

ORIGINAL RESEARCH

To evaluate the functional result of distal tibia fractures treated with locking compression plates utilizing the minimally invasive plate osteosynthesis (MIPO) approach

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ABSTRACT

Aim: To evaluate the functional result of distal tibia fractures treated with locking compression plates utilizing the minimally invasive plate osteosynthesis (MIPO) approach. **Material and methods:** This prospective study was conducted at a tertiary care hospital over a period of one year and included 80 patients who met the inclusion criteria. Patients aged 18 years and older. Patients diagnosed with closed distal tibia fractures confirmed by radiographic evidence. Patients eligible for surgical intervention using LCP and MIPO technique. Patients and their guardians who provided written informed consent to participate in the study. The primary outcome measure was the rate of fracture union, defined as the presence of bridging callus on radiographs and the absence of pain or tenderness at the fracture site. Secondary outcome measures included functional outcomes assessed using the American Orthopaedic Foot & Ankle Society (AOFAS) score, complications such as infection, hardware irritation, and nonunion, time to union measured from the day of surgery to the confirmation of clinical and radiological union, and length of hospital stay from the day of admission to discharge. **Results:** The mean preoperative AOFAS score was 45 ± 12 , indicating a significant impairment in function prior to surgery. At six months post-surgery, the mean AOFAS score improved to 85 ± 14 , representing an 88.89% improvement. This substantial enhancement in functional outcomes underscores the effectiveness of the MIPO technique in restoring limb function and improving the quality of life for patients with distal tibia fractures. The most common complication was infection, occurring in 5% (4 patients) of the cases. Hardware irritation was reported in 3.75% (3 patients), while nonunion was observed in 2.5% (2 patients). Nail migration, another potential issue, was seen in 3.75% (3 patients). These complication rates are consistent with existing literature, indicating that the MIPO technique is associated with a low incidence of adverse outcomes. **Conclusion:** In conclusion, this study reinforces the efficacy and safety of the MIPO technique with LCP for distal tibia fractures. The high rates of fracture union, significant functional improvements, and low complication rates observed in this study underscore the benefits of this minimally invasive approach, making it a preferred option for managing these challenging fractures.

Keywords: distal tibia fractures, locking compression plates, MIPO

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INTRODUCTION

Distal tibia fractures are complex injuries often resulting from high-energy trauma such as motor vehicle accidents, falls from significant heights, or sports-related impacts. These fractures pose unique challenges due to their anatomical location and the subcutaneous position of the tibia, which increases the risk of complications such as skin necrosis, infection, and nonunion. Effective management of distal tibia

fractures is crucial to restore limb function, reduce pain, and prevent long-term disabilities.¹ Traditionally, open reduction and internal fixation (ORIF) has been the mainstay treatment for such fractures. However, ORIF is associated with extensive soft tissue dissection, which can compromise the blood supply to the fracture site and increase the risk of infection and delayed healing. In recent years, minimally invasive percutaneous osteosynthesis

(MIPO) using locking compression plates (LCP) has emerged as a preferred alternative for treating distal tibia fractures. The MIPO technique involves minimal soft tissue disruption, which helps preserve the periosteal blood supply and promotes faster healing with fewer complications.^{2,3} The locking compression plate system is designed to provide stable fixation through a combination of locking and compression screws, which enhances the stability of the fracture fixation. The LCP allows for angular stability, making it particularly beneficial in osteoporotic bone or fractures with poor bone quality. This system also enables early mobilization, which is essential for preventing joint stiffness and improving functional outcomes.^{4,5} The MIPO technique is performed through small incisions and utilizes indirect reduction methods under fluoroscopic guidance. This approach minimizes surgical trauma and reduces the risk of postoperative complications. The technique's ability to provide stable fixation with minimal invasion makes it especially suitable for fractures in the distal tibia, where the soft tissue envelope is thin, and the risk of complications from extensive surgical exposure is high.⁶⁻¹² Clinical studies have shown that the MIPO technique with LCP results in high rates of fracture union and excellent functional outcomes. Patients typically experience reduced pain, faster recovery times, and a quicker return to normal activities compared to those treated with traditional ORIF. Moreover, the risk of complications such as infections, nonunion, and hardware irritation is significantly lower with the MIPO technique.¹³⁻¹⁸ The primary outcome measure in evaluating the effectiveness of the MIPO technique is the rate of fracture union, which is assessed through clinical and radiographic evidence of healing. Secondary outcomes include functional recovery, assessed using standardized scoring systems such as the American Orthopaedic Foot & Ankle Society (AOFAS) score, and the incidence of complications. Studies have reported that the MIPO technique not only facilitates fracture healing but also enhances the overall functional recovery of the patients.

MATERIAL AND METHODS

This prospective study was conducted at a tertiary care hospital over a period of one year and included 80 patients who met the inclusion criteria.

Inclusion criteria

1. Patients aged 18 years and older.
2. Patients diagnosed with closed distal tibia fractures confirmed by radiographic evidence.
3. Patients eligible for surgical intervention using LCP and MIPO technique.
4. Patients and their guardians who provided written informed consent to participate in the study.

Exclusion criteria

1. Patients with open fractures.

2. Patients with pathological fractures due to underlying bone diseases.
3. Patients with pre-existing neuromuscular disorders affecting the lower limbs.
4. Patients with incomplete medical records or those lost to follow-up.

Preoperative assessment involved a comprehensive clinical examination and detailed medical history. Baseline investigations included complete blood count (CBC), coagulation profile, and pre-anesthetic evaluation. Radiographic evaluation was performed to classify the fracture type and plan the surgical intervention.

The surgical technique involved the use of locking compression plates (LCP) applied via the MIPO technique. **The key steps included:**

1. Patient positioning: Patients were positioned supine on a radiolucent operating table.
2. Fracture reduction: Closed reduction of the fracture was attempted under fluoroscopic guidance. In cases where closed reduction was not achievable, a mini-open approach was utilized.
3. Plate insertion: The LCP was inserted through small incisions, and screws were placed percutaneously to secure the plate. The plate was contoured to match the anatomy of the distal tibia, ensuring minimal soft tissue disruption.
4. Fracture stabilization: Adequate stabilization of the fracture was achieved by fixing the plate proximally and distally to the fracture site.
5. Closure: The insertion points were closed with absorbable sutures, and a sterile dressing was applied.

Postoperative care involved:

1. Pain management: Appropriate analgesics were administered based on the pain assessment.
2. Mobilization: Early mobilization with partial weight-bearing was encouraged as tolerated by the patient, progressing to full weight-bearing over 6 to 8 weeks.
3. Follow-up: Patients were followed up at 2 weeks, 6 weeks, 3 months, and 6 months post-surgery. Follow-up included clinical assessment and radiographic evaluation to monitor fracture healing and alignment.

Outcome measures:

1. Primary outcome: The primary outcome measure was the rate of fracture union, defined as the presence of bridging callus on radiographs and the absence of pain or tenderness at the fracture site.
2. Secondary outcomes: Secondary outcome measures included functional outcomes assessed using the American Orthopaedic Foot & Ankle Society (AOFAS) score, complications such as infection, hardware irritation, and nonunion, time to union measured from the day of surgery to the confirmation of clinical and radiological union,

and length of hospital stay from the day of admission to discharge.

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 25.0. Descriptive statistics were used to summarize demographic and clinical characteristics. Continuous variables were expressed as mean \pm standard deviation (SD), and categorical variables as frequencies and percentages. Comparative analysis was performed using the chi-square test for categorical variables and the t-test for continuous variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Rate of Fracture Union The study found a high rate of fracture union among the 80 patients treated with locking compression plates (LCP) using the MIPO technique. Specifically, 93.75% (75 patients) showed the presence of bridging callus on radiographs, indicating successful fracture healing. Additionally, 91.25% (73 patients) reported an absence of pain or tenderness at the fracture site, suggesting effective pain management and healing. Overall, 87.5% (70 patients) achieved total fracture union, which reflects the efficacy of the MIPO technique in promoting bone healing and recovery.

Table 2: Functional Outcomes (AOFAS Score) Functional outcomes were assessed using the American Orthopaedic Foot & Ankle Society (AOFAS) score. The mean preoperative AOFAS score was 45 ± 12 , indicating a significant impairment in function prior to surgery. At six months post-surgery, the mean AOFAS score improved to 85 ± 14 ,

representing an 88.89% improvement. This substantial enhancement in functional outcomes underscores the effectiveness of the MIPO technique in restoring limb function and improving the quality of life for patients with distal tibia fractures.

Table 3: Complications The incidence of complications was relatively low, highlighting the safety of the MIPO technique. The most common complication was infection, occurring in 5% (4 patients) of the cases. Hardware irritation was reported in 3.75% (3 patients), while nonunion was observed in 2.5% (2 patients). Nail migration, another potential issue, was seen in 3.75% (3 patients). These complication rates are consistent with existing literature, indicating that the MIPO technique is associated with a low incidence of adverse outcomes.

Table 4: Time to Union The majority of patients (81.25%, or 65 patients) achieved fracture union within eight weeks, reflecting the efficiency of the MIPO technique in promoting rapid bone healing. A smaller proportion, 18.75% (15 patients), required more than eight weeks to achieve union, which may be attributed to factors such as fracture complexity, patient comorbidities, or variations in individual healing rates.

Table 5: Length of Hospital Stay The length of hospital stay was less than seven days for 68.75% (55 patients) of the cohort, indicating a swift recovery period facilitated by the minimally invasive nature of the MIPO technique. In contrast, 31.25% (25 patients) had a hospital stay of seven days or more, suggesting that some patients required extended postoperative care, potentially due to complications or slower recovery rates.

Table 1: Rate of Fracture Union

Variable	Frequency (n=80)	Percentage (%)
Presence of Bridging Callus	75	93.75%
Absence of Pain or Tenderness	73	91.25%
Total Fracture Union	70	87.5%

Table 2: Functional Outcomes (AOFAS Score)

Outcome Measure	Preoperative Score (Mean \pm SD)	Postoperative Score at 6 Months (Mean \pm SD)	Improvement (%)
AOFAS Score	45 ± 12	85 ± 14	88.89%

Table 3: Complications

Complication	Frequency (n=80)	Percentage (%)
Infection	4	5%
Hardware Irritation	3	3.75%
Nonunion	2	2.5%
Nail Migration	3	3.75%

Table 4: Time to Union

Time to Union (Weeks)	Frequency (n=80)	Percentage (%)
≤ 8 Weeks	65	81.25%
> 8 Weeks	15	18.75%

Table 5: Length of Hospital Stay

Length of Hospital Stay	Frequency (n=80)	Percentage (%)
<7 Days	55	68.75%
≥7 Days	25	31.25%

Table 6: Functional Outcomes

Outcome Measure	Preoperative Score (Mean ± SD)	Postoperative Score at 6 Months (Mean ± SD)
Pain Level (VAS)	8.0 ± 1.5	2.0 ± 1.0
Range of Motion (Degrees)	60 ± 20	120 ± 15
Time to Full Weight-Bearing (Weeks)	-	8 ± 2
Return to Normal Activities (%)	-	90%

DISCUSSION

The results of this study highlight the efficacy and safety of using locking compression plates (LCP) with the minimally invasive percutaneous osteosynthesis (MIPO) technique for the treatment of distal tibia fractures.

Table 1: Rate of Fracture Union The study demonstrated a high rate of fracture union, with 93.75% of patients showing the presence of bridging callus and 91.25% reporting an absence of pain or tenderness at the fracture site. These outcomes are in line with earlier studies by Hasenboehler et al. (2007) and Krettek et al. (2001), which reported similar high union rates using the MIPO technique. The overall fracture union rate of 87.5% in this study further underscores the effectiveness of the MIPO approach in ensuring stable and timely bone healing.^{10,11}

Table 2: Functional Outcomes (AOFAS Score) The functional outcomes, assessed using the AOFAS score, showed significant improvement from a preoperative mean score of 45 ± 12 to a postoperative mean score of 85 ± 14 at six months. This represents an 88.89% improvement, which is consistent with findings by Court-Brown et al. (2006), who also reported substantial functional recovery with the use of minimally invasive techniques. The ability to achieve such a significant enhancement in functional scores reflects the MIPO technique's capability to promote early mobilization and effective rehabilitation.¹²

Table 3: Complications The incidence of complications in this study was relatively low. Infection occurred in 5% of patients, hardware irritation in 3.75%, nonunion in 2.5%, and nail migration in 3.75%. These rates are comparable to those reported by Collinge and Sanders (2000) and Vallier et al. (2008), who found similar complication rates with the MIPO technique. The low incidence of nonunion and hardware-related issues suggests that the technique not only provides stable fixation but also minimizes soft tissue disruption, thereby reducing the risk of complications.^{13,14}

Table 4: Time to Union The majority of patients (81.25%) achieved fracture union within eight weeks, which is indicative of the MIPO technique's efficiency in promoting rapid bone healing. Previous studies by Ronga et al. (2010) and Zelle et al. (2008) have also

highlighted the benefits of minimally invasive approaches in achieving quicker union times compared to traditional open methods. The small proportion of patients (18.75%) requiring more than eight weeks to achieve union could be due to factors such as the severity of the fracture, patient comorbidities, or individual variations in healing processes.^{15,16}

Table 5: Length of Hospital Stay A significant majority of patients (68.75%) had a hospital stay of less than seven days, reflecting the minimally invasive nature of the MIPO technique, which facilitates faster recovery and earlier discharge. This is supported by the findings of Helfet et al. (1997) and Redfern et al. (2004), who reported reduced hospital stays with the use of minimally invasive fracture fixation techniques. The 31.25% of patients who had longer hospital stays might have experienced more complex recoveries or complications, necessitating extended inpatient care.^{17,18}

CONCLUSION

In conclusion, this study reinforces the efficacy and safety of the MIPO technique with LCP for distal tibia fractures. The high rates of fracture union, significant functional improvements, and low complication rates observed in this study underscore the benefits of this minimally invasive approach, making it a preferred option for managing these challenging fractures.

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