Section: Orthopaedics

Original Research Article

A PROSPECTIVE COMPARATIVE STUDY TO ASSESS FUNCTIONAL AND RADIOLOGICAL OUTCOME OF INTRAMEDULLARY INTERLOCKING NAILING VS ANATOMIC PLATING OF CLOSED EXTRA-ARTICULAR DISTAL TIBIA FRACTURES IN A TERTIARY CARE CENTRE

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ABSTRACT

Background: Closed extra-articular distal tibia fractures are challenging injuries because of the subcutaneous location of the tibia, limited soft tissue coverage, proximity to the ankle joint, and risk of complications such as wound problems, malunion, delayed union and non-union. Intramedullary interlocking nailing and anatomic plating are commonly used fixation modalities, but each method has specific advantages and limitations.
Objectives: To assess the functional and radiological outcome of intramedullary interlocking nailing versus anatomic plating of closed extra-articular distal tibia fractures. The study also aimed to determine time to radiological union and evaluate postoperative complications including infection, implant failure, stiffness, malunion, and non-union.
Materials and Methods: This prospective randomised controlled trial included 30 patients with closed extra-articular distal tibia fractures. Patients were split into two equal groups of 15 cases each. Group A was treated with intramedullary interlocking nailing, while Group B was treated with plating. The study was conducted over 18 months at Subharti Medical College, Meerut. Patients were followed up at 2 weeks, 4 weeks, 3 months and 6 months. Functional and radiological outcomes were assessed using Karlsson and Peterson scoring system and American Orthopaedic Foot and Ankle Society score. Data were analysed using Microsoft Excel and SPSS version 20, with $p < 0.05$ considered statistically significant.
Results: Baseline demographic and fracture characteristics were comparable between the two groups. Intramedullary interlocking nailing was associated with shorter operating time, lower intraoperative blood loss, earlier clinical and radiological union, and better early AOFAS score at 2 weeks. Anatomic plating showed better alignment control, while wound complications were higher in the plating group and malunion was more common in the nailing group. At 6 months, both groups achieved comparable final functional outcomes.

Conclusion: Both intramedullary interlocking nailing and anatomic plating are effective treatment options for closed extra-articular distal tibia fractures. Intramedullary interlocking nailing provides shorter operative time, less blood loss, earlier union and better early functional recovery, while anatomic plating provides better alignment control but is associated with higher wound and implant-related soft tissue complications. Treatment choice should be individualized according to fracture pattern, soft tissue condition and need for alignment control.
Keywords: Distal tibia fracture, Intramedullary interlocking nailing, Anatomic plating, Extra-articular fracture, Radiological union, AOFAS score, Functional outcome, Orthopaedic trauma.

INTRODUCTION

The tibia is the most commonly fractured long bone encountered by orthopaedic surgeons because of its subcutaneous location and limited soft tissue envelope, especially in the distal one-third region. Closed extra-articular distal tibia fractures are clinically important because they occur close to the ankle joint and may adversely affect mobility, weight bearing, ankle function and quality of life.

Distal tibia fractures commonly occur after road traffic accidents, self-fall injuries and high-energy trauma. Their management is difficult because the distal tibia has poor soft tissue cover, a relatively wide metaphyseal canal and close proximity to the ankle joint. These factors make stable fixation and maintenance of alignment technically challenging and increase the risk of wound complications, delayed union, non-union, malunion and implant-related irritation.

Several treatment modalities are available for these fractures, including intramedullary interlocking nailing, open reduction and internal fixation with plating, minimally invasive plate osteosynthesis, external fixation, hybrid external fixation and Ilizarov ring fixation. However, no single treatment method perfectly fulfils all mechanical and biological requirements for distal diametaphyseal tibia fractures.

Intramedullary interlocking nailing has the advantages of smaller incisions, preservation of periosteal blood supply, reduced surgical exposure, shorter operating time and early mobilization. However, distal metaphyseal fractures may be prone to malalignment because the nail may not adequately control the wider distal fragment. Anatomic plating allows better restoration and maintenance of alignment, but the subcutaneous position of the distal tibia increases the risk of wound-related complications and implant prominence.

Therefore, this prospective comparative study was conducted to assess and compare the functional and radiological outcomes of intramedullary interlocking nailing and anatomic plating in patients with closed extra-articular distal tibia fractures in a tertiary care centre.

MATERIALS AND METHODS

Study design: Prospective randomised controlled trial.

Study subjects: A total of 30 cases were studied, with 15 cases in each group.

Study period: 18 months.

Study area: Subharti Medical College, Meerut.

Group allocation: Patients were split into two groups. Intramedullary nailing was used in Group A, while plating was used in Group B.

Sampling technique: Simple random sampling was used by alternate method.

Inclusion Criteria

- All closed extra-articular distal tibia fractures.
- Age more than 18 years.
- Patients who gave written informed consent.
- Fracture 5 cm above ankle joint line.

Exclusion Criteria

- Open fractures.
- Pathological fractures.
- Age less than 18 years.
- Presence of infection in fracture.
- Medically unfit patients.
- Intra-articular fractures.
- Associated fractures of ipsilateral lower limb.

Study Procedure: The goals and need of the study were communicated to all patients who agreed to participate, and informed consent was obtained. According to the inclusion criteria, 30 patients were enrolled in the trial and allocated into two equal groups. For each case, a comprehensive questionnaire was filled, including age, occupation and other relevant clinical details. Complications were assessed pre-operatively, intraoperatively, immediately postoperatively and during late follow-up.

Outcome assessment: Functional and radiological outcomes were assessed using Karlsson and Peterson scoring system and American Orthopaedic Foot and Ankle Society score during follow-up.

Follow-up schedule: All patients were followed up for 6 months with assessments at 2 weeks, 4 weeks, 3 months and 6 months.

Sample size estimation: Sample size was calculated using the formula n = 2 (Zalpha + Zbeta)^2 sigma^2 / d^2. In the calculation, x1 = 54.97, x2 = 47.10, Zalpha = 1.96 for 95% confidence interval, Zbeta = 0.84 for 80% power, d

= 7.87 and sigma = 10.99. The final sample size came out to be 30.58, approximated to 30.

Statistical Analysis: Data were collected and entered in Microsoft Excel. Analysis was carried out using SPSS version 20. The results were expressed in the form of descriptive and inferential statistics. Fisher's exact test was used to assess clinical outcomes between intramedullary interlocking nailing and anatomical plating groups. The significance level was set at $p < 0.05$.

RESULTS

Baseline demographic and fracture profile

The anatomic plating group had a mean age of 40.5 years, median age of 40 years, standard deviation of 7.48 years, minimum age of 29 years and maximum age of 53 years. The intramedullary interlocking nailing group had a mean age of 38.3 years, median age of 37 years, standard deviation of 7.62 years, minimum age of 28 years and maximum age of 52 years. Female patients included 6 in the anatomic plating group and 5 in the intramedullary interlocking nailing group, while male patients included 9 in the anatomic plating group and 10 in the intramedullary interlocking nailing group. Road traffic accident was the most common mode of injury, with 7 patients in each group. Fall accounted for 4 patients in each group, slip for 2 patients in each group, sports injury for 1 patient in each group and assault for 1 patient in each group. AO fracture pattern distribution was comparable, with extra-articular distal tibia comminuted fracture in 4 anatomic plating patients and 3 intramedullary interlocking nailing patients, extra-articular distal tibia simple fracture in 5 anatomic plating patients and 6 intramedullary interlocking nailing patients, and extra-articular distal tibia wedge fracture in 6 patients in each group. Injury-to-surgery interval ranged from 2 to 7 days. In the anatomic plating group, surgery was performed at 2 days in 1 patient, 3 days in 5 patients, 4 days in 3 patients, 5 days in 2 patients, 6 days in 2 patients and 7 days in 2 patients. In the intramedullary interlocking nailing group, surgery was performed at 2 days in 3 patients, 3 days in 4 patients, 4 days in 3 patients, 5 days in 2 patients, 6 days in 2 patients and 7 days in 1 patient. Treatment delay was due to skin condition, blisters and superficial abrasion.

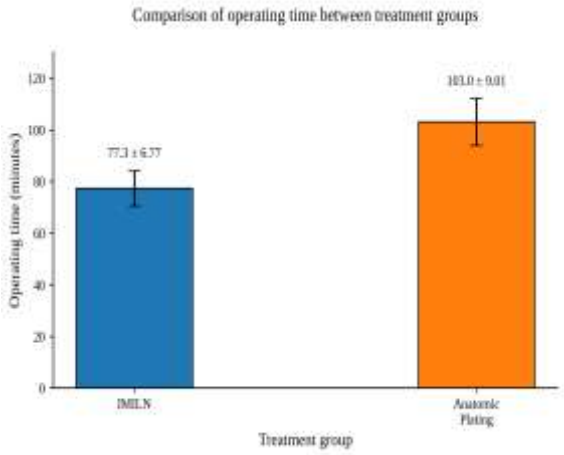

Figure 1: Comparison of operating time between treatment groups. Values are shown as mean ± SD.

Operating time was lower in the intramedullary interlocking nailing group than in the anatomic plating group, as shown in Figure 1.

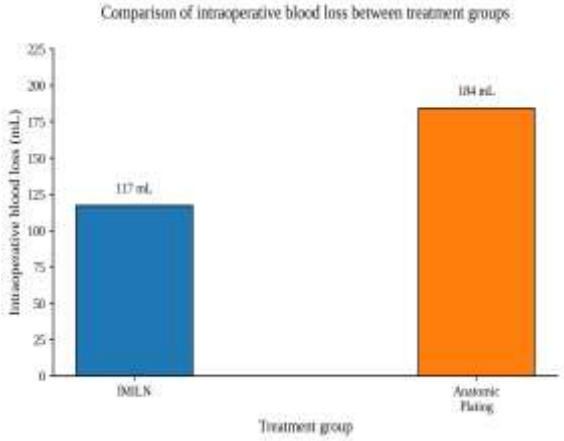

Figure 2: Comparison of intraoperative blood loss between treatment groups.

Intraoperative blood loss was lower in the intramedullary interlocking nailing group than in the anatomic plating group, as shown in Figure 2.

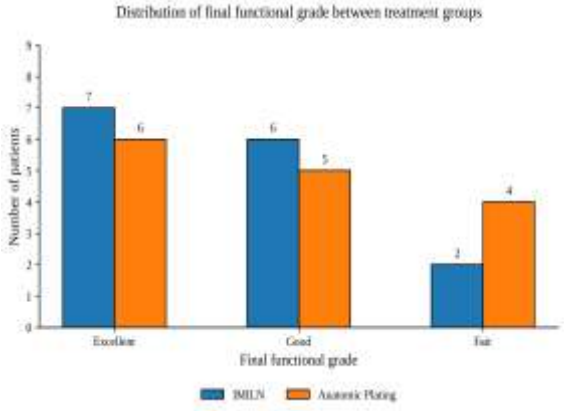

Figure 3: Distribution of final functional grade between treatment groups.

Final functional grade distribution showed good-to-excellent outcomes in most patients in both treatment groups, as shown in Figure 3.

Patient satisfaction at final follow-up was favourable in both treatment groups, as shown in Figure 4.

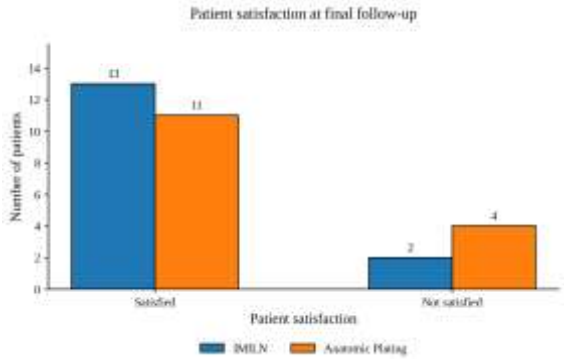

Figure 4: Patient satisfaction at final follow-up.

Table 1: Comparison of postoperative complications between treatment groups

Complication	Anatomic Plating	IMILN	Statistical result
Superficial infection	3/15	1/15	Chi-square = 0.682, p = 0.409; Fisher's exact p = 0.682
Wound complication	5/15	1/15	Chi-square = 9.13, p = 0.003; Fisher's exact p = 0.006
Malunion	0/15	5/15	Chi-square = 6.00, p = 0.050; Fisher's exact p = 0.042
Delayed union	4/15	2/15	Chi-square = 0.833, p = 0.361; Fisher's exact p = 0.651
Non-union	0/15	0/15	Statistical comparison not applicable

Table 1 shows that wound complications were significantly associated with plating, while malunion was significantly associated with intramedullary interlocking nailing. Infection, delayed union and non-union did not show a significant adverse pattern requiring separate graphical repetition.

Implant-related complications followed different patterns in the two treatment groups, with plate-related symptoms in the plating group and nail-related anterior knee or screw symptoms in the nailing group, as shown in Figure 5.

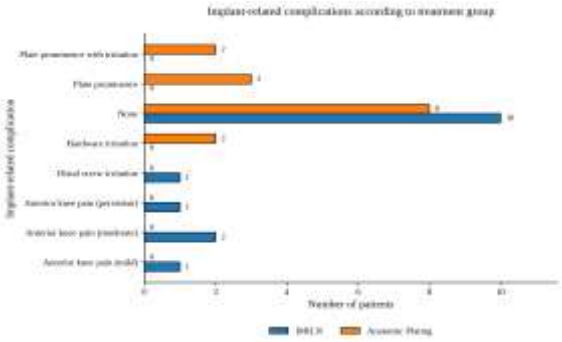

Figure 5: Implant-related complications according to treatment group. Chi-square = 12.2, df = 7, p = 0.093; Fisher's exact p = 0.032.

Table 2: Comparison of clinical and radiological union between treatment groups

Outcome	Group	N	Mean	Median	SD	SE	Independent samples t-test
Clinical union (weeks)	Anatomic Plating	15	16.5	16.0	2.20	0.568	t = 2.54; df = 28.0; p = 0.017; mean difference = 1.80; SE difference = 0.707; effect size = 0.929
Clinical union (weeks)	IMILN	15	14.7	15.0	1.63	0.422	
Radiological union (weeks)	Anatomic Plating	15	18.5	18.0	2.20	0.568	t = 2.54; df = 28.0; p = 0.017; mean difference = 1.80; SE difference = 0.707; effect size = 0.929
Radiological union (weeks)	IMILN	15	16.7	17.0	1.63	0.422	

Table 2 demonstrates earlier clinical and radiological union in the intramedullary interlocking nailing group, with statistically significant differences for both outcomes.

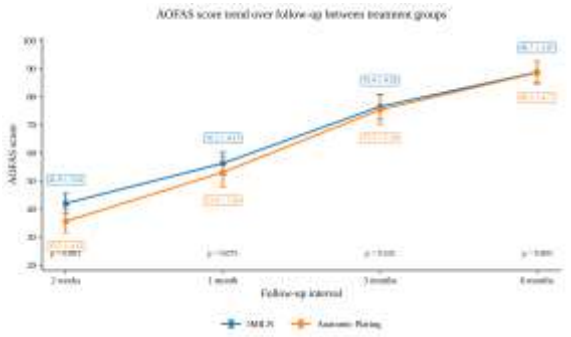

Figure 6: AOFAS score trend over follow-up between treatment groups. Values are shown as mean ± SD with p-values from independent samples t-test.

AOFAS score improved progressively in both groups. The early postoperative difference favoured intramedullary interlocking nailing, while later follow-up scores became comparable, as shown in Figure 6.

DISCUSSION

The present study compared clinical, radiological and functional outcomes of intramedullary interlocking nailing and anatomic plating in the management of closed extra-articular distal tibia fractures. Baseline demographic and fracture characteristics were comparable between groups, reducing the likelihood that outcome differences were due to initial group imbalance.

The operative profile favoured intramedullary interlocking nailing. This can be attributed to the less invasive nature of nailing, reduced surgical exposure and preservation of soft tissue envelope. Previous comparative studies have similarly reported practical advantages of nailing in operative time and surgical morbidity.[1,3,6]

Wound-related complications were more prominent after anatomic plating. This finding is clinically expected because the distal tibia is subcutaneous and has limited soft tissue coverage. Even when minimally invasive techniques are used, plate prominence and local soft tissue irritation can remain important concerns. Similar concerns regarding plating-related soft tissue complications have been described in earlier studies.[7,8]

Malunion was observed more commonly with intramedullary interlocking nailing. This reflects the technical challenge of maintaining alignment in the wider distal metaphyseal segment when using an intramedullary device. Careful entry point selection, intraoperative reduction control, distal locking and use of poller screws where required may reduce this risk. Studies focused on distal tibia nailing have highlighted the importance of meticulous technique for preventing malalignment.[2,10]

Union outcomes favoured intramedullary interlocking nailing in the present study. The biological advantage of nailing is likely related to reduced periosteal stripping and better preservation of fracture hematoma. Meta-analyses and comparative studies have also evaluated this balance between biological healing and mechanical alignment in distal tibia fractures.[8,9,11]

Functional recovery showed an early advantage with intramedullary interlocking nailing, while final functional outcomes became comparable between both techniques. This suggests that nailing may permit faster early rehabilitation, but both treatment methods can provide satisfactory medium-term functional recovery when appropriately selected and executed.

Implant-related complications differed according to treatment modality. Plating produced plate prominence and hardware irritation, whereas intramedullary nailing produced anterior knee pain and distal screw irritation. Anterior knee pain is a ecognized symptom after tibial intramedullary nailing, and implant prominence is a known concern with distal tibial plating due to the limited soft tissue envelope.[12]

Overall, intramedullary interlocking nailing offers advantages in operative efficiency, biological fixation, early union and early functional recovery, whereas anatomic plating offers superior alignment control. Therefore, treatment should be individualized based on fracture morphology, soft tissue condition, surgeon expertise and need for precise alignment restoration.

CONCLUSION

The present study demonstrated that both intramedullary interlocking nailing and anatomic plating are effective modalities for the management of closed extra-articular distal tibia fractures. Both methods achieved fracture union and improved ankle function during follow-up.

Intramedullary interlocking nailing was associated with shorter operating time, lower intraoperative blood loss, earlier clinical and radiological union, and better early functional recovery. However, it showed a higher tendency for mild malalignment in the distal metaphyseal region.

Anatomic plating provided better control of alignment and no malunion was observed in the plating group, but it was associated with higher wound complications and plate-related implant irritation due to the limited soft tissue coverage of the distal tibia.

At 6 months, final functional outcomes were comparable between the two treatment modalities. Therefore, the choice of fixation should be individualized, balancing biological healing, mechanical stability, alignment control and soft tissue preservation.

Declarations

Conflict of Interest: None.

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Ethical Approval: Obtained.

Consent: Written informed consent was obtained from all participants.

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