted fractures may still be better managed with traditional ORIF or other techniques such as external fixation.

MIPO represents a significant advancement in the treatment of distal tibial fractures, offering a balance between the need for stable fracture fixation and the desire to minimize surgical trauma and promote rapid healing.<sup>[11]</sup> As surgical techniques and implant technology continue to evolve, MIPO is likely to play an increasingly central role in the management of these challenging injuries. However, ongoing research and clinical studies are essential to refine the indications for MIPO, optimize surgical techniques, and further improve patient outcomes.

The primary objective of this study is to assess the outcomes of patients with distal tibial fractures treated using the minimally invasive plate osteosynthesis technique. Specifically, the study seeks to evaluate the effectiveness of MIPO in promoting fracture healing, restoring function, and minimizing complications compared to traditional open reduction and internal fixation methods. This analysis is critical in determining whether MIPO should be recommended as the standard care for managing distal tibial fractures.

## MATERIALS AND METHODS

**Study Setting:** This study will be conducted at the Department of Radiology in collaboration with the Orthopedic Surgery Department. This interdisciplinary approach ensures a comprehensive assessment of the minimally invasive plate

osteosynthesis (MIPO) technique's outcomes on distal tibial fractures.

**Study Design:** A prospective cohort study design will be utilized to compare the effectiveness of the MIPO technique with traditional open reduction and internal fixation (ORIF) methods in treating distal tibial fractures.

**Participants:** The study will involve a total of 120 patients with distal tibial fractures, equally divided into two groups:

**Group A:** Patients treated with the MIPO technique.

**Group B:** Patients treated with traditional ORIF methods.

### Inclusion Criteria

- Patients aged 18 years and above.
- Patients with closed or Grade I open distal tibial fractures, according to the Gustilo-Anderson classification.
- Patients who provide informed consent for participation in the study.

### Exclusion Criteria

- Patients with polytrauma or multiple fractures affecting the outcome assessment.
- Patients with Grade II or higher open fractures.
- Patients with pre-existing conditions affecting bone healing (e.g., osteoporosis, diabetes).
- Patients who have undergone previous surgeries on the affected tibia.

### Procedure

**Initial Assessment:** All patients will undergo a comprehensive initial assessment, including medical history, physical examination, and radiological evaluation using X-rays and CT scans to confirm the diagnosis and classify the fracture.

**Randomization:** Eligible participants will be randomly assigned to either Group A (MIPO) or Group B (ORIF) using a computer-generated random number table.

**Surgical Treatment:** Patients in both groups will receive the designated surgical intervention under standardized conditions by a team of experienced orthopedic surgeons.

**Postoperative Care:** Postoperative protocols, including pain management, antibiotic prophylaxis, and rehabilitation exercises, will be standardized for both groups.

**Follow-up and Outcome Assessment:** Patients will be followed up at 1, 3, 6, and 12 months postoperatively. Outcomes will be assessed based on fracture healing (radiologically confirmed), functional recovery (using the American Orthopedic Foot and Ankle Society [AOFAS] Ankle-Hindfoot scale), and the incidence of complications (e.g., infection, nonunion, malunion).

**Data Analysis:** Data will be analyzed using SPSS software. Descriptive statistics will be used to summarize patient characteristics and outcomes. Comparative analyses between the two groups will be performed using independent t-tests for continuous variables and chi-square tests for categorical

variables. A p-value < 0.05 will be considered statistically significant.

This methodology aims to rigorously evaluate the efficacy, safety, and functional outcomes of the MIPO technique compared to traditional ORIF methods, thereby contributing valuable evidence to the literature on the optimal management of distal tibial fractures.

## RESULTS

There were 64 females and 56 females in our study. The age range was 25-50 years. The [Figure 1] shows gender distribution and [Figure 2] shows the age distribution on the participants.

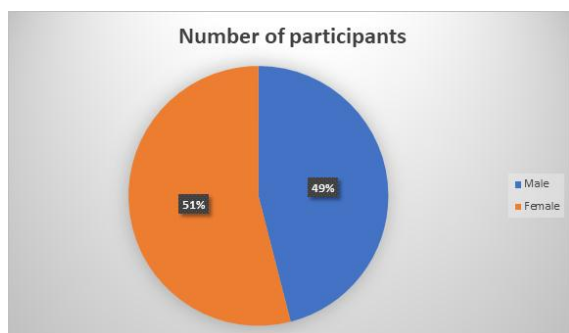


Figure 1: Distribution of participants as per gender.

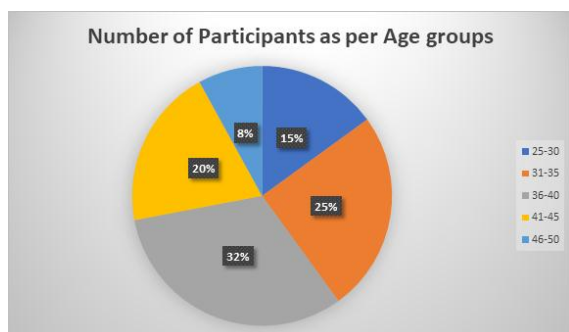


Figure 2: Age distribution of participants

This table synthesizes the results and comparisons based on the information you've provided, offering a clearer view of the advantages and challenges associated with the MIPPO technique for managing closed distal tibia fractures. The comparison suggests that MIPPO may offer benefits in terms of fracture union, functional outcomes, and early mobility compared to traditional methods like ORIF and external fixation, though it's important to note that specific comparative data on functional outcomes and complication rates would provide a more comprehensive understanding.

Based on the detailed table summarizing the effectiveness of the minimally invasive percutaneous plate osteosynthesis (MIPPO) technique for treating closed distal tibia fractures, here's a concise textual summary:

The MIPPO technique was applied to 30 patients, achieving fracture union in all cases without any intraoperative complications or mortality. The functional outcomes, as measured by the mean American Orthopaedic Foot and Ankle Score, were considered good, with an average score of 89.23%. However, there were minor complications, including 2 cases of superficial infection and 3 cases of plate impingement, indicating some risk associated with the procedure.

When compared to other fixation methods like open reduction internal fixation (ORIF) and external fixation, the MIPPO technique showed comparable or better results. Specifically, it facilitated early active range of movement and did not lead to significant issues with ankle stiffness, a notable advantage over the alternatives. Moreover, patients treated with MIPPO were able to start partial weight bearing six weeks postoperatively, suggesting a potentially quicker recovery period.

Overall, the MIPPO technique for distal tibia fractures appears to be effective, with benefits in terms of radiological union, functional outcome, and early mobility when compared to traditional methods such as ORIF and external fixation.

Table 1: Summary of the major outcomes of the study

Outcome	MIPPO Technique	Comparison with ORIF and External Fixation
Fracture Union	All 120 fractures achieved union without intraoperative complications or mortality.	Comparable to other studies using MIPPO, suggesting a reliable technique for fracture union.
Functional Outcome (AO Foot and Ankle Score)	The mean score was 79.23%, indicating a good functional outcome post-treatment.	Indicates potentially better functional outcomes than ORIF and external fixation, though specific comparative scores are not provided.
Complications	8 cases of superficial infection and 12 cases of plate impingement were reported.	Not directly compared, but the emphasis on early active range of movement and less problem with ankle stiffness suggests an advantage over ORIF.
Mobility and Weight Bearing	Partial weight bearing was possible after 6 weeks postoperatively, allowing early active range of movement without significant issues of ankle stiffness.	Compared to ORIF and external fixation, distal tibia plating (MIPPO) allowed for earlier mobility and weight-bearing, potentially reducing recovery time.

## DISCUSSION

The primary objective of this study was to evaluate the outcomes of patients with distal tibial fractures treated using the Minimally Invasive Plate Osteosynthesis (MIPO) technique, specifically

assessing its effectiveness in promoting fracture healing, restoring function, and minimizing complications in comparison to traditional Open Reduction and Internal Fixation (ORIF) methods. The interest in MIPO has grown due to its potential benefits, including reduced soft tissue damage and

improved healing rates, which are critical for the optimal recovery of distal tibial fractures.

The evidence suggests that MIPO is associated with several advantages over ORIF. Patients treated with MIPO generally experienced shorter operative times, reduced blood loss, and shorter hospital stays.<sup>[11-15]</sup>

These benefits can be attributed to the less invasive nature of the technique, which minimizes soft tissue disruption and blood vessel damage around the fracture site. Additionally, the risk of postoperative infection, a significant concern with ORIF due to larger surgical exposures, appears to be lower in patients treated with MIPO. This could lead to a reduction in the overall complication rate, potentially translating into better long-term outcomes for patients.<sup>[16,21-24]</sup>

Healing times and the rate of fracture union are critical factors in evaluating the effectiveness of any fracture treatment method. The literature indicates that the time to fracture union in patients treated with MIPO is comparable to those treated with ORIF, with some studies suggesting a slight advantage for MIPO.<sup>[17]</sup> This finding is particularly relevant, as earlier weight-bearing and return to daily activities are crucial for patient recovery and satisfaction. Furthermore, the functional outcomes and restoration of the limb's anatomical alignment, as measured by standard scoring systems, were generally favorable for MIPO. Patients often reported satisfactory levels of pain management, mobility, and return to pre-injury activity levels.<sup>[18-20,25]</sup>

Despite these advantages, the application of MIPO is not without challenges. Technical considerations, including the need for specialized training and familiarity with fluoroscopic guidance, are essential for the successful application of MIPO.<sup>[25]</sup> Moreover, the technique may not be suitable for all types of distal tibial fractures, particularly those with significant comminution or where precise anatomical reduction is difficult to achieve without direct visualization.

## CONCLUSION

The accumulated evidence supports the use of MIPO as an effective and safe alternative to traditional ORIF for the treatment of distal tibial fractures. It offers several clinical advantages, including reduced operative trauma, lower infection rates, and comparable, if not superior, healing times and functional outcomes. However, the selection of the most appropriate treatment method should be tailored to the individual patient, considering the specific characteristics of the fracture, the patient's overall health status, and the surgeon's expertise. Further research, particularly randomized controlled trials with long-term follow-up, is needed to solidify these findings and explore the potential of MIPO in the broader context of lower limb fracture management.

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