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A study of functional outcome of distal tibial extra-articular fracture fixed with locking compression plate using MIPPO technique

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Abstract
Background: Distal metaphysical fractures of Tibia are difficult to manage due to its poor blood supply and limited soft tissue envelope. Most of these are managed surgically using closed reduction with IMIL nail, ORIF with plating, closed reduction and percutaneous plating or external fixation. Principles of biological fixation advocate realignment by manipulation at a distance from fracture site, leaving comminuted fragments out of mechanical construct and preserving soft tissues with limited exposure. Thus MIPPO with LCP has emerging as a popular treatment option for distal tibial fractures.
Objectives: To evaluate the functional and radiological results of Locking Compression Plate (LCP) osteosynthesis in extra articular distal tibial fractures using Minimal Invasive Percutaneous Plate Osteosynthesis Technique (MIPPO)
Methodology: Patients with closed extra articular distal tibial fractures admitted under orthopedics in KIMS hospital were operated by Locking Compression Plate using MIPPO technique. Patients were followed up at regular intervals of 6 weeks for about 6 to 10 months. They were assessed clinically, functionally and with radiological evaluations. Functional assessment was done using AOFAS scoring system.
Results: In our study, the average age of patients was 46 years (19 – 68) with the male predominance (75%). Average time interval between injury and operation in our study was 3.2 days (2-7 days). Mean duration of surgery was 98.80 minutes. Mean interval of follow up was 7.8 months (6 to 10 months). Average period for radiological consolidation was 22 weeks. All patients achieved functional range of ankle movements during follow up period of 6-10 months. Functional outcome was measured using AOFAS score and mean AOFAS score was 88 at the end of 24 weeks. 02 cases of superficial wound infection/ delayed wound healing were encountered. 01 of case Deep Infection needing implant removal was seen. No other complications like deformities, compartment syndrome, non-union, implant irritation/skin impingement or implant failure were seen in our study.
Conclusion: LCP using MIPPO offers a biological advantage by preserving periosteal blood supply, which is particularly critical with distal tibial injuries. Combined with C arm guidance helps in indirect reduction of distal tibial fractures in restoring length and alignment, thus reducing the chances of malunion and deformities. There is decrease in the rate of deep infection in patients treated with MIPPO technique with good radiological union. It helps in early mobilization of ankle movements and reducing ankle stiffness thus improving clinical and functional outcome.

Keywords: Distal tibial fracture, LCP plate, MIPPO, AOFAS score

Introduction
Distal tibial fractures are one of the most complex injuries around the ankle joint, accounting for approximately 7% of all tibial fractures [1]. Fractures of the distal tibial metaphysis with or without intra-articular extension can present a management challenge because of their inherent instability, scarcity of soft tissues, subcutaneous nature and poor vascularity of bone. Treatment modality is dictated by the fracture displacement, comminution, intra-articular extension and injury to the soft-tissue envelope [2]. Soft-tissue management has been seen to play a vital role in the management alongside the bony reconstruction [3].
Several methods of treatment are implemented including non-operative treatment, external fixation, intramedullary nailing, and internal fixation with traditional implants (standard screws and plates) [4]. However, each of these treatment options is associated with certain challenges [5]. For the recent decade, nailing and plating for fracture stabilization have been successfully used in treating fractures of lower extremity, especially distal tibia.

The goal of the techniques is to achieve stable fixation while maintaining the fracture biology and minimizing the soft tissue problems. The use of Locking Compression Plate has revolutionized the management of fractures by reducing immobilization in bed and ensuring early return to work. Compared to conventional plates, locking plates impart a higher degree of stability and provides better protection against primary and secondary loss of reduction [6, 7, 8].

Locking plates have the biomechanical properties of internal and external fixators, with superior holding power because of fixed angular stability through the head of locking screws, independent of friction fit [9]. Locking plates are particularly useful in severely comminuted and fragility fractures due to their biomechanical properties of fixation [10]. Stress is laid on maintaining a precarious balance between devascularisation and mechanical perfection. This system stimulates callus formation due to flexible elastic fixation [11].

A mechanically stable fracture-bridging osteosynthesis can be obtained without significant dissection and surgical trauma to the bone and surrounding soft tissues by minimally invasive percutaneous plate osteosynthesis (MIPPO) [12].

The objective of this study was to evaluate the functional results as well as radiological results and various complications associated with Locking Compression Plate osteosynthesis using MIPPO technique in extra-articular distal tibial fractures.

Materials and methods

Source of Data

The study was conducted on 20 patients admitted with extra articular distal tibial fracture during June 2013 to June 2017, in Department of Orthopaedics, Kempegowda institute of medical sciences and research centre, Bangalore.

Inclusion Criteria

1. Age: Above 18 years up to 70 years of either sex
2. Closed Distal Tibial extra articular fractures (as per AO Classification [1] 43A1, 43A2, 43A3)

Exclusion Criteria

1. Pathological fractures
2. Old neglected fractures
3. Old fractures with implant failure
4. Associated with Neuro-Vascular injuries or compartment syndrome

Clinical Assessment

On admission of the patient, a careful history was elicited from the patient and/or attenders to reveal the mechanism of injury and the severity of the trauma.

The patients were then assessed clinically to evaluate their general condition and the local injury. Methodical examination was done to rule out fractures at other sites.

Radiographic Assessment

Standard guidelines were followed to get radiographs. Antero-posterior and lateral radiographs of the affected leg along with ankle were taken and the fracture patterns were classified based on the AO/OTA classification of fractures of distal tibia.

Pre Operative Evaluation

Inpatients meeting the inclusion and exclusion criteria were selected for the study. All the patients were explained about the aims of the study, the methods involved and an informed written consent was obtained before being included in the study. Anti-edema measures were taken to reduce swelling. Pre-operative antibiotics were administered 30 min before the operation

Operative Procedure

All patients were operated by Locking Compression Plate (LCP) done using MIPPO technique. Surgery was performed under spinal or General Anesthesia. Tournique was used. A vertical or curvilinear incision was made at the level of medial malleolus. Care was taken not to injure great saphenous vein and saphenous nerve. Subcutaneous plane was made without disturbing the fracture hematoma. Indirect reduction of fracture was done under C-arm guidance and fixed with LCP plate and screws. In some cases fibula fracture was fixed first by open reduction using DCP/1/3 semitubular plate and screws.

Post Operative Period

Immediate post-operative complications like fat embolism, compartment syndrome, neurological damage and vascular injury is looked for. Intravenous antibiotic regimen was continued for 5 days after the surgery. Another 5 days of oral antibiotics were advised. Suture or staple removal was done at 10-12th post-operative day.

Active quadriceps exercises are restarted on the 1st post-operative day with active ankle and toe movements with knee mobilization as far as the patient is comfortable and free of pain. The patients were made to ambulate from the 3rd post-operative day without bearing weight on the operated leg with crutches or walker.

Follow Up

The Patients were followed up at regular intervals of 6 weeks for up to 6-10 months to assess clinically, functionally using AOFAS (American Orthopaedic Foot and Ankle Society) scoring system and with radiological evaluation. Partial and full weight-bearing were allowed based on radiological and consolidation of the fractures. The fracture was designated as united, when there was periosteal bridging callus at the fracture site at least in three cortices in the anteroposterior and lateral views. Trabeculations extending across the fracture site was also taken into consideration.

Results

Table1: Age distribution of patients studied

AGE	No.	%
<20	1	05
20-30	5	25
31-40	5	25
41-50	4	20
51-60	4	20
61-70	1	05
Total	20	100
Mean	46.00	

Table 2: Gender distribution of patients studied

Gender	Patients	
	No	%
Female	5	25
Male	15	75
Total	20	100

Table 3: Occupation distribution

Occupation	Patients	
	No	%
Farmer	3	15
Housewife	2	10
Businessman	3	15
Governmentofficer	3\	15
Labourer	4	20
Lawyer	1	05
Student	2	10
Teacher	1	05
Truckdriver	1	05
Total	10	100

Table 4: Mode of Injury distribution

Mode of Injury	Patients	
	No	%
Road-traffic accident	10	50
Self-fall	04	20
Fall from height	05	25
Contact sports	01	05
Total	10	100

Table 5: Side of limb involved

Side	Patients	
	No	%
Right	13	65
Left	07	35
Total	20	100

Table 6: Fracture distribution as per AO/OTA classification system

AO fracture type	Patients	
	No	%
Type 43A1	15	75
Type 43A2	04	20
Type 43A3	01	05
Total	20	100

Table 7: Duration of surgery (in minutes)

Duration of surgery (in minutes)	Patients	
	No	%
1-60	0	0.0
61-90	8	40.0
91-120	12	60.0
121-150	0	0.0
Total	10	100.0
Mean±SD	98.80±11.09	

Table 8: Coronal plane deformity

Coronal Angulation	6weeks	12weeks	24weeks
Valgus (<50)	NIL	NIL	NIL
Valgus (>50)	NIL	NIL	NIL
No deformity	20(100%)	20(100%)	20(100%)

Table 9: Post op Infections

Postop Infections	Patients	
	No	%
Deep infection	1	05
Superficial infection (delayed healing)	2	10
Total	03	15

Illustration
Radiographs

Pre Op

Immediate Post Op

24 Weeks Follow Up

Clinical Photos

Doriflexion Plantar flexion

Discussion

Treating fractures of distal tibia is considered to be a challenging task because of the status of the soft tissue and degree of comminution sustained at the time of injury, which affect the long term clinical results. The goal of the operative treatment is to obtain anatomical alignment of the joint surface by providing enough stability to allow early movement This should be accomplished using techniques that minimize osseous and soft tissue devascularization in the hopes of decreasing the complications resulting from treatment [6, 7, 8].

The present study was undertaken to evaluate the functional and radiological outcome of plate osteosynthesis with LCP using MIPPO. We evaluated our results and compared them to those obtained by various other studies utilizing similar modalities of treatment. Our analysis was as follows:

Age distribution

Our study revealed the average age of patients with such injuries to be 46 years. Ranging from 19 to 68 yrs. It is comparable to a study on similar fractures conducted by below authors

Study	Average age
Bahari *et al*. [13]	35
Redfern *et al*. [14]	38.3
Sitnik *et al*. [15]	43
JJ Guo *et al*. [16]	44.4
Harenbohler *et al*. [17]	46
C Mauffry *et al*. [18]	46
Present study	46

Sex distribution

In our study, the male predominance for such kind of injuries was high compared to other studies due to the facts like male dominance over females in travelling, occupational injuries etc. in India. It is comparable to other studies on similar fractures.

Study	Male percentage	Female percentage
JJGuo *et al*. [16]	50	35
C Mauffery *et al*. [18]	66	34
Present study	75	25

Occupation: Majority of our patients were from the rural background and involved in hardmanua labour.

Mode of injury: Most common mode of injury was high energy trauma. They were Road traffic accident and fall from height

Side of injury: Fracture were more frequent on right side tibia i.e., 13 patients (65 %)

Fracture type: According to AO classification system, 15 patients were of type 43A1

Time interval: Average time interval between injury and operation in our study was 3.2 days (2-7 days)

Duration of surgery

It was mean of 98.80 minutes. It was because a minimally invasive plate osteosynthesis need high precision, traction that is not fixed, and repeated c-arm exposures for indirect fracture reduction, implant placement and subsequent fixation. It is comparable to other studies on similar fractures.

Study	Average operative time (in minutes)
JJ Guo *et al*. [16]	97.9
Harenbohler *et al*. [17]	86.6
Borg *et al*. [19]	82
Present study	98.9

Follow up: Patients were followed up clinically, functionally as well as with radiological evaluation on regular interval for mean of 7.8 months (6 to 10 months)

Knee activity and knee pain

Knee movements were not affected and knee pain was not there in any of our patients

Range of motion

Ankle movements were started immediately after surgery on post op day 1. Non weight bearing mobilization was done till 4-6 weeks after surgery. Partial weight bearing was started at 6-8 weeks. As the union progressed total weight bearing was allowed by 12-14 weeks depending on radiological union. 18 patients (90%) gained full range of motion by 24 weeks. 2 patients (10%) gained full range of motion by 28-30 weeks after physiotherapy.

Duration of time to radiological consolidation

The average time for fracture consolidation in various studies conducted using similar methods was between 16-22 weeks. Our study had average radiological consolidation at 22 weeks. It is comparable to other studies on similar fractures.

Study	Mean time to union (in weeks)
Bahari *et al*. [13]	22.4
Redfern *et al*. [14]	23
JJ Guo *et al*. [16]	17.6
Collinge *et al*. [20]	21
Present study	22

Functional outcome

Functional outcome was measured using AOFAS score and mean AOFAS score was 88 at the end of 24 weeks. It is comparable to other studies on similar fractures.

Study	Mean AOFAS score
JJ Guo *et al*. [16]	83.9
Collinge *et al*. [20]	85
Present study	88

Complications

In our study, 2 patients had ankle stiffness at the end of 24 weeks of follow up. Patients were managed with physiotherapy. Stiffness gradually improved and functional range of ankle movements was achieved by 28-30 weeks.

We had 2 cases of superficial wound infection/ delayed wound healing. Treated with antibiotics and regular dressing. The wounds eventually healed.

Deep Infection needing implant removal

Only one case of plate fixation needed implant removal after fracture union at 9 months because of non-healing ulcer. Patient was a 68 year old diabetic man on treatment for 13 years. However minimally invasive, incidence of infection in plate osteosynthesis is expected to be higher than closed intramedullary nailing in distal tibia fractures because of subcutaneous bone, lack of soft tissue, cortical bone and precarious blood supply. Wound healed well after implant removal.

Study	Infection rate (%)
Bahari *et al*. [13]	7.14
Redfern *et al*. [14]	5
Sitnik *et al*. [15]	9
JJ Guo *et al*. [16]	14.6
Borg *et al*. [19]	14.3
Present study	15

In our study, all fractures united. no deformities were observed. No other complications like compartment syndrome, non-union, implant irritation/skin impingement or implant failure were seen in our study.

Conclusion

LCP using MIPPO offers a biological advantage by preserving periosteal blood supply, which is particularly critical with distal tibial injuries. MIPPO technique combined with C arm guidance helps in indirect reduction of distal tibial fractures in restoring length and alignment, thus reducing the chances of malunion and deformities. There is decrease in the rate of deep infection in patients treated with MIPPO technique because of minimal exposure and decreased soft tissue damage. As a result a good radiological union is achieved. Rigid fixation by LCP using MIPPO technique helps in early mobilization of ankle movements and reducing ankle stiffness thus improving clinical and functional outcome. Thus we conclude that when extra-articular closed tibial fractures are treated with LCP using MIPPO technique gives good radiological and functional results

Declarations

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Conflict of interest: None declared

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