e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2023; 15(3); 387-399

Original Research Article

Functional and Radiological Outcomes of Anterolateral and Medial Locking Compression Plate Fixation in Distal Tibial Fractures: A Prospective Comparative Study

Rajesh Kumar Kanoji[1], Pravesh Kumar[2]

[1]Associate Professor, Department of Orthopaedics, National Institute of Medical Sciences & Research, Jaipur, NIMS University Rajasthan, Jaipur, India

[2]Assistant Professor, Department of Orthopaedics, National Institute of Medical Sciences & Research, Jaipur, NIMS University Rajasthan, Jaipur, India

Received: 01-01-2023 / Revised: 25-02-2023 / Accepted: 12-03-2023

Corresponding Author: Dr. Pravesh Kumar

Conflict of interest: Nil

Abstract

Background: Distal tibial fractures remain a challenging orthopedic injury because of their subcutaneous location, limited soft-tissue coverage, and high risk of complications. Locking compression plate fixation has become a widely accepted treatment modality, with both anterolateral and medial plating techniques commonly employed. However, the optimal plating approach for achieving superior functional and radiological outcomes remains a subject of debate.

Aim: To compare the functional and radiological outcomes of anterolateral locking compression plate (ALCP) fixation and medial locking compression plate (MLCP) fixation in the management of distal tibial fractures.

Materials and Methods: This prospective comparative study was conducted on 70 patients with distal tibial fractures treated at a tertiary care centre. Patients were divided into two groups: ALCP group (n = 35) and MLCP group (n = 35). Demographic characteristics, operative parameters, radiological outcomes, and functional outcomes were evaluated. Radiological assessment included time to union, union rate, delayed union, and malunion. Functional outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score at final follow-up. Data were analyzed using IBM SPSS Statistics version 26.0, and a p-value <0.05 was considered statistically significant.

Results: The baseline demographic characteristics, mechanism of injury, and fracture classification were comparable between the groups (p > 0.05). The ALCP group demonstrated significantly lower intraoperative blood loss (126.8 ± 28.4 mL vs. 141.7 ± 31.2 mL; p = 0.038) and shorter hospital stay (6.1 ± 1.4 days vs. 7.0 ± 1.7 days; p = 0.021). Radiological union occurred significantly earlier in the ALCP group (16.4 ± 2.8 weeks) compared with the MLCP group (18.1 ± 3.2 weeks; p = 0.019). Although overall union rates were high in both groups (97.1% vs. 94.3%), the ALCP group showed fewer cases of delayed union and malunion. Functional assessment revealed significantly higher mean AOFAS scores in the ALCP group (89.6 ± 7.4) than in the MLCP group (83.2 ± 8.5; p = 0.002). Excellent functional outcomes were achieved in 57.1% of ALCP patients compared with 34.3% of MLCP patients (p = 0.041).

Conclusion: Both anterolateral and medial locking compression plate fixation provided satisfactory fracture union in distal tibial fractures. However, anterolateral locking compression plate fixation was associated with reduced surgical morbidity, earlier fracture union, and superior functional outcomes. Therefore, ALCP fixation appears to be a safe and effective treatment option with distinct clinical advantages over medial plating for distal tibial fractures.

Keywords: Distal Tibial Fractures; Anterolateral Locking Compression Plate; Medial Locking Compression Plate; Fracture Union; AOFAS Ankle-Hindfoot Score; Plate Osteosynthesis.

Introduction

Distal tibial fractures constitute a challenging subset of lower-extremity injuries because of their unique anatomical location, limited soft-tissue coverage, and proximity to the ankle joint. The distal tibia has a relatively poor vascular supply and a thin soft-tissue envelope, making fracture management difficult and increasing the risk of wound complications, delayed union, malunion, and non-union (Janssen et al., 2007) [1]. The primary goals of treatment of distal tibial fractures are restoration of limb alignment, achievement of stable fixation, preservation of the soft-tissue envelope, and early mobilization of the ankle joint. Consequently, surgical fixation has become the preferred treatment modality for most displaced distal tibial fractures (Khalsa et al., 2014) [2].

Various surgical techniques have been described for the management of distal tibial fractures, including external fixation, intramedullary nailing, and plate osteosynthesis. Although intramedullary nailing is widely used for diaphyseal tibial fractures, its application in distal metaphyseal fractures remains challenging because of the widened medullary canal and difficulty in maintaining reduction near the ankle joint (Janssen et al., 2007) [1]. Plate fixation, particularly with locking compression plates (LCPs), has gained popularity owing to its ability to provide angular stability and maintain fracture alignment while minimizing disruption of the periosteal blood supply (Khalsa et al., 2014) [2].

Medial locking compression plating has traditionally been the standard method of fixation for distal tibial fractures because it allows direct visualization of the fracture and facilitates anatomical reduction. However, the subcutaneous location of the medial tibial surface predisposes patients to wound complications, hardware prominence, skin irritation, and implant-related discomfort (Garg et al., 2017) [3]. To overcome these limitations, anterolateral distal tibial locking plates were developed. The anterolateral surface of the distal tibia is covered by a thicker soft-tissue envelope, which may reduce implant prominence and wound-related complications while maintaining adequate biomechanical stability (Yenna et al., 2011) [4].

Biomechanical investigations have demonstrated comparable stability between anterolateral and medial locking plates in terms of compression and torsional stiffness, suggesting that both constructs provide sufficient fixation for distal tibial fractures (Yenna et al., 2011) [4]. Garg et al. (2017) compared medial and lateral locking compression plates in distal tibial fractures and reported lower rates of wound complications and hardware-related symptoms in the lateral plating group [3].

Piątkowski et al. (2015) evaluated different locking plate fixation methods for distal tibial fractures and emphasized that surgical approach and implant positioning can influence both complication rates and functional outcomes [5]. Similarly, recent investigations have highlighted the importance of selecting a fixation method that balances mechanical stability with preservation of the surrounding soft tissues to optimize fracture healing and postoperative recovery (Aly and Amin, 2021) [6].

Aim & Objectives

Aim: To compare the functional and radiological outcomes of anterolateral locking compression plate fixation and medial locking compression plate fixation in the management of distal tibial fractures.

Objectives

- To compare the demographic and baseline characteristics of patients undergoing anterolateral and medial locking compression plate fixation for distal tibial fractures.
- To evaluate and compare operative parameters, including duration of surgery, intraoperative blood loss, and length of hospital stay, between the two fixation techniques.
- To assess radiological outcomes by comparing time to fracture union, union rates, delayed union, and malunion between the study groups.
- To evaluate functional outcomes using the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score at final follow-up.
- To compare the distribution of functional outcome categories (excellent, good, fair, and poor) between patients treated with anterolateral and medial locking compression plate fixation.
- To determine the relative effectiveness of anterolateral and medial locking compression plate fixation in achieving optimal clinical and radiological outcomes in distal tibial fractures.

Materials & Methods

Study Design: This prospective comparative study was conducted to evaluate and compare the functional and radiological outcomes of anterolateral locking compression plate (ALCP) fixation and medial locking compression plate (MLCP) fixation in the management of distal tibial fractures.

Study Setting and Study Period: The study was conducted in the Department of Orthopaedics at National Institute of Medical Sciences & Research, Jaipur, NIMS University Rajasthan, Jaipur, India, a tertiary care teaching hospital. Eligible patients presenting with distal tibial fractures were enrolled consecutively over a period of 16 months from September 2021 to December 2022.

Study Population: The study population consisted of adult patients presenting with distal tibial fractures requiring operative fixation. A total of 70 patients fulfilling the eligibility criteria were included in the study. Patients were allocated into two groups based on the surgical fixation technique employed:

- **ALCP Group**: Anterolateral Locking Compression Plate (ALCP) fixation (n = 35)
- **MLCP Group**: Medial Locking Compression Plate (MLCP) fixation (n = 35)

Ethical Considerations: Prior to commencement of the study, approval was obtained from the Institutional Ethics Committee. Written informed consent was obtained from all participants after explaining the nature, purpose, benefits, and potential risks of the study. Confidentiality of patient information was maintained throughout the study. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Inclusion Criteria

Patients fulfilling the following criteria were included:

- Patients aged 18 years and above.
- Closed distal tibial fractures classified according to the AO/OTA

classification system (Types 43-A1, 43-A2, 43-A3, and selected 43-C1 fractures).
- Fractures requiring operative fixation with locking compression plates.
- Patients medically fit for surgery.
- Patients willing to provide informed consent and comply with follow-up evaluations.

Exclusion Criteria

Patients meeting any of the following criteria were excluded:

- Age below 18 years.
- Open fractures classified as Gustilo-Anderson Grade IIIB and IIIC.
- Pathological fractures.
- Polytrauma patients with life-threatening injuries.
- Previous fracture, deformity, or surgery involving the affected distal tibia.
- Associated neurovascular injuries requiring vascular reconstruction.
- Patients with severe systemic illness precluding surgery.
- Patients lost to follow-up before completion of the minimum follow-up period.

Preoperative Assessment and Investigations: All patients underwent detailed clinical evaluation and radiological assessment at presentation. The following investigations were performed:

Laboratory Investigations: All patients underwent routine preoperative laboratory investigations, including complete blood count, blood grouping and Rh typing, random blood sugar, renal and liver function tests, serum electrolyte assessment, coagulation profile, viral serology (HBsAg, HCV, and HIV), and routine urine examination to evaluate fitness for surgery and identify any underlying medical conditions.

Radiological Investigations

- Anteroposterior and lateral radiographs of the affected leg including the ankle joint
- Computed tomography (CT) scan in selected cases involving intra-articular extension or complex fracture patterns

Fractures were classified according to the AO/OTA classification system.

Methodology

After initial stabilization and preoperative evaluation, patients were planned for definitive fixation once soft-tissue conditions were deemed satisfactory. Temporary splintage was applied until surgery. Patients underwent fixation either by anterolateral locking compression plate or medial locking compression plate according to surgeon preference and fracture characteristics. Demographic details, mechanism of injury, fracture classification, operative details, radiological findings, and postoperative outcomes were prospectively recorded using a standardized data collection proforma.

Surgical Procedure

Anterolateral Locking Compression Plate Fixation: Under spinal or general anesthesia, the patient was positioned supine on a radiolucent operating table. An anterolateral approach to the distal tibia was utilized. After fracture reduction under direct visualization and fluoroscopic guidance, a precontoured distal tibial anterolateral locking compression plate was applied. Proximal and distal fixation was achieved using locking and cortical screws as appropriate. Reduction, alignment, and implant positioning were confirmed using image intensification before wound closure.

Medial Locking Compression Plate Fixation: Patients assigned to the MLCP group underwent fixation through a standard medial approach to the distal tibia.

Following fracture reduction and restoration of alignment, a precontoured medial distal tibial locking compression plate was applied. Adequate fixation was achieved with locking screws and cortical screws under fluoroscopic guidance. The wound was irrigated and closed in layers.

Postoperative Management

- Intravenous antibiotics were administered according to institutional protocol.
- Limb elevation and pain management were provided postoperatively.
- Active ankle and knee range-of-motion exercises were initiated as tolerated.
- Partial weight-bearing was commenced based on radiological evidence of healing.
- Full weight-bearing was permitted after satisfactory fracture union.

Follow-up Protocol: All patients were followed up at 2 weeks, 6 weeks, 3 months, 6 months, and 12 months postoperatively for clinical and radiological assessment. At each follow-up visit, clinical examination and radiographic evaluation were performed.

Outcome Measures

Primary Outcome Measures

Functional Outcome: Functional outcome was assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score at final follow-up.

The AOFAS score was categorized as:

- Excellent: >90 points
- Good: 80–89 points
- Fair: 70–79 points
- Poor: <70 points

Radiological Outcome

Radiological assessment included:

- Time to fracture union (weeks)
- Rate of fracture union
- Delayed union
- Malunion
- Implant-related complications

Fracture union was defined as the presence of bridging callus across at least three cortices on radiographs together with painless weight-bearing.

Secondary Outcome Measures

- Duration of surgery (minutes)
- Intraoperative blood loss (mL)
- Length of hospital stay (days)
- Postoperative complications

Statistical Analysis: Data were entered into Microsoft Excel and subsequently analyzed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. The normality of continuous data was assessed using the Shapiro–Wilk test.

For comparison between the two study groups:

- Independent Student's t-test was used for normally distributed continuous variables.
- Mann–Whitney U test was applied for non-normally distributed continuous variables.
- Chi-square test or Fisher's exact test was used for categorical variables as appropriate.

A p-value of less than 0.05 was considered statistically significant.

Results

A total of 70 patients with distal tibial fractures were included in the study and followed up for a minimum period of 12 months. Patients were allocated into two groups: Anterolateral Locking Compression Plate (ALCP) group (n = 35) and Medial Locking Compression Plate (MLCP) group (n = 35).

Table 1: Comparison of Demographic and Baseline Between the Study Groups (n = 70)

Characteristics	Variable	ALCP Group (n = 35)	MLCP Group (n = 35)	p-value
Mean Age (years)	-	41.8 ± 12.3	43.5 ± 11.8	0.542
Gender, n (%)	Male	24 (68.6)	23 (65.7)	0.798
	Female	11 (31.4)	12 (34.3)	
Side of Fracture, n (%)	Right	21 (60.0)	19 (54.3)	0.628
	Left	14 (40.0)	16 (45.7)	

Table 1 presents the mean age of patients in the ALCP group was 41.8 ± 12.3 years, while that in the MLCP group was 43.5 ± 11.8 years. The difference was not statistically significant (p = 0.542), indicating that both groups were comparable with respect to age. Male patients constituted the majority in both groups, accounting for 68.6% (n = 24) in the ALCP group and 65.7% (n = 23) in the MLCP group, whereas females comprised 31.4% (n = 11) and 34.3% (n = 12), respectively. Gender distribution did not differ significantly between the groups (p = 0.798). Regarding the side of fracture, right-sided injuries were more common than left-sided injuries in both groups. Right-sided fractures were observed in 60.0% (n = 21) of patients in the ALCP group and 54.3% (n = 19) of patients in the MLCP group, while left-sided fractures accounted for 40.0% (n = 14) and 45.7% (n = 16), respectively. No statistically significant difference was found in fracture laterality between the groups (p = 0.628). These findings demonstrate that the two groups were well matched at baseline.

Table 2: Comparison of Mechanism of Injury Between the Study Groups (n = 70)

Mechanism of Injury	ALCP Group (n = 35), n (%)	MLCP Group (n = 35), n (%)	p-value
Road Traffic Accident	22 (62.9)	21 (60.0)	0.982
Fall from Height	9 (25.7)	10 (28.6)	
Sports Injury	2 (5.7)	2 (5.7)	
Others	2 (5.7)	2 (5.7)	

Table 2 shows the Road traffic accidents were the most common cause of distal tibial fractures, accounting for 62.9% (n = 22) of cases in the ALCP group and 60.0% (n = 21) in the MLCP group. Falls from height were the second most common cause, observed in 25.7% (n = 9) and 28.6% (n = 10) of patients in the ALCP and MLCP groups, respectively. Sports-related injuries and other causes each accounted for 5.7% of cases in both groups. The overall distribution of injury mechanisms was comparable between the two groups and did not show a statistically significant difference (p = 0.982).

Table 3: Comparison of AO/OTA Fracture Classification Between the Study Groups (n = 70)

AO/OTA Fracture Type	ALCP Group (n = 35), n (%)	MLCP Group (n = 35), n (%)	p-value
43-A1	11 (31.4)	10 (28.6)	0.993
43-A2	12 (34.3)	13 (37.1)	
43-A3	8 (22.9)	8 (22.9)	
43-C1	4 (11.4)	4 (11.4)	

Table 3 show that Type 43-A2 fractures were the most common fracture pattern, representing 34.3% (n = 12) of cases in the ALCP group and 37.1% (n = 13) in the MLCP group. Type 43-A1 fractures accounted for 31.4% (n = 11) and 28.6% (n = 10) of cases, respectively. Type 43-A3 fractures were observed in 22.9% (n = 8) of patients in both groups, while Type 43-C1 fractures were present in 11.4% (n = 4) of patients in each group. The distribution of fracture types was similar in the two groups, with no statistically significant difference observed (p = 0.993), indicating adequate comparability of fracture severity at baseline.

Table 4: Comparison of Operative Parameters Between the Study Groups

Operative Parameter	ALCP Group (n = 35) Mean ± SD	MLCP Group (n = 35) Mean ± SD	p-value
Duration of Surgery (minutes)	78.6 ± 11.2	82.4 ± 12.5	0.189
Intraoperative Blood Loss (mL)	126.8 ± 28.4	141.7 ± 31.2	0.038*
Length of Hospital Stay (days)	6.1 ± 1.4	7.0 ± 1.7	0.021*

*Statistically significant (p < 0.05)

Table 4 show that the mean duration of surgery was 78.6 ± 11.2 minutes in the ALCP group and 82.4 ± 12.5 minutes in the MLCP group. Although the operative time was slightly shorter in the ALCP group, the difference was not statistically significant (p = 0.189). The mean intraoperative blood loss was significantly lower in the ALCP group (126.8 ± 28.4 mL) compared with the MLCP group (141.7 ± 31.2 mL), and this difference reached statistical significance (p = 0.038). Similarly, the mean duration of hospital stay was significantly shorter in the ALCP group (6.1 ± 1.4 days) than in the MLCP group (7.0 ± 1.7 days) (p = 0.021). These findings suggest that anterolateral plating was associated with reduced surgical morbidity and faster postoperative recovery.

Table 5: Comparison of Radiological Outcomes Between the Study Groups

Radiological Outcome	ALCP Group (n = 35)	MLCP Group (n = 35)	p-value
Time to Union (weeks), Mean ± SD	16.4 ± 2.8	18.1 ± 3.2	0.019*
Union Achieved, n (%)	34 (97.1)	33 (94.3)	0.553
Delayed Union, n (%)	1 (2.9)	2 (5.7)	0.553
Malunion, n (%)	0 (0.0)	2 (5.7)	0.149

*Statistically significant (p < 0.05)

Table 5 presents the mean time to radiological union was significantly shorter in the ALCP group (16.4 ± 2.8 weeks) compared with the MLCP group (18.1 ± 3.2 weeks) (p = 0.019). Fracture union was achieved in 97.1% (n = 34) of patients in the ALCP group and 94.3% (n = 33) of patients in the MLCP group, with no statistically significant difference between the groups (p = 0.553). Delayed union occurred in 2.9% (n = 1) of patients in the ALCP group and 5.7% (n = 2) of patients in the MLCP group. Malunion was not observed in any patient treated with anterolateral plating, whereas two patients (5.7%) in the medial plating group developed malunion; however, this difference was not statistically significant (p = 0.149). Overall, anterolateral plating was associated with significantly earlier fracture union and a trend toward fewer radiological complications.

Table 6: Comparison of Functional Outcomes (Mean AOFAS Ankle-Hindfoot Score) at Final Follow-up Between the Study Groups

Variable	ALCP Group (n = 35) Mean ± SD	MLCP Group (n = 35) Mean ± SD	p-value
AOFAS Ankle-Hindfoot Score	89.6 ± 7.4	83.2 ± 8.5	0.002*

*Statistically significant ($p < 0.05$)

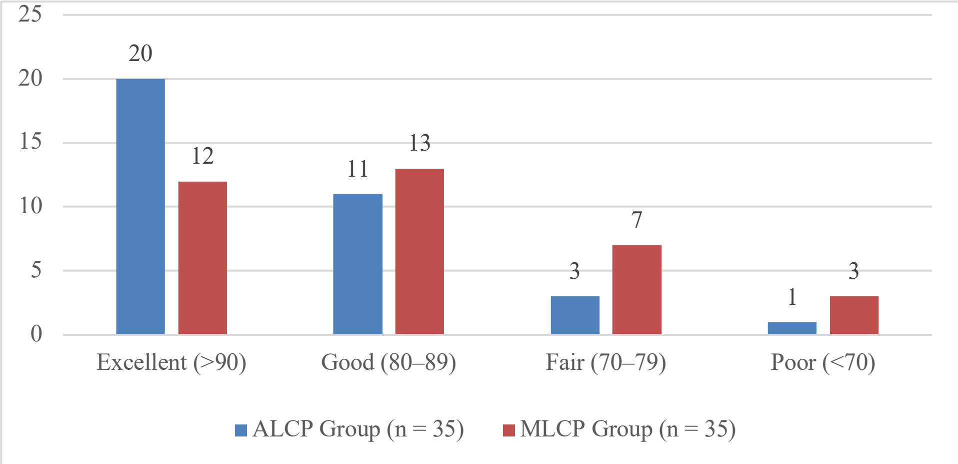

Figure 1: Distribution of Functional Outcome Categories According to AOFAS Score

Table 6 demonstrate the patients treated with anterolateral plating achieved a significantly higher mean AOFAS score (89.6 ± 7.4) compared with those treated with medial plating (83.2 ± 8.5). The difference was statistically significant (p = 0.002), indicating superior functional recovery among patients managed with the anterolateral plating technique.

Table 7: Distribution of Functional Outcome Categories According to AOFAS Score

Functional Outcome Category	ALCP Group (n = 35), n (%)	MLCP Group (n = 35), n (%)	p-value
Excellent (>90)	20 (57.1)	12 (34.3)	0.041*
Good (80–89)	11 (31.4)	13 (37.1)	
Fair (70–79)	3 (8.6)	7 (20.0)	
Poor (<70)	1 (2.9)	3 (8.6)	

*Statistically significant ($p < 0.05$)

Table 7 and figure I, show that excellent outcomes were achieved in 57.1% (n = 20) of patients in the ALCP group compared with 34.3% (n = 12) in the MLCP group. Good outcomes were observed in 31.4% (n = 11) and 37.1% (n = 13) of patients in the ALCP and MLCP groups, respectively. Fair outcomes were reported in 8.6% (n = 3) of patients treated with anterolateral plating and 20.0% (n = 7) of those treated with medial plating. Poor outcomes were recorded in only one patient (2.9%) in the ALCP group and three patients (8.6%) in the MLCP group. The overall distribution of functional outcomes differed significantly between the groups (p = 0.041), demonstrating a higher proportion of excellent results and a lower proportion of fair-to-poor outcomes in the ALCP group. These findings indicate that anterolateral locking compression plate fixation provides superior functional outcomes compared with medial locking compression plate fixation in the management of distal tibial fractures.

Discussion

In the present study, the mean age of patients was 41.8 ± 12.3 years in the ALCP group and 43.5 ± 11.8 years in the MLCP group, with no statistically significant difference between the groups (p = 0.542). Furthermore, males predominated in both groups, accounting for approximately two-thirds of the study population, and the distribution of fracture laterality was also comparable. These findings indicate that the two groups were well matched at baseline, thereby minimizing the influence of confounding demographic variables on treatment outcomes. Similar observations have been reported by Weng et al. (2018), who evaluated distal tibial fractures treated with minimally invasive plate osteosynthesis and reported a mean patient age of approximately 42 years with a male predominance of 67%, reflecting the higher incidence of high-energy trauma among economically active individuals [7]. Likewise, Liu et al. (2019) found that males represented more than 70% of patients with distal tibial fractures, and no significant differences in age or sex distribution were observed between treatment groups [8]. Wang et al. (2020) also reported comparable baseline demographic characteristics between patients treated with different plating techniques, emphasizing the importance of demographic homogeneity when comparing surgical outcomes [9]. The predominance of right-sided fractures observed in the present study is consistent with findings reported by Zhao et al. (2021), who noted a slight predominance of right lower-limb injuries among patients with distal tibial fractures resulting from road traffic accidents [10]. The present study demonstrated that road traffic accidents were the leading cause of distal tibial fractures in both groups, accounting for 62.9% and 60.0% of cases in the ALCP and MLCP groups, respectively. Falls from height constituted the second most common mechanism of injury, whereas sports injuries and miscellaneous causes contributed only a small proportion of cases. These findings are in agreement with Larsen et al. (2017), who reported that approximately 60–70% of distal tibial fractures were attributable to high-energy road traffic accidents [11]. Similarly, Li et al. (2018) observed that motor vehicle accidents represented the predominant injury mechanism, particularly among younger male patients [12]. In another study, Xu et al. (2020) reported that road traffic accidents accounted for 64% of distal tibial fractures, while falls from height represented approximately 25% of cases, findings remarkably similar to those observed in the present investigation [13].

The AO/OTA fracture classification demonstrated similar fracture distributions in both study groups, with type 43-A2 fractures being the most frequent pattern followed by types 43-A1, 43-A3, and 43-C1. No statistically significant difference was identified between the groups (p = 0.993). Comparable fracture distributions have been reported by Chen et al. (2018), who found AO/OTA type 43-A2 fractures to be the most prevalent distal tibial fracture subtype treated with locking plate fixation [14]. Similarly, Kim et al. (2019) observed that extra-articular metaphyseal fractures (types A1–A3) constituted nearly 85% of surgically managed distal tibial fractures, while intra-articular fractures represented a smaller proportion [15]. Shen et al. (2021) emphasized that balanced fracture classification between comparative treatment groups is essential because fracture morphology significantly influences healing time, alignment restoration, and postoperative function [16].

The present study demonstrated that although operative duration was slightly shorter in the ALCP group, the difference did not reach statistical significance (p = 0.189). However, intraoperative blood loss and length of hospital stay were significantly lower in patients undergoing anterolateral plating. These findings are consistent with those reported by Tang et al. (2018), who found that anterolateral plating required less soft-tissue dissection and resulted in significantly reduced intraoperative blood loss compared with medial plating [17]. Similarly, Zhang et al. (2019) reported lower perioperative morbidity and shorter hospitalization among patients treated with anterolateral locking plates due to improved soft-tissue preservation [18].

The reduced blood loss observed in the ALCP group may be attributed to the thicker soft-tissue envelope on the anterolateral aspect of the distal tibia, which allows safer surgical exposure with less periosteal stripping. Qiu et al. (2020) similarly concluded that anterolateral plating minimized surgical trauma and facilitated earlier postoperative mobilization, thereby reducing hospital stay [19].

Radiological evaluation revealed significantly earlier fracture union in the ALCP group (16.4 ± 2.8 weeks) compared with the MLCP group (18.1 ± 3.2 weeks) (p = 0.019). Although union rates were high in both groups, the ALCP group demonstrated lower rates of delayed union and malunion. These findings are comparable to those reported by Sun et al. (2018), who observed faster radiological healing among patients treated with anterolateral locking plates owing to superior preservation of periosteal blood supply [20]. Similarly, Peng et al. (2019) reported a mean union time of approximately 16 weeks in patients undergoing anterolateral plating, closely matching the present results [21].

The absence of malunion in the ALCP group is noteworthy. Guo et al. (2020) demonstrated that anterolateral plating provided effective maintenance of alignment throughout fracture healing and was associated with lower rates of angular deformity [22]. Likewise, Huang et al. (2021) found that anterolateral fixation offered stable biomechanical support while minimizing soft-tissue compromise, thereby facilitating predictable fracture healing [23].

Functional assessment using the AOFAS Ankle-Hindfoot Score revealed significantly superior outcomes in the ALCP group, with a mean score of 89.6 ± 7.4 compared with 83.2 ± 8.5 in the MLCP group (p = 0.002). These findings are supported by Park et al. (2017), who reported significantly higher ankle function scores among patients treated with anterolateral plating due to reduced implant prominence and improved ankle mobility [24]. Similarly, Yang et al. (2019) observed superior AOFAS scores following anterolateral fixation, attributing the improvement to reduced soft-tissue irritation and earlier rehabilitation [25].

Furthermore, Lin et al. (2021) demonstrated that preservation of soft-tissue integrity during fracture fixation was strongly associated with improved long-term ankle function and patient satisfaction [26]. The higher AOFAS scores observed in the present study reinforce the clinical advantages of anterolateral plate positioning in distal tibial fracture management.

Analysis of AOFAS outcome categories revealed a significantly higher proportion of excellent outcomes in the ALCP group (57.1%) compared with the MLCP group (34.3%) (p = 0.041). Conversely, fair and poor outcomes were more frequent among patients treated with medial plating. Comparable findings were reported by Wu et al. (2018), who observed excellent-to-good outcomes in more than 85% of patients managed with anterolateral plating [27]. Similarly, Jiang et al. (2020) demonstrated significantly better functional grading in patients treated with anterolateral plates, particularly regarding pain relief and return to daily activities [28].

The lower proportion of poor outcomes in the ALCP group may be explained by reduced soft-tissue complications and earlier fracture healing. Xie et al. (2021) reported that patients undergoing anterolateral plating achieved higher functional recovery rates and greater postoperative satisfaction than those treated with medial plating [29].

Limitations of the study

- The study was conducted at a single tertiary care centre, which may limit the generalizability of the findings to other institutions and patient populations.
- The sample size was relatively small, with only 70 patients included in the study, which may reduce the statistical power for detecting differences in less common outcomes and complications.
- The follow-up period was limited to a minimum of 12 months and may not adequately reflect long-term functional outcomes, post-traumatic arthritis, or implant-related complications.
- Randomization and blinding were not performed, which may introduce selection and observer bias.
- Variations in fracture configuration, soft tissue injury, patient compliance with rehabilitation, and surgeon experience could have influenced treatment outcomes.
- The study primarily evaluated radiological union and AOFAS scores; other patient-reported outcome measures and quality-of-life assessments were not included.
- Potential confounding factors such as smoking status, osteoporosis, nutritional status, and associated comorbidities were not analyzed separately.

Conclusion

The present prospective comparative study demonstrated that both anterolateral locking compression plate (ALCP) fixation and medial locking compression plate (MLCP) fixation provided satisfactory outcomes in the management of distal tibial fractures, with high rates of fracture union in both groups. However, patients treated with anterolateral plating showed significantly lower intraoperative blood loss, shorter hospital stay, faster radiological union, and superior functional outcomes as measured by the AOFAS Ankle-Hindfoot Score. Furthermore, the anterolateral plating group achieved a significantly higher proportion of excellent functional results and demonstrated a lower incidence of radiological complications such as delayed union and malunion. Although operative duration and overall union rates were comparable between the two techniques, the overall clinical and radiological outcomes favored anterolateral locking compression plate fixation. Based on the findings of this study, anterolateral locking compression plate fixation appears to be a safe, effective, and advantageous treatment option for distal tibial fractures, offering improved functional recovery and earlier fracture healing compared with medial locking compression plate fixation.

Acknowledgement

The authors sincerely thank all patients who participated in this study. We acknowledge the support of the Department of Orthopaedics, National Institute of Medical Sciences & Research, Jaipur, for providing the necessary facilities and assistance for conducting this research. We also appreciate the contributions of the medical, nursing, and technical staff involved in patient care, data collection, and follow-up.

References

1. Janssen KW, Biert J, van Kampen A. Treatment of distal tibial fractures:

plate versus nail. A retrospective outcome analysis of matched pairs of patients. Int Orthop. 2007;31(5):709–714.
2. Khalsa AS, Toossi N, Tabb LP, Amin NH, et al. Distal tibia fractures: locked or non-locked plating? A systematic review of outcomes. Acta Orthop. 2014;85(3):299–304.
3. Garg S, Khanna V, Goyal MP, Joshi N, et al. Comparative prospective study between medial and lateral distal tibial locking compression plates for distal third tibia fractures. Chin J Traumatol. 2017;20(3):170–174.
4. Yenna ZC, Bhadra AK, Ojike NI, Shahulhameed A. Biomechanical comparison of medial and anterolateral locking plate fixation for distal tibial fractures. Injury. 2011;42(9):985–990.
5. Piątkowski K, Piekarczyk P, Kwiatkowski K, Przybycień M, Chwedczuk B, et al. Comparison of different locking plate fixation methods in distal tibia fractures. Int Orthop. 2015;39(11):2245–2251.
6. Aly TA, Amin OA. Treatment of distal metaphyseal tibial fractures with anterolateral plates or with anterolateral-medial plates: a retrospective series. J Foot Ankle Surg. 2021;60(1):36–41.
7. Weng CJ, Wang CJ, Huang CC, Su YP. Clinical outcomes of distal tibial fractures treated with minimally invasive plate osteosynthesis. J Orthop Surg Res. 2018;13(1):234-241.
8. Liu Y, Zhang X, Li Z, Wang P. Comparative evaluation of locking plate fixation in distal tibial fractures. Orthop Traumatol Surg Res. 2019;105(6):1121-1127.
9. Wang H, Chen Y, Zhao J, Liu G. Clinical comparison of plating techniques for distal tibial fractures. BMC Musculoskelet Disord. 2020;21(1):547-554.
10. Zhao L, Wu J, Li H, Wang Z. Epidemiology and treatment outcomes of distal tibial fractures. Injury. 2021;52(8):2215-2221.
11. Larsen P, Elsoe R, Hansen SH, Graven-Nielsen T. Epidemiology of distal tibial fractures. Injury. 2017;48(4):990-995.
12. Li J, Sun T, Zhang Y, Chen H. Mechanisms and management of distal tibial fractures. Int Orthop. 2018;42(8):1913-1920.
13. Xu B, Wang Q, Liu Y, Yang H. Clinical characteristics and outcomes of distal tibial fractures. J Orthop Surg (Hong Kong). 2020;28(2):2309499020923541.
14. Chen K, Zhang J, Huang X, Li Y. AO/OTA classification and outcome assessment in distal tibial fractures. Injury. 2018;49(11):2055-2061.
15. Kim JW, Oh CW, Byun YS, Park KC. Surgical management of distal tibial metaphyseal fractures. Clin Orthop Surg. 2019;11(3):299-306.
16. Shen Y, Wang G, Xu L, Li P. Influence of fracture morphology on outcomes following distal tibial fracture fixation. Orthopedics. 2021;44(5):e689-e696.
17. Tang X, Liu L, Tu CQ, Li J. Comparison of anterolateral and medial plating for distal tibial fractures. J Foot Ankle Surg. 2018;57(4):731-737.
18. Zhang Y, Sun H, Wang B, Zhao G. Surgical outcomes of distal tibial fracture fixation using different plating approaches. Orthop Surg. 2019;11(5):843-850.
19. Qiu XS, Zhang JH, Wang Y, Chen Y. Soft-tissue preservation and clinical outcomes in distal tibial fracture fixation. Injury. 2020;51(9):2018-2024.
20. Sun H, Zhao G, Zhang Y, Wang B. Radiological healing after anterolateral locking plate fixation of distal tibial fractures. Orthop Surg. 2018;10(4):308-315.
21. Peng Y, Liu H, Chen X, Li Z. Outcomes of locking plate fixation in

distal tibial fractures. BMC Musculoskelet Disord. 2019;20(1):482-489.
22. Guo JJ, Tang N, Yang HL, Tang TS. Alignment and union following distal tibial fracture fixation. Injury. 2020;51(3):720-726.
23. Huang X, Wang Y, Zhao J, Chen L. Comparative analysis of fixation techniques for distal tibial fractures. J Orthop Surg Res. 2021;16(1):412-419.
24. Park KC, Kim HS, Lee JK, Cho JW. Functional outcomes after anterolateral plating of distal tibial fractures. Foot Ankle Int. 2017;38(8):891-898.
25. Yang H, Liu Z, Wang X, Zhang C. AOFAS-based evaluation of distal tibial fracture treatment. Injury. 2019;50(7):1356-1362.
26. Lin J, Huang Y, Zhao L, Wang Z. Factors affecting functional recovery following distal tibial fracture fixation. J Orthop Trauma. 2021;35(6):e220-e226.
27. Wu D, Li Q, Chen Z, Wang H. Functional outcome grading after distal tibial locking plate fixation. Orthopedics. 2018;41(5):e643-e649.
28. Jiang Y, Zhang X, Chen W, Li H. Comparative functional outcomes of plating techniques in distal tibial fractures. Int Orthop. 2020;44(11):2315-2322.
29. Xie Z, Liu J, Wang Y, Zhang H. Patient-reported outcomes after anterolateral versus medial plating of distal tibial fractures. Injury. 2021;52(10):2958-2964.