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Research Article

Comparative Evaluation of Locking Compression Plate Versus Intramedullary Nailing in Distal Tibial Fractures

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ABSTRACT
Background: Distal tibial fractures are challenging due to limited soft tissue coverage and compromised vascularity. This study compared the clinical, radiological, and functional outcomes of locking compression plate (LCP) fixation and intramedullary nailing (IMN).
Materials and Methods: This prospective comparative study included 120 patients with distal tibial fractures, divided into LCP (n=60) and IMN (n=60) groups. Operative parameters, fracture union, functional outcomes using the AOFAS score, and postoperative complications were assessed over six months.
Results: Operative duration was significantly shorter with IMN than LCP (72.8 ± 13.4 versus 88.4 ± 15.6 minutes; p<0.001). Mean fracture union time was 17.6 ± 3.5 weeks with IMN and 19.2 ± 3.8 weeks with LCP (p=0.018). Six-month union rates were comparable (93.3% versus 91.7%). AOFAS scores were also similar (87.8 ± 8.2 versus 86.5 ± 8.6; p=0.398). Malunion was more frequent with IMN (10.0% versus 3.3%), whereas superficial infection was higher with LCP (10.0% versus 3.3%).
Conclusion: IMN offered faster recovery and earlier fracture union, while LCP provided better alignment control. Both techniques achieved comparable functional outcomes.

Keywords: Distal Tibial Fracture, Locking Compression Plate, Intramedullary Nailing, Fracture Union, Functional Outcome.

INTRODUCTION

Distal tibial fractures represent a significant challenge in orthopaedic practice because of the unique anatomical and biomechanical characteristics of the distal tibia. These fractures generally involve the distal segment of the tibia and commonly result from high-energy trauma, including road traffic accidents and falls from height[1]. The subcutaneous location, limited soft tissue coverage, relatively poor vascularity, and proximity to the ankle joint increase the risk of complications such as delayed union, nonunion, malunion, wound infection, and impaired functional recovery [1,2].The primary objectives of distal tibial fracture management are to achieve stable fixation, restore anatomical alignment, preserve fracture-site vascularity, and facilitate early mobilization. Various treatment modalities are available, including conservative management, open reduction and internal fixation (ORIF), minimally invasive percutaneous plate osteosynthesis (MIPPO), intramedullary nailing (IMN), and external fixation. Although conservative treatment may be appropriate for stable and undisplaced fractures, surgical intervention is generally preferred for displaced and unstable fractures. However, the optimal surgical technique remains controversial because each method has distinct advantages and limitations [3,4].

Locking compression plate (LCP) fixation has gained widespread acceptance, particularly for distal metaphyseal fractures, because it provides angular stability and secure fixation of short distal fragments. The MIPPO technique further enhances its biological advantages by minimizing soft tissue dissection, preserving periosteal circulation, and maintaining the fracture hematoma. These features promote

fracture healing while ensuring adequate mechanical stability. Nevertheless, plate fixation may be associated with wound complications, infection, implant prominence, soft tissue irritation, and delayed union, particularly because of the limited soft tissue coverage over the anteromedial tibial surface [5–7].Intramedullary nailing offers an alternative method of fixation that provides load-sharing stability with relatively minimal disruption of surrounding soft tissues. Its advantages include smaller surgical incisions, preservation of fracture biology, reduced soft tissue injury, and the potential for earlier weight-bearing and rehabilitation. Advances in nail design and distal locking mechanisms have expanded its application to distal metaphyseal fractures. However, the widened medullary canal and short distal fracture fragment may compromise fixation stability, increasing the risk of angular malalignment, rotational instability, and malunion. Postoperative anterior knee pain is another recognized complication [8,9].Previous studies have reported varying outcomes regarding the effectiveness of these fixation techniques. Guo et al. demonstrated satisfactory fracture healing with both minimally invasive plating and intramedullary nailing, without a significant difference in union time [10]. Similarly, Costa et al., in the UK FixDT randomized clinical trial, reported comparable disability outcomes at six months, although differences in early postoperative recovery were observed [11]. Recent meta-analyses have also highlighted differences in wound complications, malalignment, and postoperative knee pain between the two fixation methods, indicating that neither technique is consistently superior across all outcome measures [12].Despite advances in surgical techniques, uncertainty persists regarding the most appropriate fixation method for distal tibial fractures. Therefore, the present study was undertaken to compare the clinical, radiological, and functional outcomes of locking compression plate fixation versus intramedullary nailing, with particular emphasis on fracture union rate, time to union, postoperative functional recovery, and associated complications, to determine their relative effectiveness and safety in the management of distal tibial fractures.

MATERIALS AND METHODS

This hospital-based prospective comparative study was conducted in the Department of Orthopaedics at a tertiary care hospital to compare the clinical, radiological, and functional outcomes of locking compression plate (LCP) fixation and intramedullary nailing (IMN) in patients with distal tibial fractures. The study was conducted after obtaining approval from the Institutional Ethics Committee.A total of 120 patients with distal tibial fractures requiring surgical intervention were included in the study. Patients were divided into two groups:

- Group A (n=60): Patients treated with locking compression plate fixation.
- Group B (n=60): Patients treated with intramedullary interlocking nailing.

Inclusion Criteria

Patients aged 18 years and above with radiologically confirmed, displaced or unstable extra-articular distal tibial fractures, including closed fractures and Gustilo–Anderson grade I open fractures, who provided written informed consent were included.

Exclusion Criteria

Patients younger than 18 years, those with intra-articular fractures, Gustilo–Anderson grade II or III open fractures, pathological fractures, associated major neurovascular injuries, previous surgery involving the affected tibia, or medical contraindications to surgery were excluded.

Preoperative Assessment

All patients underwent detailed clinical examination and radiological evaluation. Demographic characteristics, mechanism of injury, fracture pattern, associated injuries, and neurovascular status were documented. Anteroposterior and lateral radiographs were obtained, and fractures were classified using the AO/OTA classification system. Routine preoperative investigations and anaesthetic assessments were performed.

Surgical Procedure

All procedures were performed under spinal or general anaesthesia using standard aseptic precautions. In Group A, fracture fixation was performed using an anatomically contoured distal tibial locking compression plate through a minimally invasive approach wherever feasible. Fracture reduction and implant positioning were confirmed under fluoroscopic guidance. In Group B, intramedullary interlocking nailing was performed following fracture reduction, with proximal and distal locking screws providing axial and rotational stability. Appropriate

alignment and implant placement were confirmed intraoperatively.

Postoperative Management

Postoperative management included analgesics, antibiotics, wound care, and early physiotherapy. Active knee and ankle mobilization was initiated as tolerated. Weight-bearing was gradually advanced according to fracture stability and radiological healing. Sutures were generally removed after 10–14 days.

Follow-Up and Outcome Assessment

Patients were evaluated at 2 weeks, 6 weeks, 3 months, and 6 months postoperatively. Clinical and radiological assessments included fracture union, time to union, limb alignment, range of motion, and postoperative complications. Functional outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score. Complications such as infection, delayed union, nonunion, malunion, implant failure, and anterior knee pain were recorded.

Statistical Analysis

Data were analysed using SPSS. 26 statistical software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The independent samples t-test or Mann–Whitney U test was used for continuous variables, and the Chi-square test or Fisher's exact test was applied to categorical variables, as appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 120 patients were included, with 60 patients each in the locking compression plate (LCP) and intramedullary nailing (IMN) groups.The mean age was 42.6 ± 12.4 years in the LCP group and 40.8 ± 11.9 years in the IMN group (p=0.418). Males predominated in both groups (70.0% vs. 65.0%; p=0.573). Road traffic accidents were the most common mechanism of injury (65.0% vs. 68.3%), while most fractures were closed (88.3% vs. 85.0%). Baseline characteristics were comparable between the groups (p>0.05) (Table 1).The IMN group had significantly shorter operative duration (72.8 ± 13.4 vs. 88.4 ± 15.6 minutes; p<0.001), lower intraoperative blood loss (85.4 ± 25.8 vs. 118.6 ± 32.5 mL; p<0.001), and shorter hospital stay (5.9 ± 1.8 vs. 6.8 ± 2.1 days; p=0.013). Partial weight-bearing (5.2 ± 1.3 vs. 6.4 ± 1.5 weeks; p<0.001) and full weight-bearing (12.1 ± 2.6 vs. 13.8 ± 2.9 weeks; p=0.001) were also achieved significantly earlier in the IMN group (Table 2).Mean fracture union time was significantly shorter in the IMN group (17.6 ± 3.5 vs. 19.2 ± 3.8 weeks; p=0.018). Union by six months was achieved in 93.3% of IMN patients and 91.7% of LCP patients (p=0.729). Delayed union (5.0% vs. 6.7%), nonunion (1.7% in both groups), and malunion (10.0% vs. 3.3%) showed no statistically significant differences (p>0.05) (Table 3).The IMN group demonstrated significantly higher AOFAS scores at six weeks (59.6 ± 8.1 vs. 55.8 ± 8.4; p=0.013) and three months (75.8 ± 8.7 vs. 72.4 ± 9.2; p=0.040). However, six-month AOFAS scores were comparable (87.8 ± 8.2 vs. 86.5 ± 8.6; p=0.398). Ankle dorsiflexion (16.8 ± 4.1° vs. 17.2 ± 3.8°; p=0.580) and plantarflexion (37.9 ± 5.8° vs. 38.6 ± 5.4°; p=0.495) also showed no significant differences (Table 4, Figure 1).Superficial wound infection (10.0% vs. 3.3%), deep infection (3.3% vs. 1.7%), wound dehiscence (6.7% vs. 1.7%), and implant irritation (11.7% vs. 3.3%) were more frequent in the LCP group, although differences were not statistically significant (p>0.05). Anterior knee pain occurred exclusively in the IMN group (16.7% vs. 0.0%; p<0.001). Implant failure was observed in 1.7% of patients in both groups (Table 5, Figure 2).Fracture union time showed a significant negative correlation with six-month AOFAS scores in both LCP (r=-0.412; p=0.001) and IMN groups (r=-0.386; p=0.002). Age was positively correlated with union time in the LCP group (r=0.284; p=0.028), but not significantly in the IMN group (r=0.251; p=0.053). Age also showed significant negative correlations with six-month AOFAS scores in both groups (LCP: r=-0.312; p=0.015; IMN: r=-0.275; p=0.033) (Table 6, Figure 3).

Table 1. Comparison of Demographic and Baseline Characteristics Between the Two Groups

Parameters	LCP (n=60)	IMN (n=60)	p-value	Statistical test
Mean age (years)	42.6 ± 12.4	40.8 ± 11.9	0.418	Independent t-test
Sex			0.573	Pearson Chi-square test
Male	42 (70.0%)	39 (65.0%)		
Female	18 (30.0%)	21 (35.0%)		

Mechanism of injury			0.726	Pearson Chi-square test
Road traffic accident	39 (65.0%)	41 (68.3%)		
Fall from height	14 (23.3%)	12 (20.0%)		
Other causes	7 (11.7%)	7 (11.7%)		
Fracture type			0.648	Pearson Chi-square test
Closed	53 (88.3%)	51 (85.0%)		
Gustilo–Anderson grade I	7 (11.7%)	9 (15.0%)		

Table 2. Comparison of Operative Parameters Between the Two Groups

Parameters	LCP (n=60)	IMN (n=60)	p-value	Statistical test
Operative duration (minutes)	88.4 ± 15.6	72.8 ± 13.4	<0.001	Independent t-test
Intraoperative blood loss (mL)	118.6 ± 32.5	85.4 ± 25.8	<0.001	
Hospital stay (days)	6.8 ± 2.1	5.9 ± 1.8	0.013	
Time to partial weight-bearing (weeks)	6.4 ± 1.5	5.2 ± 1.3	<0.001	
Time to full weight-bearing (weeks)	13.8 ± 2.9	12.1 ± 2.6	0.001	

Table 3. Comparison of Fracture Union and Radiological Outcomes Between the Two Groups

Parameters	LCP (n=60)	IMN (n=60)	p-value	Statistical test
Mean time to union (weeks)	19.2 ± 3.8	17.6 ± 3.5	0.018	Independent t-test
Fracture union by 6 months	55 (91.7%)	56 (93.3%)	0.729	Fisher's exact test
Delayed union	4 (6.7%)	3 (5.0%)	0.697	
Non union	1 (1.7%)	1 (1.7%)	1.000	
Malunion	2 (3.3%)	6 (10.0%)	0.143	

Table 4. Comparison of Functional Outcomes Between the Two Groups

Parameters	LCP (n=60)	IMN (n=60)	p-value	Statistical test
AOFAS score at 6 weeks	55.8 ± 8.4	59.6 ± 8.1	0.013	Independent t-test
AOFAS score at 3 months	72.4 ± 9.2	75.8 ± 8.7	0.040	
AOFAS score at 6 months	86.5 ± 8.6	87.8 ± 8.2	0.398	
Ankle dorsiflexion at 6 months (degrees)	17.2 ± 3.8	16.8 ± 4.1	0.580	
Ankle plantarflexion at 6 months (degrees)	38.6 ± 5.4	37.9 ± 5.8	0.495	

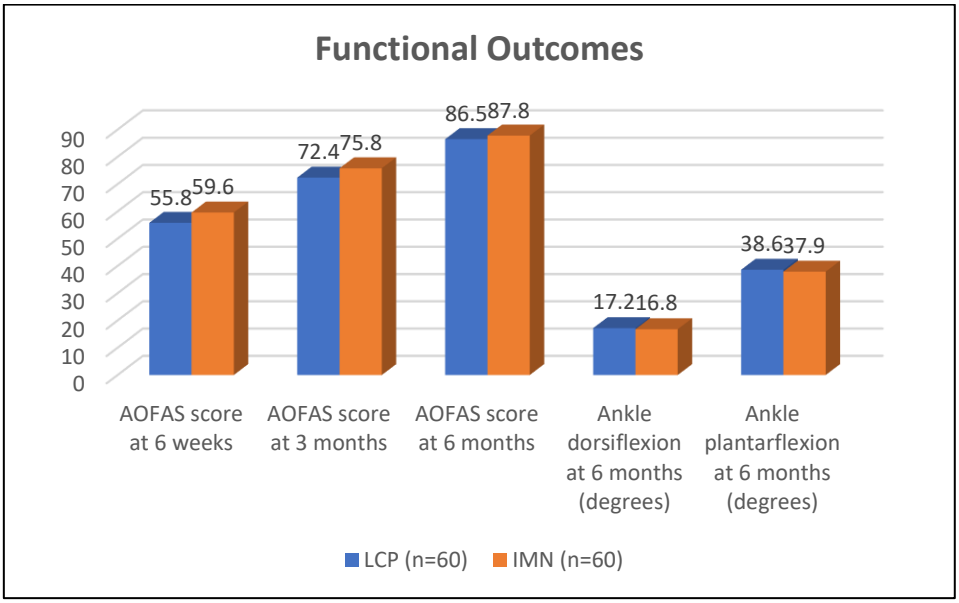


Figure 1. Comparison of Functional Outcomes Between the Two Groups

Table 5. Comparison of Postoperative Complications Between the Two Groups

Complications	LCP (n=60)	IMN (n=60)	p-value	Statistical test
Superficial wound infection	6 (10.0%)	2 (3.3%)	0.143	Fisher's exact test
Deep infection	2 (3.3%)	1 (1.7%)	0.559	
Wound dehiscence	4 (6.7%)	1 (1.7%)	0.171	
Implant prominence/irritation	7 (11.7%)	2 (3.3%)	0.083	
Anterior knee pain	0 (0.0%)	10 (16.7%)	<0.001	
Implant failure	1 (1.7%)	1 (1.7%)	1.000	

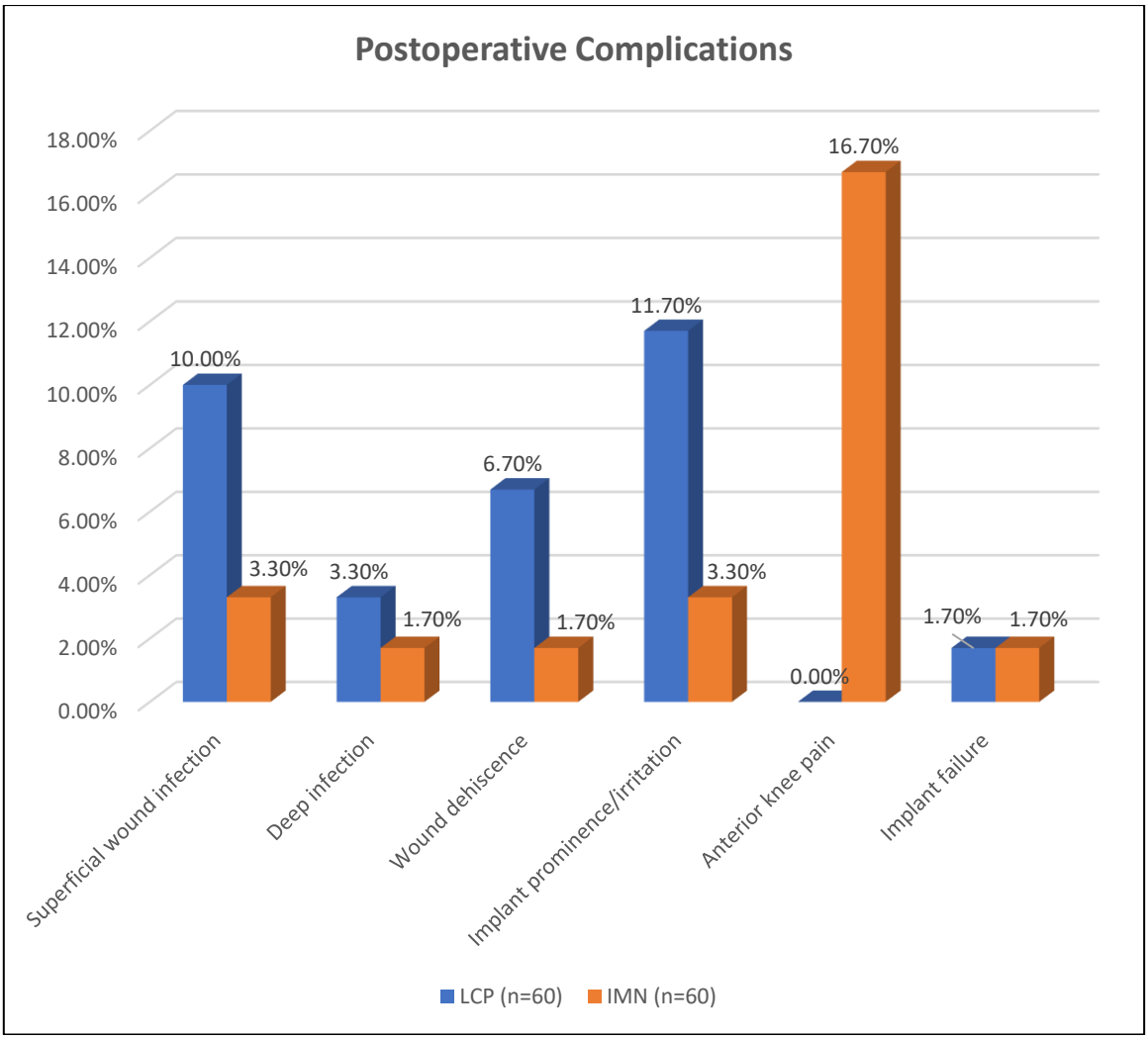


Figure 2. Comparison of Postoperative Complications Between the Two Groups

Table 6. Correlation of Fracture Union Time with Functional Outcome at Six Months

Parameters	Group	Correlation coefficient (r)	p-value	Statistical test
Union time vs AOFAS score at 6 months	LCP	-0.412	0.001	Pearson correlation
Union time vs AOFAS score at 6 months	IMN	-0.386	0.002	
Age vs union time	LCP	0.284	0.028	
Age vs union time	IMN	0.251	0.053	
Age vs AOFAS score at 6 months	LCP	-0.312	0.015	
Age vs AOFAS score at 6 months	IMN	-0.275	0.033	

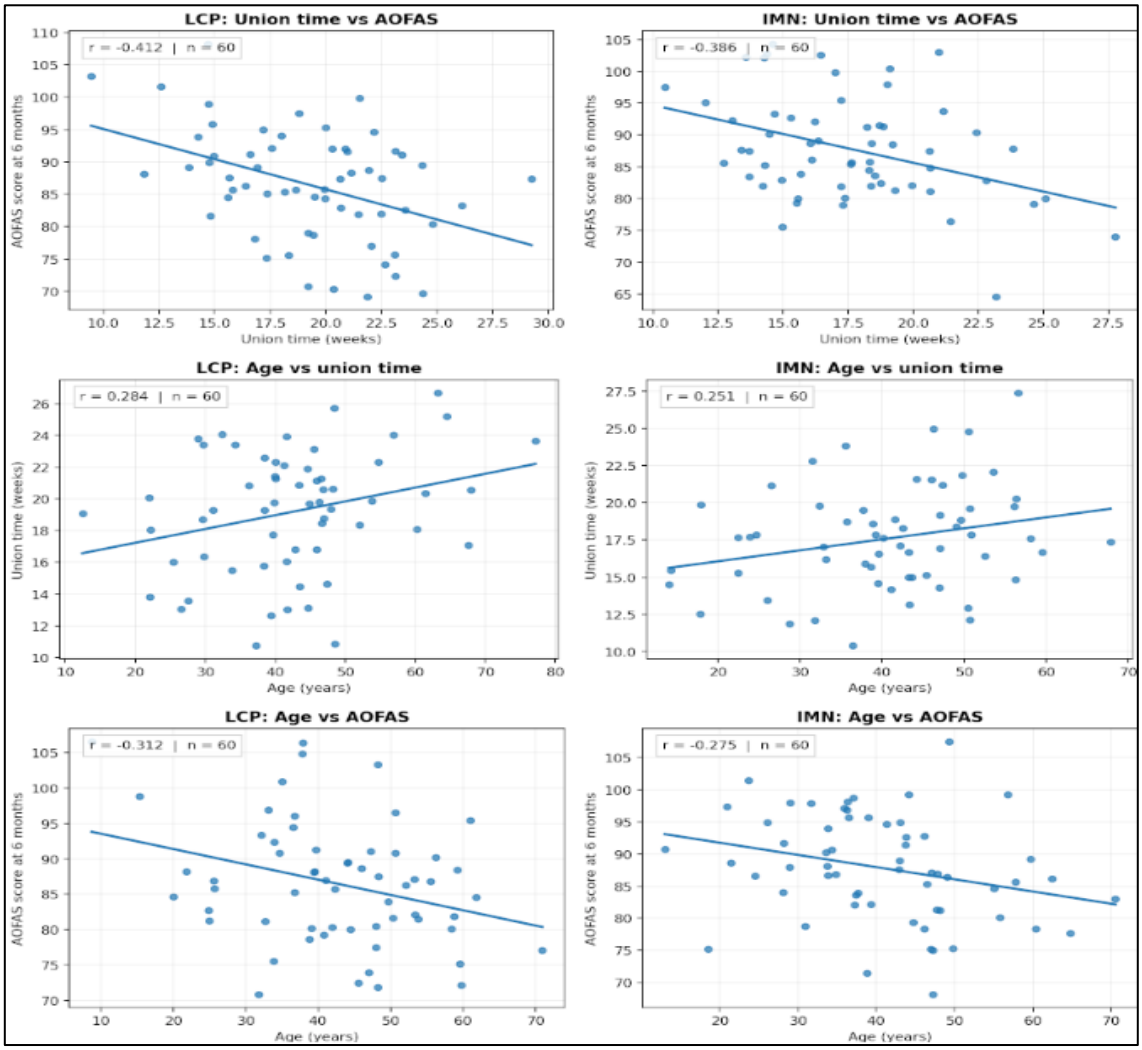


Figure 3. Correlation of Fracture Union Time with Functional Outcome at Six Months

DISCUSSION

The present comparative study included 120 patients, with 60 patients each undergoing locking compression plate (LCP) fixation and intramedullary nailing (IMN) for distal tibial fractures. The mean age was 42.6 ± 12.4 years in the LCP group and 40.8 ± 11.9 years in the IMN group (p=0.418). Males constituted 70.0% and 65.0%, respectively, while road traffic accidents were the predominant mechanism of injury (65.0% versus 68.3%). Polat et al. [13] compared 15 MIPO and 10 IMN patients, while Gupta et al. [14] evaluated 79 patients treated with locking plates. Hasenboehler et al. [15] studied 32 patients, including 26 males and 6 females, demonstrating a similar male predominance.The mean operative duration was significantly longer in the LCP group (88.4 ± 15.6 minutes) than in the IMN group (72.8 ± 13.4 minutes; p<0.001). Blood loss was also greater with LCP (118.6 ± 32.5 versus 85.4 ± 25.8 mL; p<0.001). Conversely, Polat et al. [13] reported significantly greater blood loss with IMN (p=0.012), along with longer incisions (p=0.019) and greater fluoroscopy time (p=0.004). Collinge et al. [16] demonstrated that minimally invasive plating could preserve soft tissues in high-energy distal tibial fractures.Hospital stay was shorter following IMN (5.9 ± 1.8 days) than LCP (6.8 ± 2.1 days; p=0.013). Partial weight-bearing began at 5.2 ± 1.3 versus 6.4 ± 1.5 weeks, while full weight-bearing occurred at 12.1 ± 2.6 versus 13.8 ± 2.9 weeks, respectively. However, Polat et al. [13] found no significant difference in time to weight-bearing between the two techniques (p=0.177).The mean union time was 19.2 ± 3.8 weeks in the LCP group and 17.6 ± 3.5 weeks in the IMN group (p=0.018). Union by six months occurred in 91.7% and 93.3%, respectively. Polat et al. [13] reported no significant difference in union time (p=0.402). Collinge et al. [16] reported a mean union time of 35 weeks in 26 patients, with 9 (35%)

requiring secondary surgery. Gupta et al. [14] reported a mean union time of 19 weeks, with 7 delayed unions and 3 nonunions. Hasenboehler et al. [15] reported union in 23 of 32 patients by six months. These findings indicate that fracture severity and fixation stability influence healing. Malunion occurred in 3.3% of LCP patients and 10.0% of IMN patients (p=0.143). Polat et al. [13] found no significant difference in overall malunion (p=0.358), although rotational malalignment was significantly greater with IMN (p=0.027). Collinge et al. [16] reported acceptable alignment in 25 of 26 patients, while Gupta et al. [14] documented 2 cases of malunion among 80 fractures. These findings suggest that plating may offer advantages in maintaining distal tibial alignment. At six weeks, AOFAS scores were 55.8 ± 8.4 in the LCP group and 59.6 ± 8.1 in the IMN group (p=0.013). At six months, scores improved to 86.5 ± 8.6 and 87.8 ± 8.2, respectively (p=0.398). Excellent-to-good outcomes were achieved in 83.3% and 86.7% of patients. Similarly, Polat et al. [13] reported comparable functional outcomes between groups (p=0.807). Collinge et al. [16] also demonstrated satisfactory long-term recovery following minimally invasive plating, although some functional limitations persisted. Superficial infection occurred in 10.0% of LCP patients compared with 3.3% of IMN patients, while implant irritation occurred in 11.7% and 3.3%, respectively. Anterior knee pain was observed in 16.7% following IMN and none following LCP. Polat et al. [13] reported comparable infection rates between techniques (p=0.404). Gupta et al. [14] documented 2 cases of delayed wound breakdown and significantly greater medial malleolar irritation with bulkier plates (81% with 4.5-mm LC-LCP versus 25% with distal medial tibial LCP; p<0.001). Hasenboehler et al. [15] reported 3 reoperations, including one for plate bending and two for pseudoarthrosis. These findings highlight technique-specific complications. Union time showed a negative correlation with six-month AOFAS scores in the LCP (r=-0.412, p=0.001) and IMN groups (r=-0.386, p=0.002), suggesting an association between earlier healing and better functional recovery. Although Polat et al. [13], Collinge et al. [16], Gupta et al. [18], and Hasenboehler et al. [15] evaluated healing and functional outcomes, directly comparable correlation coefficients were not reported.

CONCLUSION

Intramedullary nailing demonstrated shorter operative duration, reduced blood loss, earlier weight-bearing, and faster fracture union compared with locking compression plate fixation. However, LCP fixation showed better fracture alignment and a lower incidence of anterior knee pain. Both techniques provided comparable fracture union rates and satisfactory functional outcomes at six months.

Limitations

The study was limited by its single-centre design, relatively small sample size, and short follow-up duration of six months.

REFERENCES

1. Joveniaux P, Ohl X, Harisboure A, Berrichi A, Labatut L, Simon P, et al. Distal tibia fractures: management and complications of 101 cases. Int Orthop. 2010;34(4):583-588.
2. Newman SD, Mauffrey CP, Krikler S. Distal metadiaphyseal tibial fractures. Injury. 2011;42(10):975-984.
3. Lin ZQ, Zhang HZ, Luo GG, et al. Comparison of 3 treatment methods for distal tibial fractures: a network meta-analysis. Med Sci Monit. 2019;25:7480-7487.
4. Daolagupu AK, Mudgal A, Agarwala V, Dutta KK. A comparative study of intramedullary interlocking nailing and minimally invasive plate osteosynthesis in extra articular distal tibial fractures. Indian J Orthop. 2017;51(3):292-298.
5. Ronga M, Longo UG, Maffulli N. Minimally invasive locked plating of distal tibia fractures is safe and effective. Clin Orthop Relat Res. 2010;468(4):975-982.
6. Shrestha D, Acharya BM, Shrestha PM. Minimally invasive plate osteosynthesis with locking compression plate for distal diametaphyseal tibia fracture. Kathmandu Univ Med J. 2011;9(34):62-68.
7. Zou J, Zhang W, Zhang CQ. Comparison of minimally invasive percutaneous plate osteosynthesis with open reduction and internal fixation for treatment of extra-articular distal tibia fractures. Injury. 2013;44(8):1102-1106.
8. Bong MR, Kummer FJ, Koval KJ, Egol KA. Intramedullary nailing of the lower extremity: biomechanics and biology. J Am Acad Orthop Surg. 2007;15(2):97-106.
9. Vallier HA, Cureton BA, Patterson BM. Randomized, prospective comparison of

plate versus intramedullary nail fixation for distal tibia shaft fractures. J Orthop Trauma. 2011;25(12):736-741.

10. Guo JJ, Tang N, Yang HL, Tang TS. A prospective, randomised trial comparing closed intramedullary nailing with percutaneous plating in the treatment of distal metaphyseal fractures of the tibia. J Bone Joint Surg Br. 2010;92(7):984-988.
11. Costa ML, Achten J, Griffin J, Petrou S, Pallister I, Lamb SE, et al. Effect of locking plate fixation vs intramedullary nail fixation on 6-month disability among adults with displaced fracture of the distal tibia: the UK FixDT randomized clinical trial. JAMA. 2017;318(18):1767-1776.
12. Li X, Chen K, Xue H, Cheng J, Yu X. Efficacy comparison between intramedullary nail fixation and plate fixation in distal tibia fractures: a meta-analysis of randomized controlled trials. J Orthop Surg Res. 2024;19:403.
13. Polat A, Kose O, Canbora K, Yanık S, Guler F. Intramedullary nailing versus minimally invasive plate osteosynthesis for distal extra-articular tibial fractures: a prospective randomized clinical trial. J Orthop Sci. 2015;20(4):695-701.
14. Gupta RK, Rohilla RK, Sangwan K, Singh V, Walia S. Locking plate fixation in distal metaphyseal tibial fractures: series of 79 patients. Int Orthop. 2010;34(8):1285-1290.
15. Hasenboehler E, Rikli D, Babst R. Locking compression plate with minimally invasive plate osteosynthesis in diaphyseal and distal tibial fracture: a retrospective study of 32 patients. Injury. 2007;38(3):365-370.
16. Collinge C, Kuper M, Larson K, Protzman R. Minimally invasive plating of high-energy metaphyseal distal tibia fractures. J Orthop Trauma. 2007;21(6):355-361.