

ORIGINAL ARTICLE

Ultra-distal Tibial Fractures: A retrospective comparison of distal plate versus nail fixation

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ABSTRACT

Background: Ultra-distal tibial fractures, involving the metaphyseal and epiphyseal regions of the distal tibia, are challenging to manage due to limited bone stock, complex anatomy and soft tissue vulnerability.

Aim: To compare the clinical and radiological outcomes of distal tibial plate fixation versus intramedullary nail fixation in the treatment of ultra-distal tibial fractures.

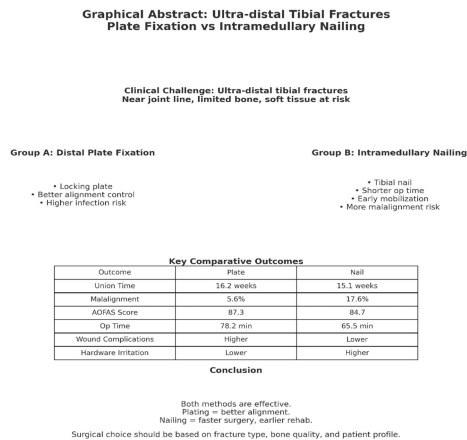
Methods: A retrospective study was conducted in the Department of Orthopedic THQ Hospital Samarbagh Dir lower KPK during May 2022 to June 2023. Patients were divided into two groups: Group A (n=18) underwent distal tibial plating and Group B (n=17) received intramedullary nailing. Data were collected on union time, malalignment, functional outcomes (AOFAS score), operative time, hospital stay, and complications.

Results: The mean time to union was 16.2±2.4 weeks in the plating group and 15.1±2.1 weeks in the nailing group (p=0.12). Malalignment occurred in 5.6% of the plating group and 17.6% of the nailing group (p = 0.24). Mean AOFAS scores at 12 months were 87.3 ± 6.8 (plating) and 84.7±7.5 (nailing) (p=0.21). Operative time and hospital stay were significantly shorter in the nailing group (p< 0.05). Superficial wound complications were more frequent in the plating group, whereas hardware irritation was more common with nailing.

Conclusion: It is concluded that both distal plating and intramedullary nailing are viable options for managing ultra-distal tibial fractures. Plating offers better alignment control, while nailing provides benefits in terms of surgical efficiency and early rehabilitation.

Keywords: Intramedullary nail, tibial fracture, Ultra-distal tibial fractures

Figure 1: Graphical Abstract



easily develop problems such as malalignment and delayed union and nonunion and post-traumatic arthritis². Operation of ultra-distal tibial fractures offers healthcare providers a serious challenge because they must select suitable fixation methods. Medical professionals establish intramedullary nailing (IMN) as the preferred treatment approach for both diaphyseal and proximal metaphyseal tibial fractures. The benefits of this technique include minimally invasive treatment and preservation of periosteal blood supply as well as its capacity to distribute loads across the structure which makes it suitable for various treatment approaches³.

The use of IMN as a treatment method for ultra-distal fractures remains disputed because the short distal fragment prevents the placement of multiple locking screws which reduces the stability of the fixation. The quality of reduction during surgery needs fluoroscopic assistance alongside correct technique because malreduction in coronal and sagittal planes remains a documented risk factor⁴.

Placing locking compression plates (LCPs) directly onto the distal tibia allows for better visual inspection of the break and improved joint alignment control and robust fixation for osteoporotic bones. The procedure allows physicians to add multiple screws within the distal fragment thus enabling enhanced rotational stability when treating comminuted situations⁵. The procedure comes with potential risks such as thorough soft tissue surgical breakdown and higher wound separation alongside deep infection potential especially in open fractures or cases with deteriorated soft tissue coverage⁶. Modern surgical approaches with improved implant technology are focused on resolving the limitations associated with the procedure. The advancements of suprapatellar nailing procedures as well as far distal targeting guides and multi-planar distal locking screws have made IMN suitable for the treatment of fractures extending further down the bone. MIPO techniques have been developed to minimize the soft tissue damage from plating while maintaining disk stability⁷. The identification of a superior fixation strategy for ultra-distal tibial

INTRODUCTION

Ultra-distal tibial fractures represent a unique and challenging subset of lower extremity injuries, often occurring near the ankle joint with minimal diaphyseal extension. These fractures, typically classified within the AO/OTA 43-A or 43-B categories, are frequently the result of high-energy trauma such as motor vehicle accidents or falls from a height in younger individuals, or low-energy twisting injuries in osteoporotic bone among the elderly¹.

These particular fractures at this ankle joint location present an increased challenge for stable fixation repairs because they

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fractures faces challenges because high-quality examinations about this specific category are lacking. Intramedullary nailing functions as a minimal procedure which maintains the periosteal bloodstream while diminishing operative site access⁸. The IMN construct provides an advantage to mechanical loading in the axial direction and leads to rapid weight-bearing periods and reduced hospital stay durations. The technique encounters difficulties when securing fixation to short distal fragments and carries the risks of malalignment in both coronal and sagittal planes while hardware placed near the distal segment may lead to ankle irritation⁹. The merging of modern nailing systems through multi-locking capabilities alongside distal targeting instruments has extended IMN applications for treating fractured areas distally along the bone. The outcome success of plating distal tibial fractures improved as a result of anatomically contoured pre-shaped plate design alongside minimally invasive percutaneous plate osteosynthesis (MIPPO) techniques¹⁰.

The objective of the study was to compare the clinical and radiological outcomes of distal tibial plate fixation versus intramedullary nail fixation in the treatment of ultra-distal tibial fractures.

METHODOLOGY

This retrospective comparative study was conducted at Department of Orthopedic THQ Hospital Samarbagh Dir lower KPK during May 2022 to June 2023. A total of 35 patients who presented with ultra-distal tibial fractures were included in the study.

Inclusion criteria

- Age ≥ 18 years
- Fracture located within the distal 4–6 cm of the tibial plafond (confirmed radiologically)
- Closed or Gustilo-Anderson Grade I open fractures
- Minimum follow-up of 12 months postoperatively

Exclusion criteria

- Pathological fractures
- Polytrauma patients with hemodynamic instability
- Patients with concurrent ipsilateral foot or ankle fractures
- Gustilo-Anderson Grade II and III open fractures
- Previous history of surgery on the affected limb

Data collection: Patients were divided into two groups based on the fixation technique utilized. Patients were divided into two groups based on the fixation method used:

Group A (n = 18): Treated with distal tibial locking plate fixation

Group B (n = 17): Treated with intramedullary nailing

Group A consisted of 18 patients who underwent distal tibial plate fixation using locking compression plates. Group B included 17 patients treated with intramedullary nailing. The choice of fixation technique was determined by the attending orthopedic surgeon, based on fracture morphology, bone quality, and the overall condition of the surrounding soft tissues. Experienced trauma surgeons performed all procedures and maintained the same treatment protocols because they were proficient in both operative approaches. Surgical plate insertion for patients in Group A happened through minimally invasive access points that used anteromedial or medial incisions based on the fracture alignment and tissue conditions. Medical professionals used anatomically designed locking compression plates which were targeted for the distal tibia section. The reduction process happened indirectly whenever possible by focusing on blood supply maintenance and soft tissue preservation during treatment. Patients in Group B underwent intramedullary nailing through two feasible approaches which included both parapatellar and infrapatellar methods. Fluoroscopy was used for tibial nail insertion while the surgeons ensured proper alignment within all planes as a top priority. Multiple angled screws were put in place for achieving stable fixation of difficult to treat ultra-distal bone segments since this

area has restricted bone resources. Every patient received the same protocol of postoperative care. Postoperative treatment involved intravenous antibiotics given both during and after surgery extending to 24–48 hours. The physical therapy program included passive and active range of motion exercises that health professionals performed during the first week after surgery. The healthcare provider allowed patients to bear weight on their operated foot partially from week six to eight according to their X-ray healing progress. The patient received full weight-bearing permission once doctors validated sufficient callus formation together with cortical bridging. The evaluations included clinical tests and radiological assessments which took place at scheduled check-ups 2 weeks after surgery and then at 6 weeks and 3 months and directly postoperative.

Statistical Analysis: Data were analyzed using SPSS v21. Continuous variables were expressed as means with standard deviations and analyzed using the Student's t-test. Categorical variables were compared using the Chi-square test or Fisher's exact test, depending on the data distribution. A p-value of less than 0.05

RESULTS

Data were collected from 35 patients, mean age of patients in Group A (plate fixation) was 42.6 ± 11.3 years, while Group B (nail fixation) had a mean age of 40.8 ± 10.7 years ($p=0.52$). The male-to-female ratio was also similar between the groups, with Group A having 11 males and 7 females, and Group B having 10 males and 7 females ($p=0.91$). The primary mechanism of injury was road traffic accidents, which accounted for 66.7% of cases in Group A and 64.7% in Group B ($p = 0.89$), followed by falls from height in both groups (33.3% in Group A and 35.3% in Group B).

Table 1: Patient Demographics and Injury Characteristics

Parameter	Group A Plate Fixation (n = 18)	Group B: Nail Fixation (n = 17)	p-value
Mean age (years)	42.6 ± 11.3	40.8 ± 10.7	0.52
Male : Female	11:7	10:7	0.91
Mechanism of injury			
Road traffic accident	12 (66.7%)	11 (64.7%)	0.89
- Fall from height	6 (33.3%)	6 (35.3%)	

The mean time to union was slightly shorter in the nail group (15.1 ± 2.1 weeks) compared to the plate group (16.2 ± 2.4 weeks), though the difference was not significant. Malalignment occurred more frequently in the nail group (17.6%) than in the plate group (5.6%), but this was also not statistically significant. The AOFAS scores were similar between the two groups, though the plate group showed better alignment control (10.1 ± 0.7 vs 8.4 ± 1.3 , $p=0.03$).

Table 2: Radiological Outcomes

Outcome	Group A Plate (n=18)	Group B Nail (n=17)	p-value
Time to union (weeks)	16.2 ± 2.4	15.1 ± 2.1	0.12
Union within 16 weeks	14 (77.8%)	15 (88.2%)	0.41
Delayed union (>20 weeks)	2 (11.1%)	1 (5.9%)	0.60
Malalignment (>5°)	1 (5.6%)	3 (17.6%)	0.24
Total AOFAS Score	87.3 ± 6.8	84.7 ± 7.5	0.21
Pain	36.2 ± 3.1	34.8 ± 3.4	0.18
Function	41.0 ± 4.2	41.5 ± 4.6	0.72
Alignment	10.1 ± 0.7	8.4 ± 1.3	0.03*

*Significant at $p < 0.05$

The operative time was significantly shorter in the nail fixation group (65.5 ± 8.9 minutes) compared to the plate fixation group (78.2 ± 10.4 minutes), with a p-value of <0.01 . Additionally, the hospital stay was shorter in the nail group (3.9 ± 1.1 days) compared to the plate group (4.7 ± 1.2 days), with a p-value of 0.04.

Table 3: Operative and Hospitalization Details

Parameter	Group A Plate	Group B Nail	p-value
Operative time (minutes)	78.2 ± 10.4	65.5 ± 8.9	<0.01*
Hospital stays (days)	4.7 ± 1.2	3.9 ± 1.1	0.04*

*Significant at p < 0.05

Superficial wound infections occurred in 11.1% of the plate group and 0% in the nail group ($p=0.23$), while deep infections were observed in 5.6% of the plate group and 0% in the nail group ($p = 0.33$). Hardware irritation or the need for implant removal was more common in the nail group (17.6%) compared to the plate group (5.6%), though the difference was not statistically significant ($p=0.24$). Non-union rates were similar in both groups, with one case in each group ($p=0.97$). Overall, the total complication rate was 22.2% in the plate group and 17.6% in the nail group ($p = 0.66$), indicating no significant difference between the two fixation methods.

Table 4: Complications

Complication	Group A Plate (n= 8)	Group B Nail (n=17)	P value
Superficial wound infection	2 (11.1%)	0 (0%)	0.23
Deep infection	1 (5.6%)	0 (0%)	0.33
Hardware irritation/implant removal	1 (5.6%)	3 (17.6%)	0.24
Non-union	1 (5.6%)	1 (5.9%)	0.97
Total complications	4 (22.2%)	3 (17.6%)	0.66

DISCUSSION

The management of ultra-distal tibial fractures presents unique challenges due to the proximity of the fracture to the ankle joint, limited distal bone stock, and delicate soft tissue envelope. The study that included 35 patients demonstrated similar advantageous results for both distal plating and intramedullary nailing regarding bone union and implant position, and patient rehabilitation. The nailing approach produced a result of 15.1 ± 2.1 weeks for radiological union, while plating achieved 16.2 ± 2.4 weeks for the same outcome, although the statistics showed no significant difference between groups¹¹. The approach for both methods led to low delayed union rates, thus showing biological fixation remains effective when used correctly¹².

The nailing group experienced malalignment in the coronal plane at a rate of 17.6%, whereas the plating group had a rate of 5.6%. Numerous studies have demonstrated that the restrictions of distal screw purchase and short working segment in intramedullary nails can hinder accurate fracture alignment in very distal bone fractures. The observations in this study suggest this trend while showing no statistical significance¹³. Direct visualization and control of fracture fragments under plate fixation provides better alignment quality that an advantage comminuted and intra-articular fracture treatments. The plating technique showed a non-significant slight advantage over intramedullary nailing according to AOFAS Ankle-Hindfoot Score assessments but both procedures yielded identical functional outcome results¹⁴. Operation times as well as postoperative hospital stays came out shorter when intramedullary nailing techniques were employed. These clinical findings remain essential when applied to large-trauma centers along with patient groups that need early rehabilitation leading to hospital discharge. The comprehensive soft tissue surgical procedures for plating create increased risks particularly in parts with poor blood vessel circulation¹⁵. Although all infections remained contained to superficial layers no one patient developed implant failure or deep osteomyelitis the results emphasize the essential role of careful surgical technique and standardized postoperative wound care¹⁶⁻¹⁸. Ankle joints experienced more hardware disturbances during nailing procedures because the locking screws operated proximal to this sensitive area. This study has several limitations. The retrospective method of analysis produces selection and observer biases that naturally affect the

study results. The limited number of patients in the study reduced the statistical effectiveness of subgroup analysis.

CONCLUSION

It is concluded that both distal tibial plate fixation and intramedullary nail fixation are effective surgical options for the management of ultra-distal tibial fractures, with each method offering distinct advantages depending on the clinical context. Plate fixation provides better control over fracture alignment and may be more suitable for comminuted or intra-articular fractures, where precise anatomical reduction is crucial. In contrast, intramedullary nailing offers shorter operative times, earlier mobilization, and reduced hospital stays, making it an efficient alternative in extra-articular fracture patterns with adequate distal bone for locking.

Ethics approval and consent to participate: This study was approved by the Ethical Review Board THQ Hospital Samarbagh Dir. All methods were carried out in accordance with the Helsinki Declaration.

Authorship and contribution declaration: Each author of this article fulfilled following Criteria of Authorship:

1. Conception and design of or acquisition of data or analysis and interpretation of data.
2. Drafting the manuscript or revising it critically for important intellectual content.
3. Final approval of the version for publication.

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