



ISSN: 2395-1958  
IJOS 2019; 5(1): 12-17  
© 2019 IJOS  
www.orthopaper.com  
Received: 03-11-2018  
Accepted: 06-12-2018

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## MIPO with anatomical plate for distal tibia extra articular fractures: A safe and effective modality

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DOI: <https://doi.org/10.22271/ortho.2019.v5.i1a.03>

### Abstract

**Background:** Distal tibia fractures are often amongst the most difficult fractures to treat because of the hour glass shape of the distal tibia poses a difficulty to achieve fixation with intramedullary nails. Surgical management of the distal tibia can be challenging to treat because of the limited soft tissue, the subcutaneous location, and poor vascularity. Minimally invasive percutaneous plate osteosynthesis (MIPPO) with locking-plates are a newer form of treatment.

**Objectives:** To prospectively study the functional and radiological outcome of distal tibia fractures managed by CRIF by MIPO with medial LCP.

**Materials and Methods:** Patients with fractures of distal tibia extra articular metaphyseal tibial fractures managed with CRIF by MIPO with medial LCP were followed up prospectively till fracture union. Their functional and radiological outcome was assessed by using IOWA knee and ankle scoring index.

**Conclusion:** All fractures united well. Two infections were seen. Distal tibia fractures can be managed well with CRIF by MIPO with medial LCP. No patients developed a coronal plane deformity, one diabetic patient needed implant removal after fracture union due to non healing ulcer. But all patients had good functional outcome.

**Keywords:** Distal tibial fracture, LCP, MIPO, IOWA knee and ankle evaluation

### Introduction

The distal tibia was defined as the area within two Müller squares of the ankle joint, in which the proximal and the distal segments of long bones are defined by a square whose sides have the same length as the widest part of the epiphysis<sup>[1-2]</sup>.

Distal tibia fractures are often amongst the more difficult fractures to treat. They are only 1-10% of lower extremity fractures<sup>[3]</sup>. Conservative treatment by casting leads to prolonged immobilization, leading to ankle and knee stiffness affecting quality of life of the patient<sup>[4]</sup>. Surgical management of the distal tibia can be challenging to treat because of the limited soft tissue, the subcutaneous location, and poor vascularity. Minimally invasive percutaneous plate osteosynthesis (MIPPO) with locking-plates and intramedullary tip locking nailing are the two common forms of treatment<sup>[5]</sup>. For the past decade, nailing and plating for fracture reduction has been successful in treating fractures of lower extremity especially distal tibia. The goal of the techniques is to apply stable fixation while maintaining the fracture biology and minimizing the soft tissue problems<sup>[6, 7, 8]</sup>. Compared to conventional plates, locking plates impart a higher degree of stability and provides better protection against primary and secondary loss of reduction. Stable intramedullary nailing of the distal tibia may be difficult to achieve because the hourglass shape of the intramedullary canal distally. This prevents a tight endosteal fit for the nail and makes the fixation prone for torsional and angular instability<sup>[1]</sup>. Several minimally invasive plate osteosynthesis (MIPPO) techniques have been developed, with high union rates.

The purpose of this study was to assess the functional and, radiological outcome of the extra articular fractures of the distal tibia managed surgically with a Locking compression plate by MIPO technique.

**Materials and Methods**

This study consisted of prospective follow up of 15 patients with distal tibial extra articular fractures AO classification 43A1, 43A2 and 43A. Patients then underwent CRIF by MIPPO with LCP with or without fibula fixation as indicated. Fibula was fixed first either with an intramedullary nail or a 1/3<sup>rd</sup> tubular plate or DCP as per fracture personality, skin condition and surgeon preference.

**I) Inclusion criteria**

- a) Age: Above 18 years up to 70 years of either sex
- b) Distal Tibial extra articular fractures (as per AO Classification 43A1, 43A2, 43A3)

**II) Exclusion criteria**

- a) Pathological fractures
- b) Old neglected fractures
- c) Old fractures with implant failure

**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 vital parameters, general condition and the local injury. Methodical examination was done to rule out fractures at other sites after ruling out major life threatening injuries.

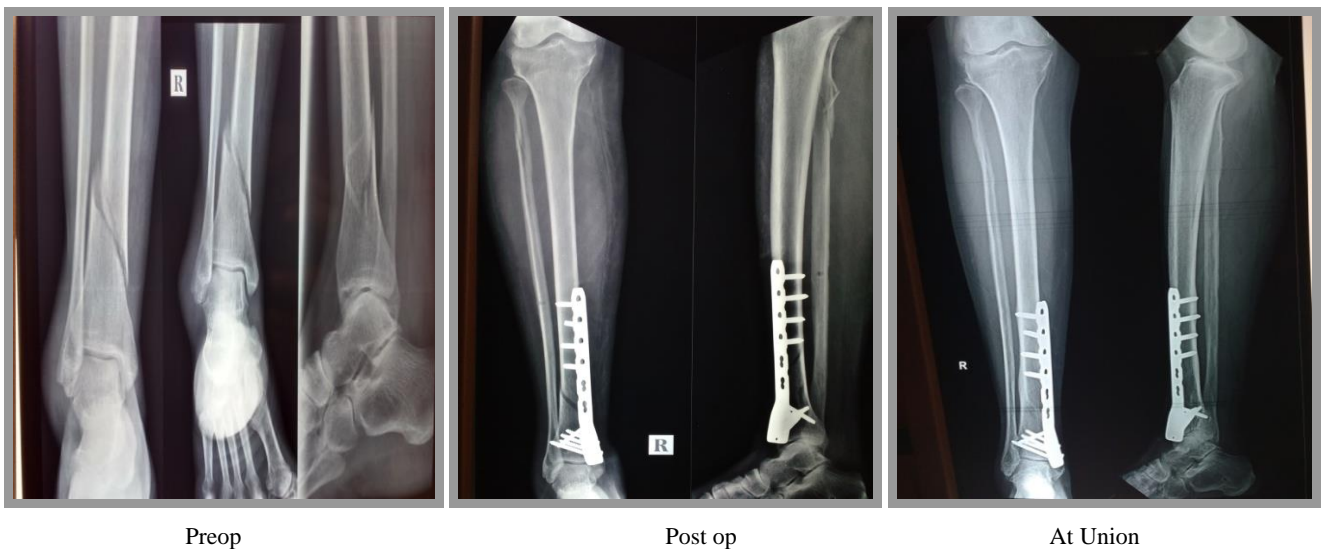
**Radiographic Assessment**

Standard guidelines were utilized to get radiographs – Anteroposterior 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.

**Follow up**

The patients were followed up at intervals of 6 weeks for up to 6-10months to assess the functional and radiological union. 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 [9]. Partial and full weight-bearing were allowed based on radiological and consolidation of the fractures. Patients were be followed up for a period of 6weeks, 12 weeks and 24 weeks at regular intervals and assessed clinically functionally and radiologically based in IOWA knee evaluation and ankle evaluation rating system [9]. Also angular deformity post op and at subsequent follow ups was also assessed.

**Case Illustrations**



**Case 1: Radiographs of case 1**



**Case 2: Radiographs of Case 2**



Pre-op



Post op



At Union

**Case 3: Radiographs of case 3**



Pre-op



Post- op



At Union

**Case 4: Radiographs of Case 4**



Non Healing Wound



Post Implant Removal

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 issue devascularization in the hopes of decreasing the complications resulting from treatment [10].

MIPO provided a closed biological environment for fracture healing with minimal soft tissue trauma and no periosteal stripping as the plate is placed Epi-periosteally. The purpose of our study was the assess the functional outcome, fracture union and fracture alignment after fixation and in subsequent follow ups.

## Results

The results of our study are tabulated as below.

### Age distribution

**Table 1:** Age distribution of patients studied

Age group	Number	%
18-20	0	0
21-30	3	20
31-40	5	33.3
41-50	3	20
51-60	3	20
61-70	1	6.6
Total	15	100%

Mean Age = 41 years, Max Age = 68, Min Age = 22

### Sex distribution

Our study had male pre ponderance

**Table 2:** Gender distribution of patients studied

Sex	Number	% age
Male	11	73.3
Female	4	26.6
Total	15	100

### Occupation

Most of our patients were of low to middle class families mostly businessmen having sedentary lifestyles.

**Table 3:** Occupation distribution in patients studied

Occupation	Number	%age
Farmer	4	26.7
Housewife	3	20
Businessman	2	13.3
Lawyer	1	6.6
Student	2	13.3
Government Employee	3	20
Total	15	100

### Type of Fracture

**Table 4:** Table showing the distribution and percentage of open and closed fractures

Type	Number	% age
Open	3	20
Closed	12	80
Total	15	100

### Mode of Injury

**Table 5:** Table showing the mode of injury in the patients in the study

Mode	Number	% age
Road Traffic Accident	9	60
Fall from height	3	20
Self – Fall	2	13.3
Contact Sport	1	6.7
Total	15	100

### Side Predilection

**Table 6:** Table showing side predilection in the patients in our study

Side	Number	% age
Right	7	46.7
Left	8	53.3
Total	15	100

Average Duration of surgery was 102 minutes. Average number of days of hospital stay is 13 days. Two cases of post op infections, one superficial and one deep. Superficial infection was managed conservatively and subsided with antibiotics and regular dressings. One diabetic, elderly gentleman developed wound dehiscence after 9 weeks post op at the proximal end of the plate away from the fracture site. He had uncontrolled sugars and was managed initially with conservative management – regular dressings and culture specific antibiotics. The fracture continued to heal in the meanwhile with no evidence of osteomyelitis. After fracture union at 30 weeks, he underwent implant removal and the wound healed uneventfully after that.

### Functional outcome

It was assessed using the IOWA knee and ankle evaluation rating system [9] and is tabulated as below

**Table 7:** Table showing the IOWA knee score at 6, 12 and 24 weeks

Average Score as per IOWA knee evaluation rating system	6 weeks	12 weeks	24 weeks
Knee Activity Scoring (max 35)	9	14	31
Knee freedom From pain scoring (max 35)	35	35	35
Knee Gait scoring (max10)	8	8	9
Knee ROM score (max 10)	10	10	10

**Table 8:** Table showing the IOWA ankle score at 6, 23, and 24 weeks

Average Score as per IOWA ankle evaluation rating system	6 weeks	12 weeks	24 weeks
Ankle activity scoring (max 40)	0	0	26
Ankle freedom from pain scoring (max 40)	14	28	37
Ankle gait scoring (max10)	2	8	10
Ankle ROM	13	18	20

### Grade of callus formation

All fractures united well. No cases of non union were seen.

**Table 9:** This table shows the distribution (both number and percentage) of grade of callus formation in patients of the study at 6, 12 and 24 weeks

Grade of callus formation N=20	6 weeks	12 weeks	24 weeks
1	0(0%)	0(0%)	0(0%)
2	0(0%)	1(6.7%)	8(53.3%)
3	0(0%)	14(93.3%)	7(4.7%)
4	0(0%)	0(0%)	0(0%)
5	15(80%)	0(0%)	0(0%)

### Assessment of Coronal deformity

**Table 10:** Coronal deformity in two groups of patients studied

Coronal Angulation	6 weeks	12 weeks	24 weeks
Varus (>5°)	0(0%)	0(0%)	0(0%)
Valgus(>5°)	01(6.7%)	1(6.7%)	1(6.7%)
No deformity	14 (93.3%)	14 (93.3%)	14 (93.3%)
Total	15(100%)	15(100%)	15(100%)

## Discussion

### Age distribution

In this study it was found that the average age of patients with such injuries was 41 years. (19 – 68 years). Here is a comparison to other authors.

**Table 11:** Comparison of our study to other authors with respect to Age distribution

Study	Minimum age (years)	Maximum age (years)	Average
TT Guo <i>et al.</i> [5]	23	70	42
C Mauffry <i>et al.</i> [11]	23	70	46
Somshekar <i>et al.</i> [10]	19	68	46
This study	22	68	41

### Sex distribution

In our study there is a male preponderance.

**Table 12:** Comparison of our study to other authors with respect to sex distribution

Study	Male	Female
TT Guo <i>et al.</i> [5]	50	35
C Mauffry <i>et al.</i> [11]	66	34
Somshekar <i>et al.</i> [11]	80	20
This study	73.3	26.7

Most common mode of injury was road traffic accident and average duration of surgery was 83 minutes. Most of the cases were performed on a simple table. Calcaneal pin traction was applied in some cases to facilitate traction. No Knee pain post op was seen, which is classic of tibia nailing due to the operative trauma. In our study we started ROM movements at the ankle and knee as soon as the patient was comfortable under adequate analgesia. Patients were kept on non weight bearing mobilization for 4-6 weeks post op and partial weight bearing was initiated after 4-6 weeks. As radiological union progressed patient was allowed full weight bearing at around 10-12 weeks. At around 20-24 weeks radiological union was achieved.

### Radiological union

All fractures united. There were no non unions or mal unions.

**Table 13:** Comparison of our study to other authors with respect to Mean time to union

Study	Mean time to union (in weeks)
Kasper W <i>et al.</i> [11]	19
Ajay Krishnan <i>et al.</i> [12]	20
TT Guo <i>et al.</i> [5]	17.6
Somshekar <i>et al.</i> [10]	26
Present study	22

### Complications

As the skin and soft tissue cover over the distal end of tibia are precarious in blood supply, wound related complications are generally more common in this modality of fixation. In a study conducted by C. Mauffrey *et al.* [1] a randomized pilot trial of "locking plate" fixation versus intramedullary nailing for extra-articular fractures of the distal tibia, three patients (6.8%) in the IM nail group and six (14.6%) in the locking-plate group had wound problems. Compartment syndrome was noted in one patient in each group. In a study conducted by J. J. Guo [5], wound complications were more common in the LCP Group, 14.6% compared with 6.8% in the IMN group. All were delayed wound healing. Gupta *et al.* [13] reported 2 cases of wound breakdown, in their series of 79 patients.

With respect to alignment and deformity, In a study by Somshekar *et al.*, 4 out of 10 patients had a slight coronal plane deformity of less than 5° in patients managed by IMIL nailing as opposed to none in LCP. In a study by Kasper *et al.*

[11], 2 patients (16.7%) of IM nailing group had varus/valgus malalignment of >5°, two (16.7%) patients had rotational malalignment of >15° after ORIF versus 3 (25%) after IM nailing.

In a study by Sayed Abbas *et al.* [14] assessment of the treatment outcome of closed extra-articular distal tibia fracture: IM nailing vs plating, non-union occurred in thirteen patients, 8 patients had non-union in plating group and 5 of 27 patients in IM nailing group. 11 of twenty seven patients in IM nailing group suffered from malunion while only 4 patients in the other group had this complication. Lau *et al.* [15] reported a rate of late infection of 15% in MIPO fixation of a locking plate in distal tibial fractures and 52% of their patients had the implant removed because of skin impingement Gupta *et al.* [13] reported 25 patients out of 79 needing implant removal due to various reasons including impingement, wound breakdown and infection.

### Pitfalls of our study

Relatively small sample size of 15, many not be representative of the entire cohort of patients with distal tibial metaphyseal fractures. A larger sample size and a longer followup will be more conclusive. Further more, a comparative analysis of MIPO with other modalities like CRIF with IMIL nail, Ex-fix, Ilizarov fixator etc will help ascertaining which the better modality of treatment is. Also, the cases were performed by more than one surgeon, hence difference in operative techniques and subjective acceptance of fracture reduction may also have role to play in the final functional outcome of the patient.

### Authors' preferences for this modality

Choosing the right patient and right time of surgery is of paramount importance. In our opinion we feel a younger age group is likely to fare better with this modality. It may also be wise to delay definitive fixation of the swelling is more. Appearance of wrinkles over the skin may be a good clinical indicator on deciding the time of surgery. It is better to avoid this method in patients with potential wound healing problems seen in conditions like Uncontrolled Diabetes mellitus and Peripheral vascular disease. Fibular fixation is recommended when the fracture is within 5 cm of the ankle mortise for gaining the height and correcting rotational deformity. In isolated tibial fractures with intact fibula it may be better to prefer absolute stability over relative stability in type of fixation. Soft tissues must be handled with care and at most gently. For skin closure we prefer using a 3-0 non absorbable suture and tensionless sutures like Allgower sutures are preferred over mattress sutures. Use of tourniquet is dependent on surgeon preference.

### Conclusion

In this study functional outcome of 15 patients with extra-articular tibia fractures managed with CRIF with MIPPO using medial LCP were studied prospectively. Average age was 41 years with a male preponderance. Most of the injuries were due to a road traffic accident. Average operating time was 102 minutes and most of our cases were performed on a traction table. No Poller screws were used. Fibula was fixed if the fracture was within 5 cm of ankle mortise to gain height and correct rotation using either plate or intramedullary nail depending on fracture personality, patient profile, severity of injury, skin condition and surgeon preference.

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