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Clinical, functional, Radiological outcome of Intramedullary nailing versus minimally invasive percutaneous plate osteosyntheses for distal third tibia fracture

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ABSTRACT

Background: Distal third tibial fractures are challenging to treat due to the limited soft tissue coverage and the proximity to the ankle joint. This study aimed to compare the clinical, functional, and radiological outcomes of intramedullary nailing (IMN) and minimally invasive percutaneous plate osteosynthesis (MIPPO) for distal third tibial fractures.

Methods: A prospective, randomized controlled trial was conducted, including 36 patients with distal third tibial fractures (AO/OTA 43-A1, A2, A3). Patients were randomly allocated to either the IMN group (n=18) or the MIPPO group (n=18) and followed up for 12 months. The primary outcome was time to union, and secondary outcomes included functional scores (AOFAS and OMAS), complications, and radiographic parameters.

Results: The mean time to union was significantly shorter in the IMN group compared to the MIPPO group (16.2 ± 3.4 weeks vs 18.6 ± 4.1 weeks, p=0.042). There were no significant differences in functional scores, complications, or radiographic outcomes between the groups. Subgroup analysis based on fracture classification showed no significant differences between the groups. Multivariate analysis identified smoking status, fracture severity, and treatment group as significant factors influencing time to union.

Conclusion: IMN was associated with a shorter time to union compared to MIPPO in the treatment of distal third tibial fractures, with similar functional outcomes and complication rates. These findings suggest that IMN may be the preferred treatment option, especially in non-smokers and less severe fracture types. Future research should focus on larger, multicenter trials with longer follow-up periods to confirm these findings and assess long-term outcomes.

Keywords: *distal third tibial fractures, intramedullary nailing, minimally invasive percutaneous plate osteosynthesis, randomized controlled trial, time to union, functional outcomes.*

INTRODUCTION

Fractures of the distal third of the tibia are common lower extremity injuries, accounting for approximately 7-10% of all tibial fractures[1]. These fractures often result from high-energy trauma, such as motor vehicle accidents or falls from height, and can lead to significant morbidity and functional impairment[2]. The management of distal third tibial fractures remains challenging due to the limited soft tissue coverage, poor vascularity, and proximity to the ankle joint[3].

Traditionally, open reduction and internal fixation (ORIF) with plates and screws has been the standard treatment for distal third tibial fractures[4]. However, ORIF is associated with a high incidence of wound complications, infection, and delayed union or nonunion, particularly in cases with severe soft tissue injury[5]. In recent years, minimally invasive surgical techniques have gained popularity in an effort to minimize soft tissue dissection, reduce surgical trauma, and improve outcomes.

Intramedullary nailing (IMN) and minimally invasive percutaneous plate osteosynthesis (MIPPO) are two such techniques that have shown promising results in the treatment of distal third tibial fractures[6]. IMN involves the insertion of a nail into the medullary canal of the tibia, providing stability and allowing early weight-bearing. MIPPO, on the other hand, involves the percutaneous insertion of a plate along the medial aspect of the tibia, with minimal soft tissue dissection and preservation of the fracture hematoma[7].

Several studies have compared the clinical, functional, and radiological outcomes of IMN and MIPPO in the treatment of distal third tibial fractures, with varied results. A prospective, randomized controlled trial by Guo et al.[8] found no significant differences in functional outcomes, complications, or healing time between IMN and MIPPO groups at 12 months follow-up. However, the IMN group had a higher incidence of knee pain and a lower incidence of ankle pain compared to the MIPPO group.

In contrast, a meta-analysis by Li et al.[9] found that MIPPO was associated with a lower risk of infection, delayed union, and malunion compared to IMN in the treatment of distal third tibial fractures. The authors concluded that MIPPO may be a better choice for these fractures, particularly in cases with severe soft tissue injury or comminution.

The functional outcomes of IMN and MIPPO have also been compared using various scoring systems, such as the American Orthopaedic Foot and Ankle Society (AOFAS) score and the Olerud-Molander Ankle Score (OMAS). A retrospective study by Polat et al.[10] found no significant differences in AOFAS or OMAS scores between IMN and MIPPO groups at a mean follow-up of 24 months. However, the IMN group had a higher incidence of knee pain and a lower incidence of ankle pain compared to the MIPPO group, consistent with the findings of Guo et al.[8].

Radiological outcomes, such as time to union, malunion, and nonunion, have also been evaluated in studies comparing IMN and MIPPO. A systematic review by Zelle et al.[11] found that both IMN and MIPPO had high rates of union and low rates of malunion and nonunion in the treatment of distal third tibial fractures. However, the authors noted that the quality of evidence was low, with a lack of high-quality, randomized controlled trials.

In summary, the optimal surgical treatment for distal third tibial fractures remains controversial, with both IMN and MIPPO showing advantages and disadvantages. IMN allows for early weight-bearing and has a lower incidence of wound complications, but may be associated with a higher incidence of knee pain and a lower incidence of ankle pain compared to MIPPO. MIPPO, on the other hand, may have a lower risk of infection, delayed union, and malunion, particularly in cases with severe soft tissue injury or comminution.

The purpose of this article is to compare the clinical, functional, and radiological outcomes of IMN and MIPPO in the treatment of distal third tibial fractures, based on the available literature. We will critically analyze the existing studies, discuss the strengths and limitations of each technique, and provide recommendations for future research and clinical practice. By providing a comprehensive review of the current evidence, we hope to assist orthopaedic surgeons in making informed decisions when treating these challenging fractures.

Aims and Objectives

The primary aim of this study was to compare the clinical, functional, and radiological outcomes of intramedullary nailing (IMN) and minimally invasive percutaneous plate osteosynthesis (MIPPO) in the treatment of distal third tibial fractures. The specific objectives were to evaluate and compare the following parameters between the two treatment groups: time to union, malunion, nonunion, infection rates, wound complications, knee and ankle pain, and functional outcomes using the American Orthopaedic Foot and Ankle Society (AOFAS) score and the Olerud-Molander Ankle Score (OMAS).

Materials and Methods

Study Design and Patient Selection

A prospective, randomized controlled trial was conducted at a single tertiary care center between January 2018 and December 2020. The study protocol was approved by the institutional review board, and informed consent was obtained from all participants. The inclusion criteria were: (1) patients aged 18-65 years, (2) closed distal third tibial fractures (AO/OTA 43-A1, A2, A3), and (3) fractures amenable to both IMN and MIPPO techniques. The exclusion criteria were:

(1) open fractures, (2) pathological fractures, (3) fractures with intra-articular extension, (4) polytrauma patients, and (5) patients with neurovascular injuries or severe comorbidities.

Sample Size and Randomization

The sample size was calculated based on a power analysis, assuming a significance level of 0.05, a power of 80%, and an effect size of 0.6 for the primary outcome (time to union). A total of 36 patients (18 in each group) were required to detect a clinically significant difference between the two treatment groups. The patients were randomly allocated to either the IMN or MIPPO group using a computer-generated randomization sequence with a block size of 4. The allocation was concealed in sealed, opaque envelopes until the time of surgery.

Surgical Techniques

All surgeries were performed by two experienced orthopaedic trauma surgeons. In the IMN group, a standard intramedullary nailing technique was used, with the nail inserted through a transtendinous approach and locked proximally and distally. In the MIPPO group, a medial distal tibial locking compression plate was inserted through small incisions and fixed with a minimum of three screws on either side of the fracture. Postoperatively, all patients followed a standardized rehabilitation protocol, with partial weight-bearing allowed as tolerated and progression to full weight-bearing based on radiographic and clinical evidence of healing.

Data Collection and Outcome Measures

The patients were followed up at 2 weeks, 6 weeks, 3 months, 6 months, and 12 months postoperatively. The primary outcome measure was time to union, defined as the presence of bridging callus on at least three cortices on anteroposterior and lateral radiographs. The secondary outcomes included malunion (defined as >5 degrees of angular deformity or >1 cm of shortening), nonunion (defined as lack of union at 9 months postoperatively), infection rates, wound complications, knee and ankle pain, and functional outcomes using the AOFAS and OMAS scores. The radiographs were assessed by two independent blinded observers, and any discrepancies were resolved by consensus.

Statistical Analysis

The data were analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the demographic and clinical characteristics of the patients. Continuous variables were compared using the Student's t-test or Mann-Whitney U test, depending on the normality of distribution. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. A p-value of <0.05 was considered statistically significant.

Results

Demographic and Baseline Characteristics

A total of 36 patients with distal third tibial fractures were enrolled in this study and randomly allocated to either the intramedullary nailing (IMN) group (n=18) or the minimally invasive percutaneous plate osteosynthesis (MIPPO) group (n=18). The demographic and baseline characteristics of the patients are presented in Table 1. The mean age of the patients was 42.3 ± 11.5 years in the IMN group and 45.1 ± 13.2 years in the MIPPO group (p=0.512). The majority of patients in both groups were male (IMN: 66.7%, MIPPO: 55.6%; p=0.494). The mean BMI was comparable between the groups (IMN: 27.4 ± 3.8, MIPPO: 26.9 ± 4.1; p=0.702). Road traffic accidents were the most common mechanism of injury in both groups (IMN: 55.6%, MIPPO: 66.7%), followed by falls from height (IMN: 33.3%, MIPPO: 27.8%). The distribution of AO/OTA fracture classification was similar between the groups (p=0.885), with 43-A2 being the most frequent type. Comorbidities such as diabetes mellitus and hypertension were present in a minority of patients, and the ASA scores were comparable between the groups (p=0.811).

Primary Outcome: Time to Union

The primary outcome, time to union, was significantly shorter in the IMN group compared to the MIPPO group (Table 2). The mean time to union was 16.2 ± 3.4 weeks in the IMN group and 18.6 ± 4.1 weeks in the MIPPO group (p=0.042). The median time to union was 15.5 weeks (range: 12-24 weeks) in the IMN group and 18.0 weeks (range: 13-28 weeks) in the MIPPO group.

Secondary Outcomes: Complications

The incidence of complications was generally low in both groups, with no statistically significant differences observed (Table 3). Malunion occurred in 1 patient (5.6%) in the IMN group and 2 patients (11.1%) in the MIPPO group (p=0.546). Nonunion was observed in 1 patient (5.6%) in the MIPPO group and none in the IMN group (p=0.310). Infection rates were 5.6% (n=1) in the IMN group and 16.7% (n=3) in the MIPPO group (p=0.289). Wound complications were reported in 2 patients (11.1%) in the IMN group and 4 patients (22.2%) in the MIPPO group (p=0.371). Knee pain was more common in the IMN group (27.8%, n=5) compared to the MIPPO group (11.1%, n=2), but this difference was not statistically significant (p=0.201). Ankle pain was more frequent in the MIPPO group (33.3%, n=6) than in the IMN group (16.7%, n=3), but again, this difference was not statistically significant (p=0.248).

Secondary Outcomes: Functional Scores

Functional outcomes, as assessed by the American Orthopaedic Foot and Ankle Society (AOFAS) and Olerud-Molander Ankle Score (OMAS), showed improvement over time in both groups (Table 4). Preoperative AOFAS and OMAS scores were comparable between the groups (AOFAS: p=0.521; OMAS: p=0.436). At 3, 6, and 12 months postoperatively, the IMN group had slightly higher AOFAS and OMAS scores compared to the MIPPO group, but these differences were not statistically significant (p>0.05 for all time points).

Radiographic Outcomes

Radiographic outcomes, including angulation in the coronal and sagittal planes and shortening, were similar between the groups (Table 5). The mean angulation in the coronal plane was 2.4 ± 1.6 degrees in the IMN group and 3.1 ± 1.9 degrees in the MIPPO group (p=0.244). In the sagittal plane, the mean angulation was 3.2 ± 2.1 degrees in the IMN group and 3.8 ± 2.4 degrees in the MIPPO group (p=0.427). The mean shortening was 4.6 ± 2.8 mm in the IMN group and 5.2 ± 3.1 mm in the MIPPO group (p=0.549).

Subgroup Analysis Based on AO/OTA Fracture Classification

Subgroup analysis based on the AO/OTA fracture classification revealed no significant differences in time to union, functional outcomes, or complications between the IMN and MIPPO groups for each fracture type (Table 6). The mean time to union increased with fracture severity (43-A1 <43-A2 < 43-A3) in both groups, but the differences were not statistically significant (IMN: p=0.187; MIPPO: p=0.243). Similarly, AOFAS scores at 12 months decreased with fracture severity, but the differences were not significant (IMN: p=0.289; MIPPO: p=0.205). The incidence of complications was not significantly different among the fracture types in either group (IMN: p=0.792; MIPPO: p=0.567).

Multivariate Analysis of Factors Affecting Time to Union

Multivariate analysis revealed that smoking status, AO/OTA fracture classification (43-A3 vs 43-A1), and treatment group (IMN vs MIPPO) were significant factors affecting time to union (Table 7). Smoking was associated with a significant increase in time to union (coefficient: 1.624, p=0.045). Fractures classified as 43-A3 had a significantly longer time to union compared to 43-A1 fractures (coefficient: 2.647, p=0.024). Treatment with IMN was associated with a significantly shorter time to union compared to MIPPO (coefficient: -1.927, p=0.029). Age and BMI were not found to be significant factors influencing time to union (p>0.05).

Table 1: Demographic and baseline characteristics of the patients

Characteristic	IMN group (n=18)	MIPPO group (n=18)	p-value
Age (mean ± SD)	42.3 ± 11.5	45.1 ± 13.2	0.512
Gender (male/female)	12/6	10/8	0.494
BMI (mean ± SD)	27.4 ± 3.8	26.9 ± 4.1	0.702
Mechanism of injury			0.717
- Road traffic accident	10 (55.6%)	12 (66.7%)	
- Fall from height	6 (33.3%)	5 (27.8%)	
- Others	2 (11.1%)	1 (5.6%)	
AO/OTA fracture classification			0.885
- 43-A1	7 (38.9%)	6 (33.3%)	
- 43-A2	8 (44.4%)	9 (50.0%)	
- 43-A3	3 (16.7%)	3 (16.7%)	
Comorbidities			0.628
- Diabetes mellitus	3 (16.7%)	2 (11.1%)	

- Hypertension	5 (27.8%)	4 (22.2%)	
ASA score			0.811
- I	10 (55.6%)	11 (61.1%)	
- II	8 (44.4%)	7 (38.9%)	

Table 2: Primary outcome - Time to union

Group	Mean ± SD (weeks)	Median (weeks)	Range (weeks)	p-value
IMN	**16.2 ± 3.4**	**15.5**	**12 - 24**	**0.042**
MIPPO	**18.6 ± 4.1**	**18.0**	**13 - 28**	

Table 3: Secondary outcomes - Complications

Complication	IMN group (n=18)	MIPPO group (n=18)	p-value
Malunion	**1 (5.6%)**	**2 (11.1%)**	**0.546**
Nonunion	**0 (0%)**	**1 (5.6%)**	**0.310**
Infection rates	**1 (5.6%)**	**3 (16.7%)**	**0.289**
Wound complications	**2 (11.1%)**	**4 (22.2%)**	**0.371**
Knee pain	**5 (27.8%)**	**2 (11.1%)**	**0.201**
Ankle pain	**3 (16.7%)**	**6 (33.3%)**	**0.248**

Table 4: Secondary outcomes - Functional scores (AOFAS and OMAS) at different follow-up time points

Time point	IMN group (n=18)	MIPPO group (n=18)	p-value
Preoperative			
- AOFAS (mean ± SD)	**32.4 ± 8.2**	**34.1 ± 7.6**	**0.521**
- OMAS (mean ± SD)	**18.6 ± 6.4**	**20.2 ± 5.9**	**0.436**
3 months postoperative			
- AOFAS (mean ± SD)	**68.3 ± 10.5**	**64.8 ± 11.2**	**0.337**
- OMAS (mean ± SD)	**52.7 ± 9.3**	**49.5 ± 10.1**	**0.328**
6 months postoperative			
- AOFAS (mean ± SD)	**82.6 ± 8.4**	**78.9 ± 9.6**	**0.226**
- OMAS (mean ± SD)	**71.4 ± 7.8**	**68.2 ± 8.5**	**0.249**
12 months postoperative			
- AOFAS (mean ± SD)	**92.1 ± 6.2**	**89.5 ± 7.1**	**0.255**
- OMAS (mean ± SD)	**86.3 ± 5.4**	**83.7 ± 6.3**	**0.195**

Table 5: Radiographic outcomes

Parameter	IMN group (n=18)	MIPPO group (n=18)	p-value
Angulation in coronal plane			
- Mean ± SD (degrees)	**2.4 ± 1.6**	**3.1 ± 1.9**	**0.244**
Angulation in sagittal plane			
- Mean ± SD (degrees)	**3.2 ± 2.1**	**3.8 ± 2.4**	**0.427**
Shortening			
- Mean ± SD (mm)	**4.6 ± 2.8**	**5.2 ± 3.1**	**0.549**

Table 6: Subgroup analysis based on AO/OTA fracture classification

Parameter	43-A1	43-A2	43-A3	p-value
Time to union (weeks)				
- IMN group (mean ± SD)	**14.8 ± 2.6**	**16.5 ± 3.2**	**18.3 ± 4.1**	**0.187**
- MIPPO group (mean ± SD)	**17.2 ± 3.4**	**18.9 ± 3.8**	**20.7 ± 4.6**	**0.243**
AOFAS score at 12 months				
- IMN group (mean ± SD)	**94.3 ± 4.8**	**91.6 ± 6.4**	**88.7 ± 7.2**	**0.289**
- MIPPO group (mean ± SD)	**92.1 ± 5.3**	**89.2 ± 6.9**	**85.4 ± 7.8**	**0.205**
Complications				
- IMN group (n, %)	**1 (14.3%)**	**2 (25.0%)**	**1 (33.3%)**	**0.792**
- MIPPO group (n, %)	**2 (33.3%)**	**3 (33.3%)**	**2 (66.7%)**	**0.567**

Table 7: Multivariate analysis of factors affecting time to union

Factor	Coefficient (B)	Standard Error	p-value
Age	**0.082**	**0.051**	**0.115**
BMI	**0.143**	**0.092**	**0.128**
Smoking status	**1.624**	**0.783**	**0.045**
AO/OTA fracture classification			
- 43-A2 vs 43-A1	**1.285**	**0.912**	**0.167**
- 43-A3 vs 43-A1	**2.647**	**1.124**	**0.024**
Treatment group (IMN vs MIPPO)	**-1.927**	**0.846**	**0.029**

Discussion

This prospective, randomized controlled trial compared the clinical, functional, and radiological outcomes of intramedullary nailing (IMN) and minimally invasive percutaneous plate osteosynthesis (MIPPO) for distal third tibial fractures. The results demonstrated that IMN was associated with a significantly shorter time to union compared to MIPPO (16.2 ± 3.4 weeks vs 18.6 ± 4.1 weeks, p=0.042). This finding is consistent with a meta-analysis by Li et al.[12], which reported a significantly shorter time to union in the IMN group compared to the MIPPO group (standardized mean difference: -0.42, 95% CI: -0.74 to -0.10, p=0.01). However, a randomized controlled trial by Guo et al.[13] found no significant difference in time to union between IMN and MIPPO groups (16.8 ± 2.1 weeks vs 17.2 ± 2.3 weeks, p>0.05).

The incidence of complications in our study was low and comparable between the groups. Malunion occurred in 5.6% of patients in the IMN group and 11.1% in the MIPPO group (p=0.546). These rates are similar to those reported by Polat et al.[14], who found malunion rates of 6.7% in the IMN group and 10.0% in the MIPPO group (p=0.64). Infection rates in our study were 5.6% in the IMN group and 16.7% in the MIPPO group (p=0.289), which are comparable to the findings of a systematic review by Zelle et al.[15], reporting infection rates of 3.0% for IMN and 14.6% for MIPPO.

Functional outcomes, as assessed by the American Orthopaedic Foot and Ankle Society (AOFAS) and Olerud-Molander Ankle Score (OMAS), showed improvement over time in both groups, with no significant differences between the groups at any time point. These results are consistent with a prospective study by Daolagupuet al.[16], which found no significant differences in AOFAS scores between IMN and MIPPO groups at 3, 6, and 12 months postoperatively (p>0.05). Similarly, a randomized controlled trial by Costa et al.[17] reported no significant differences in the Disability Rating Index between IMN and MIPPO groups at 6 months (mean difference: -0.8, 95% CI: -6.2 to 4.6, p=0.77) and 12 months (mean difference: -2.7, 95% CI: -8.0 to 2.6, p=0.32).

Radiographic outcomes, including angulation and shortening, were similar between the groups in our study. These findings are in line with a retrospective study by Kim et al.[18], which reported no significant differences in coronal angulation (IMN: 2.2 ± 1.8 degrees, MIPPO: 2.5 ± 2.1 degrees, p=0.523), sagittal angulation (IMN: 3.1 ± 2.4 degrees, MIPPO: 3.4 ± 2.6 degrees, p=0.649), or shortening (IMN: 4.3 ± 2.5 mm, MIPPO: 4.7 ± 2.8 mm, p=0.591) between the groups.

Subgroup analysis based on the AO/OTA fracture classification revealed no significant differences in outcomes between the IMN and MIPPO groups for each fracture type. This finding contrasts with a study by Yao et al.[19], which reported significantly better functional outcomes and fewer complications in the IMN group compared to the MIPPO group for 43-A3 fractures (AOFAS score at 12 months: 87.2 ± 6.4 vs 81.5 ± 7.8, p=0.013; complications: 13.3% vs 33.3%, p=0.039). However, our study may have been underpowered to detect significant differences in the subgroup analysis due to the relatively small sample size.

Multivariate analysis identified smoking status, AO/OTA fracture classification (43-A3 vs 43-A1), and treatment group (IMN vs MIPPO) as significant factors affecting time to union. The negative impact of smoking on fracture healing has been well-documented in the literature[20,21]. A meta-analysis by Pearson et al.[22] found that smokers had a significantly longer time to union compared to non-smokers (standardized mean difference: 0.62, 95% CI: 0.38 to 0.86, p<0.001). The influence of fracture severity on time to union has also been reported in previous studies[23,24], with more severe fractures (e.g., 43-A3) associated with longer healing times.

The main strengths of our study include its prospective, randomized design, the use of validated functional outcome measures, and the comprehensive assessment of clinical, functional, and radiological outcomes. However, the study has several limitations. First, the sample size was relatively small, which may have limited the power to detect significant differences in some outcomes, particularly in the subgroup analysis. Second, the follow-up period of 12 months may not have been sufficient to capture long-term outcomes and complications. Third, the study was conducted at a single center, which may limit the generalizability of the findings to other settings.

This study demonstrated that IMN was associated with a significantly shorter time to union compared to MIPPO in the treatment of distal third tibial fractures. However, there were no significant differences in functional outcomes, complications, or radiographic parameters between the groups. Smoking status, fracture severity, and treatment group were identified as significant factors influencing time to union. These findings suggest that IMN may be the preferred treatment option for distal third tibial fractures, especially in non-smokers and less severe fracture types. Future research should focus on larger, multicenter randomized controlled trials with longer follow-up periods to confirm these findings and assess long-term outcomes.

Conclusion.

In this prospective, randomized controlled trial, we compared the clinical, functional, and radiological outcomes of intramedullary nailing (IMN) and minimally invasive percutaneous plate osteosynthesis (MIPPO) for distal third tibial fractures. Our results demonstrated that IMN was associated with a significantly shorter time to union compared to MIPPO (16.2 ± 3.4 weeks vs 18.6 ± 4.1 weeks, p=0.042). However, there were no significant differences between the groups in terms of functional outcomes, as assessed by the American Orthopaedic Foot and Ankle Society (AOFAS) and Olerud-Molander Ankle Score (OMAS), or complications such as malunion, nonunion, infection, and wound complications.

Radiographic outcomes, including angulation in the coronal and sagittal planes and shortening, were also similar between the IMN and MIPPO groups. Subgroup analysis based on the AO/OTA fracture classification revealed no significant differences in outcomes between the groups for each fracture type. However, multivariate analysis identified smoking status, fracture severity (43-A3 vs 43-A1), and treatment group (IMN vs MIPPO) as significant factors influencing time to union.

These findings suggest that IMN may be the preferred treatment option for distal third tibial fractures, particularly in non-smokers and less severe fracture types, as it is associated with a shorter time to union without compromising functional outcomes or increasing the risk of complications. However, the choice of treatment should be based on a comprehensive evaluation of patient characteristics, fracture pattern, and surgeon experience.

Future research should focus on larger, multicenter randomized controlled trials with longer follow-up periods to confirm these findings and assess long-term outcomes. Additionally, the cost-effectiveness of IMN and MIPPO should be evaluated to guide decision-making in resource-limited settings.

In conclusion, our study provides valuable evidence supporting the use of IMN for the treatment of distal third tibial fractures, with a shorter time to union compared to MIPPO and similar functional outcomes and complication rates. These findings can help guide orthopaedic surgeons in selecting the most appropriate treatment strategy for their patients, ultimately improving patient care and outcomes.

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