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Original Research Article

Evaluation of distal tibial fractures with soft tissue injury treated using locking plate as an external fixator: a prospective study

M. Nazir Hossain[1]*, Amrit Khalkho[2], Aminul Islam Mamood[1], Abdul Hassan Khan[1], Sujit Narayan Nandi[1]

[1]Department of Orthopedics, Calcutta National Medical College and Hospital, Kolkata, West Bengal, India
[2]Department of Orthopedics, Deben Mahato Government Medical College and Hospital, Purulia, West Bengal, India

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***Correspondence:**
Dr. M. Nazir Hossain,
E-mail: mnh.sskm@gmail.com

ABSTRACT

Background: Distal tibial fractures are frequently associated with significant soft tissue injury because of the subcutaneous location and limited vascularity of the distal tibia. Management of these fractures remains challenging, as conventional internal fixation may increase the risk of wound complications, infection, and delayed healing. The use of a locking plate as an external fixator, also known as supercutaneous plating, has emerged as a minimally invasive alternative that provides stable fixation while preserving soft tissue integrity. Objective was to evaluate the clinical, functional, and radiological outcomes of distal tibial fractures associated with soft tissue injury treated using a locking plate as an external fixator.
Methods: This prospective hospital-based study included 32 patients with distal one-third tibial fractures associated with soft tissue injury treated between October 2022 and March 2024. Closed fractures with significant soft tissue compromise and open fractures up to Gustilo-Anderson type IIIA were included. Patients were followed up at regular intervals with clinical and radiological assessment. Outcome measures included time to fracture union, time to full weight bearing, complications, and functional outcomes assessed using the American Orthopedic Foot and Ankle Society (AOFAS) ankle-hindfoot score and visual analog scale (VAS).
Results: The mean age of the patients was 42.9±11.4 years. Road traffic accidents were the most common mechanism of injury. Eighteen patients had open fractures. The mean time to radiological union was 15.66±2.25 weeks. Full weight bearing was achieved at a mean of 14.22±2.52 weeks, and the mean time to plate removal was 19.25±2.45 weeks. Pin tract infection occurred in 6 patients and was superficial in all cases. The mean postoperative AOFAS score was 93±2.59, indicating excellent functional outcome.
Conclusions: Locking plate used as an external fixator is a safe, effective, and minimally invasive technique for the management of distal tibial fractures associated with soft tissue injury, providing excellent functional and radiological outcomes with low complication rates.

Keywords: AOFAS score, Distal tibial fracture, External fixation, Locking plate, Supercutaneous plating, Soft tissue injury

INTRODUCTION

Distal tibial fractures constitute a challenging group of injuries due to the subcutaneous location of the bone, limited soft tissue coverage, and compromised vascularity.[1,2] These fractures are frequently associated with varying degrees of soft tissue injury, which significantly influences treatment strategies and clinical outcomes. Conventional open reduction and internal fixation techniques, although biomechanically stable, are associated with increased risks of wound complications and infection in the presence of soft tissue compromise.[3,4]

Closed reduction and intramedullary nailing can minimize additional soft tissue damage and preserve fracture biology; however, distal tibial fractures may be associated with difficulties in distal locking, malalignment, distal screw failure, and potential propagation of the nail into the ankle joint.[5] Minimally invasive plate osteosynthesis (MIPPO) reduces soft tissue dissection, but implant prominence over the medial malleolus may lead to soft tissue irritation and secondary skin necrosis.[6-8]

External fixation has traditionally been used in fractures associated with severe soft tissue injury; however, conventional external fixators are bulky, uncomfortable, and associated with pin tract infection and loss of reduction.[9,10] The concept of using a locking compression plate as an external fixator, termed supercutaneous plating, combines the mechanical stability of locking plate fixation with the biological advantages of external fixation.[11-13]

This technique allows minimal soft tissue dissection, preservation of vascularity, early mobilization, and convenient implant removal without the need for a second major surgical procedure.[14-19] Despite encouraging preliminary reports, literature regarding the use of locking plates as external fixators in distal tibial fractures with soft tissue compromise remains limited. Therefore, the present study was undertaken to evaluate the clinical, functional, and radiological outcomes of distal tibial fractures managed using locking plates as external fixators.

METHODS

This prospective hospital-based study was conducted in the department of orthopedics at Calcutta National Medical College and Hospital between October 2022 and March 2024 after obtaining informed consent and institutional ethical approval. A total of 32 patients with distal one-third tibial fractures associated with soft tissue injury were included in the study.

Patients aged 18-70 years of either sex were eligible for inclusion. Inclusion criteria comprised closed fractures with significant soft tissue injury (Tscherne grade I) and open fractures up to Gustilo-Anderson type IIIA.[20] Patients with pathological fractures, Gustilo-Anderson type IIIB/IIIC injuries, severe articular comminution, polytrauma with spinal involvement, or pre-existing neurological or vascular disorders were excluded.[21]

The mean age of the study population was 42.91±11.41 years (median 44.5 years; range 25-62 years). The cohort included 18 males and 14 females. Open fractures were present in 18 patients, while 14 patients had closed fractures. Among the open fractures, 8 were Gustilo-Anderson type I, 7 were type II, and 3 were type IIIA.

Road traffic accidents were the predominant mechanism of injury, accounting for 28 cases, whereas 4 patients sustained injuries following falls from height. The majority of patients were housewives (n=13), followed by farmers (n=6) and laborers (n=5).

According to the AO/OTA classification, 14 fractures were classified as type 43A1, 11 as type 43A2, and 7 as type 43A3.[22]

Seventeen patients had no associated comorbidities. Among the remaining patients, diabetes mellitus was present in 7 cases, hypertension in 5 cases, hyperlipidemia in 2 cases, and seizure disorder in 1 case.

Surgical technique and postoperative protocol

Patients were positioned supine on a radiolucent operating table with a small support placed beneath the contralateral anterior superior iliac spine (ASIS). All procedures were performed under regional anesthesia. In closed fractures, surgery was undertaken after subsidence of soft tissue swelling, whereas open fractures underwent initial thorough debridement. Associated distal fibular fractures were internally fixed to restore length and provide lateral stability; however, proximal and middle fibular fractures were not addressed.

Figure 1: Intraoperative picture showing fracture reduction under fluoroscopic guidance.

Under fluoroscopic (C-arm) guidance, fracture reduction was achieved using manual traction and percutaneous manipulation with Schanz pins and was temporarily maintained using two percutaneous Kirschner wires (K-wires) (Figure 1). In fractures with spiral or oblique morphology, a small anterolateral incision was made near the fracture site to facilitate anatomical reduction with minimal soft tissue dissection. Reduction was achieved either by manual ankle traction or with the aid of a Steinmann pin inserted through the calcaneus, and temporary fixation was maintained using reduction clamps or K-wires.

A contralateral distal femoral locking compression plate was applied externally over the anteromedial aspect of the tibia with its contour matching the bony surface. The plate was positioned close to the bone while maintaining a slight offset using a 1-2 cm folded gauze to prevent skin irritation and facilitate soft tissue care (Figure 2). The broader distal end of the plate was oriented toward the ankle joint to allow insertion of multiple screws into the distal fragment. Through small stab incisions, sequential drilling was performed using locking drill guides, screw lengths were measured using a depth gauge, and at least four bicortical locking screws were inserted in both proximal and distal fragments. Final reduction, alignment, and screw positioning were confirmed under fluoroscopy (Figure 3). Wounds were closed in layers, and suction drainage was used in cases requiring open reduction and removed after 24 hours (Figure 4).

Figure 2: Intraoperative picture showing positioning of plate.

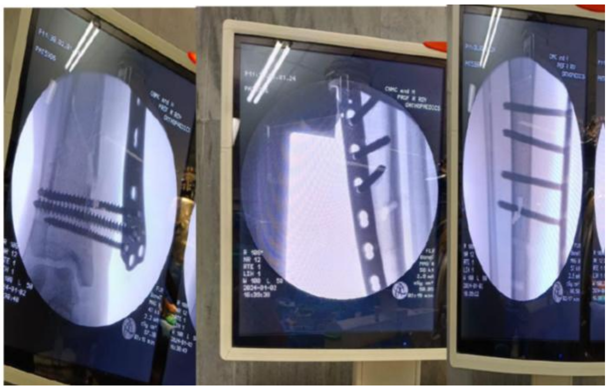

Figure 3: Intraoperative fluoroscopic images showing positioning of screws and plate.

Figure 4: Intraoperative photo showing final plate position with screws after reduction.

Postoperatively, patients were mobilized with partial weight bearing from postoperative day 2. Pin sites were cleaned twice daily using povidone-iodine solution. Follow-up evaluations were performed every 4 weeks with clinical and radiographic assessment. Full weight bearing was permitted after evidence of cortical bridging on biplanar radiographs and continued for one month prior to plate removal, which was performed in the outpatient setting. Fracture union was defined as resolution of pain at the fracture site with cortical bridging on biplanar radiographs. Complications assessed included fixation failure, infection, and nonunion.

Functional outcomes were evaluated using the American Orthopedic Foot and Ankle Society (AOFAS) ankle-hindfoot score at a minimum follow-up of one year after implant removal. Statistical analysis was performed using Student's t-test and ANOVA to determine associations between variables such as age, gender, and fracture type with clinical outcomes, with a p value <0.05 considered statistically significant.

RESULTS

The mean duration of surgery was 43.19±8.30 minutes (median 41.5 minutes; range 28-58 minutes). Pin tract infection was observed in 6 patients; all cases were superficial and managed conservatively without implant removal or progression to deep infection.

Table 1: Association between type of fracture with time for union and AOFAS score (n=32).

Fracture AO type	Frequency	Time for union (in weeks)	AOFAS score
43A1	14	14.93±2.50	94.0±2.35
43A2	11	15.82±1.89	92.91±2.43
43A3	7	16.86±1.95	91.14±2.54
P value		0.175	0.053

Fracture union was achieved in all patients. The mean time to union was 15.66±2.25 weeks (median 16 weeks; range 13-22 weeks) (Table 1). The mean time to full weight bearing was 14.22±2.52 weeks (median 14 weeks; range 10-22 weeks), while the mean duration until plate removal was 19.25±2.45 weeks (median 19.5 weeks; range 16-24 weeks).

Table 2: Association between type of injury with time for union and AOFAS score (n=32).

Injury type	Frequency	Time for union (in weeks)	AOFAS score
Open	18	15.83±2.45	92.67±2.57
Closed	14	15.43±2.03	93.43±2.65
P value		0.621	0.418

Postoperative pain assessment using the visual analog scale (VAS) demonstrated a mean score of 3.81±0.93 (median 4; range 2-6). Functional outcome evaluation using the American Orthopedic Foot and Ankle Society (AOFAS) ankle-hindfoot score revealed a mean score of 93±2.59 (median 94; range 88-96), indicating excellent functional recovery (Table 2).

DISCUSSION

Management of distal one-third tibial fractures remains challenging because of the subcutaneous location of the bone, compromised vascularity, and limited soft tissue coverage, all of which predispose to wound complications and infection (Figure 5). Although intramedullary nailing is widely practiced, distal fractures may be associated with malalignment, difficulty in distal fixation, and anterior knee pain. Locking plate fixation provides stable fixation but often requires soft tissue dissection and may increase the risk of wound-related complications. Conventional external fixation, though useful as a temporary or damage-control procedure, is frequently associated with patient discomfort, bulky hardware, and suboptimal cosmetic outcomes.

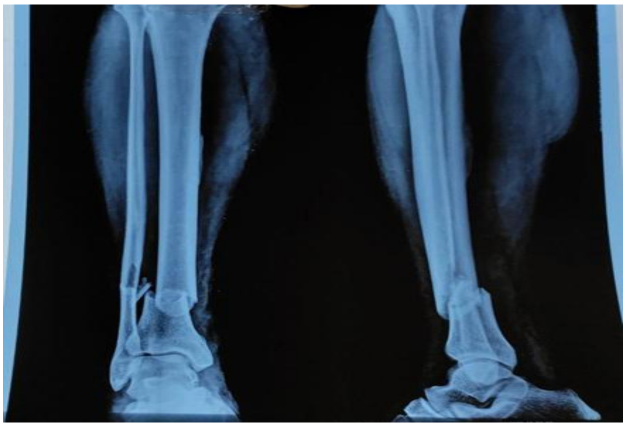

Figure 5: Pre operative x-ray showing distal tibial fracture.

Figure 6 (A and B): Immediate post operative x-ray images showing anatomical reduction and x-ray after plate removal.

In the present study, external fixation using a locking compression plate demonstrated favorable clinical and functional outcomes. The mean operative time of approximately 43 minutes reflects the relative simplicity and efficiency of the technique, likely attributable to minimal soft tissue dissection and straightforward implant application (Figure 6).

Early mobilization was possible in all patients, with partial weight bearing initiated from the second postoperative day, which may have contributed to improved rehabilitation and reduced complications related to prolonged immobilization.

Figure 7 (A and B): Clinical photo showing full weight bearing with plate.

Fracture union was achieved in all patients, with a mean union time of approximately 16 weeks, which is comparable to previously reported outcomes following intramedullary nailing and minimally invasive plating techniques (Figure 7). Stable fixation achieved through multiple bicortical locking screws, particularly in the distal fragment, likely contributed to the absence of implant failure or nonunion in this series.[23,24] Furthermore, the mean time to full weight bearing of approximately 14 weeks indicates that adequate construct stability was maintained throughout the healing period.

Pin tract infection remains a recognized complication of external fixation techniques. In the present study, pin tract infection occurred in a limited number of patients and was superficial in all cases, without progression to deep infection or implant failure. This low complication rate may be attributed to meticulous pin site care and preservation of the soft tissue envelope. Importantly, no cases of nonunion or fixation failure were encountered.

Functional outcomes were excellent, with high postoperative AOFAS scores and low VAS pain scores (Figure 8).[25] The medial placement of the plate likely minimized interference with surrounding musculature and reduced discomfort during ankle movement. In addition, the external positioning of the implant allowed simple outpatient plate removal, thereby avoiding the technical difficulties and morbidity occasionally associated with removal of intramedullary nails or internal locking plates.[26]

Figure 8 (A and B): Clinical picture showing full range of motion after plate removal.

Despite these encouraging findings, certain limitations should be acknowledged. The absence of a control group limits direct comparison with other established treatment modalities. The sample size was relatively small, and the follow-up duration may not adequately assess long-term complications or functional outcomes. Furthermore, the role of locking plate external fixation in closed distal tibial fractures remains controversial, as internal fixation continues to be considered the standard treatment in many centers.

CONCLUSION

In conclusion, the use of a locking compression plate as an external fixator appears to be a safe, minimally invasive, and effective option for the management of distal tibial fractures associated with soft tissue injury. The technique offers advantages including shorter operative time, early mobilization, reliable fracture union, low complication rates, and convenient implant removal. Further prospective comparative studies with larger sample sizes and longer follow-up are required to establish its definitive role in the management of distal tibial fractures.

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Ethical approval: The study was approved by the Institutional Ethics Committee of Calcutta National Medical College and Hospital

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