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Functional Outcome in Patients with Distal Tibia Fractures Treated with Intramedullary Nailing Vs. Minimally Invasive Plate Osteosynthesis (MIPO)

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Abstract: ***Background: Distal tibial fractures are complex injuries due to their subcutaneous location, limited soft tissue coverage, and risk of malalignment. Surgical management aims to achieve stable fixation, restore alignment, and promote early functional recovery. Intramedullary nailing (IMN) and minimally invasive plate osteosynthesis (MIPO) are widely utilized techniques, yet the optimal modality remains debated. Aim: To compare functional and radiological outcomes in patients with distal tibial fractures treated with IMN versus MIPO. Materials and Methods: This observational study was conducted over one year and included 50 patients with distal tibial fractures. Patients were allocated into two groups: IMN (n=25) and MIPO (n=25). Clinical evaluation, operative parameters, radiological union, and functional outcomes were assessed. Functional outcome was measured using the AOFAS ankle–hindfoot score at 6 months. Statistical comparison was performed between the groups. Results: IMN demonstrated lower operative time, reduced blood loss, and shorter hospital stay compared to MIPO. Radiological union rates were comparable, although minor malalignment was more frequent in the IMN group. Functional outcomes favored IMN, with significantly higher AOFAS scores and earlier return to full weight-bearing. Conclusion: Both IMN and MIPO provided satisfactory outcomes for distal tibial fractures. IMN offered superior early functional recovery, whereas MIPO achieved better alignment control. Treatment selection should be individualized based on fracture characteristics and soft tissue condition.***

Keywords: distal tibia fracture, intramedullary nailing, minimally invasive plate osteosynthesis

1. Introduction

Distal tibial fractures represent a challenging subset of lower extremity injuries due to the complex anatomy of the distal tibia, its limited soft tissue envelope, and compromised vascularity. (1) Such fractures often occur as a result of high-energy trauma, including road traffic accidents, falls from height, and sports injuries, and are frequently associated with concomitant soft tissue damage. (2,3) Optimal surgical management aims to achieve anatomical reduction, stable fixation, early mobilization, and restoration of functional outcomes while minimizing complications such as malunion, delayed union, infection, and post-traumatic arthritis. (4)

Intramedullary nailing (IMN) has gained widespread acceptance as a minimally invasive technique for diaphyseal and select distal tibial fractures, offering advantages such as reduced soft tissue disruption, load-sharing biomechanics, and early weight-bearing potential. However, concerns regarding malalignment, rotational deformities, and delayed union in highly distal fractures persist. Conversely, minimally invasive plate osteosynthesis (MIPO) provides stable fixation with preservation of periosteal blood supply by avoiding extensive dissection, while allowing for accurate alignment and angular stability. Yet, complications including infection, soft tissue irritation, and delayed weight bearing remain relevant. (5)

Comparative evaluation of IMN versus MIPO for distal tibial fractures continues to be of clinical interest, as evidence guiding optimal treatment remains heterogeneous. Our study investigates functional outcomes and complication profiles of both modalities to clarify their relative therapeutic merits.

2. Materials and Methods

Our observational study had been conducted in the Department of Orthopaedics at a tertiary care hospital over a period of one year. Patients who presented with distal tibial fractures and satisfied the inclusion criteria had been enrolled after obtaining informed consent. The study population comprised 50 adult patients aged above 18 years with closed or Gustilo-Anderson Grade I and II open fractures of the distal tibia. Patients with pathological fractures, polytrauma, or fractures extending into the plafond requiring separate fixation had been excluded.

Patients had been randomly allocated into two treatment groups: intramedullary nailing (IMN) and minimally invasive plate osteosynthesis (MIPO), each comprising 25 patients. Preoperative evaluation included detailed clinical history, physical examination, and radiographic assessment with anteroposterior and lateral views of the tibia and ankle. Routine blood investigations and anaesthesia fitness assessment had been performed for all patients prior to surgery.

Surgical procedures had been performed under regional or general anesthesia by experienced orthopaedic surgeons. In the IMN group, fractures had been stabilized using a locked tibial intramedullary nail inserted through a suprapatellar or infrapatellar approach. In the MIPO group, fractures had been fixed using a pre-contoured distal tibial locking plate inserted using minimally invasive soft tissue sparing techniques. Postoperatively, patients had received standardized antibiotic prophylaxis, analgesia, and limb elevation.

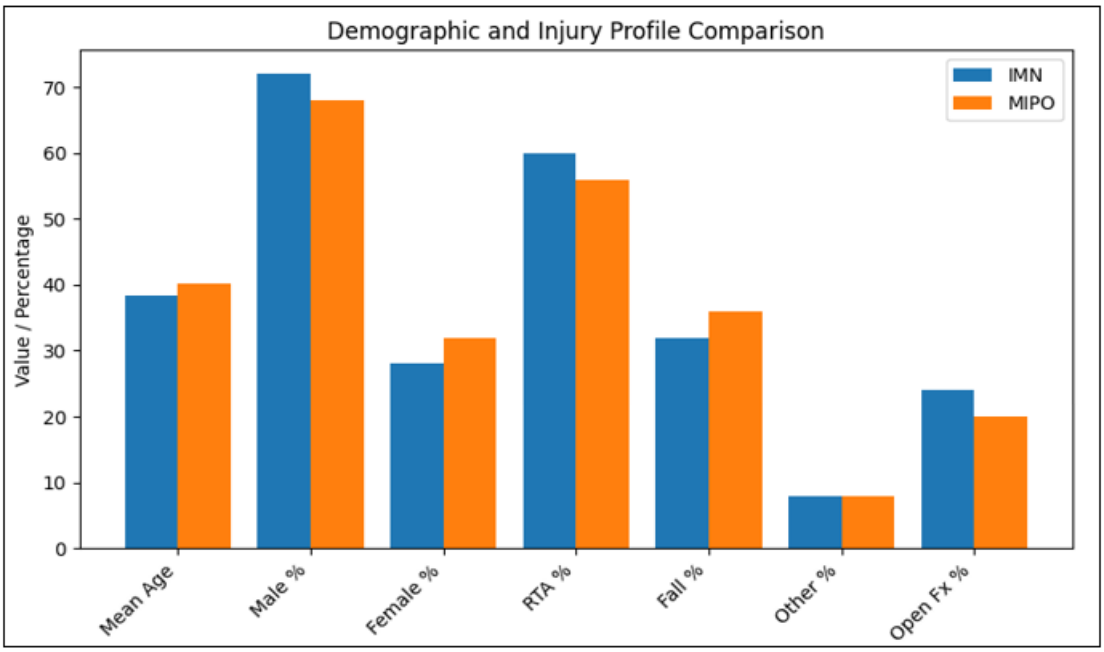
Patients had been followed at regular intervals for clinical and radiological evaluation at 6 weeks, 3 months, and 6 months.

Functional outcome had been assessed using validated scoring systems and ankle range of motion, while radiological union had been determined based on cortical bridging and absence of tenderness at the fracture site. Complications such as malalignment, infection, delayed union, and nonunion had been recorded. Data had been compiled and analyzed using appropriate statistical methods to compare the outcomes between the two treatment groups.

3. Results

Table 1: Demographic and Injury Profile of Study Participants (n=50)

Variable	IMN Group (n=25)	MIPO Group (n=25)	Total (n=50)
Mean Age (years)	38.4 ± 10.6	40.2 ± 11.4	39.3 ± 10.9
Male	18 (72%)	17 (68%)	35 (70%)
Female	7 (28%)	8 (32%)	15 (30%)
Mode of Injury: RTA	15 (60%)	14 (56%)	29 (58%)
Mode of Injury: Fall	8 (32%)	9 (36%)	17 (34%)
Other	2 (8%)	2 (8%)	4 (8%)
Open Fracture (GA I–II)	6 (24%)	5 (20%)	11 (22%)



Graph 1: Demographic and Injury Profile of Study Participants (n=50)

Table 2: Operative and Early Post-operative Parameters

Parameter	IMN Group (n=25)	MIPO Group (n=25)	p-value
Mean Operative Time (min)	72.6 ± 14.8	94.5 ± 19.2	0.001*
Mean Blood Loss (mL)	110 ± 24	148 ± 32	0.002*
Soft Tissue Complications	2 (8%)	4 (16%)	0.38
Mean Hospital Stay (days)	5.2 ± 1.4	7.1 ± 1.8	0.001*

*Significant $p < 0.05$

Table 3: Radiological Union & Alignment Outcomes

Outcome	IMN Group (n=25)	MIPO Group (n=25)	p-value
Union at 12 Weeks	12 (48%)	10 (40%)	0.56
Union at 24 Weeks	24 (96%)	23 (92%)	0.55
Mean Time to Union (weeks)	18.5 ± 3.2	19.8 ± 3.7	0.18
Malalignment (>5°)	3 (12%)	1 (4%)	0.29
Nonunion	1 (4%)	2 (8%)	0.55

Table 4: Functional Outcomes at Final Follow-up (6 Months)

Functional Parameter	IMN Group (n=25)	MIPO Group (n=25)	p-value
AOFAS Ankle–Hindfoot Score (Mean ± SD)	86.4 ± 6.8	82.1 ± 7.2	0.03*
Excellent	10 (40%)	6 (24%)	0.21
Good	12 (48%)	13 (52%)	0.58
Fair	2 (8%)	4 (16%)	0.38
Poor	1 (4%)	2 (8%)	0.55
Return to Full Weight Bearing (weeks)	14.3 ± 3.2	17.1 ± 3.9	0.01*

*Significant $p < 0.05$

Figure 1: Distal tibial fractures

4. Discussion

Distal tibial fractures pose a therapeutic challenge due to their subcutaneous location, limited soft tissue envelope, and propensity for malalignment and delayed healing. The present study compared functional and radiological outcomes of intramedullary nailing (IMN) versus minimally invasive plate osteosynthesis (MIPO) in 50 patients treated over one year, providing insights into the relative merits of each modality. (7)

The demographic distribution between the IMN and MIPO groups had been comparable, indicating that both cohorts were largely homogeneous in terms of age, sex, and mechanism of injury. High-energy trauma, predominantly road traffic accidents, had constituted the major etiological factor in both groups, aligning with trends reported in contemporary orthopaedic literature. The incidence of open fractures (GA I–II) had also been consistent with other studies evaluating distal tibial injuries treated by biological fixation techniques.

Operative parameters demonstrated meaningful differences between the two modalities. The MIPO group had exhibited significantly longer operative times and greater intraoperative blood loss compared to IMN, attributable to plate contouring, careful submuscular tunneling, and indirect fracture reduction techniques inherent to MIPO. Conversely, IMN had offered shorter surgical duration and less soft tissue handling, reflected in a shorter hospital stay. These findings corroborate prior reports indicating that IMN facilitates quicker perioperative recovery due to its minimally invasive nature and load-sharing biomechanics. (8,9)

Radiological union had been achieved in a high proportion of cases in both groups, with no statistically significant difference in union rates or mean time to union. Although IMN demonstrated a slightly faster progression to union, the clinical significance of this modest difference remains debatable. Notably, malalignment (>5°) had been more frequent in the IMN group, possibly due to challenges in maintaining distal alignment in metaphyseal fractures with limited cortical contact. MIPO, by virtue of angular stable locking plates and improved control over reduction, had yielded better alignment. However, minor alignment deviations did not appear to adversely impact functional scores within the follow-up period. (10)

Functional outcomes evaluated by AOFAS ankle–hindfoot scores at six months favored IMN, with significantly higher scores and earlier return to full weight-bearing. Earlier mobilization in IMN cases likely contributed to superior overall function, consistent with weight-sharing characteristics of intramedullary fixation. Conversely, MIPO had required delayed mobilization to safeguard against plate failure, resulting in comparatively slower functional recovery. Complication profiles between the groups had been comparable; however, superficial soft tissue complications had been more commonly reported in the MIPO cohort, which is consistent with literature referencing plate prominence and soft tissue irritation. (11,12)

Overall, both treatment modalities proved effective for distal tibial fractures with acceptable union rates and satisfactory function. IMN offered advantages in operative efficiency, soft tissue preservation, and early ambulation, whereas MIPO demonstrated superior alignment control and reduced incidence of malalignment. Treatment choice should therefore be individualized based on fracture pattern, soft tissue condition, and surgeon expertise. Further studies with larger sample sizes and longer follow-up would help clarify the long-term impact on ankle function and post-traumatic arthritis.

5. Conclusion

Both IMN and MIPO provided satisfactory outcomes for distal tibial fractures. IMN offered superior early functional recovery, whereas MIPO achieved better alignment control. Treatment selection should be individualized based on fracture characteristics and soft tissue condition.

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