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### Original Article

## Outcome of the Treatment of Distal Tibia Fractures by Minimal Invasive Locked Plate – A Short Term Study

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### Abstract

#### Background

Treatment of fracture distal tibia is challenging. Classic open reduction and internal plate fixation requires extensive soft tissue dissection and causes periosteal injury. The locking screw-plate interface allows fracture fixation without plate–bone adherence, thus preserving the fracture hematoma, and reduces the risk of nonunion by maintaining microvascular circulation within the cortex and its investing tissues.

#### Material & Methods

This study included 33 patients of age between 18 to 62 years with extra-articular and simple intra-articular fracture of distal tibia. All fractures were fixed by minimally invasive technique with pre-counteracted distal tibia locking plate under image intensifier control. The American Orthopaedic Foot and Ankle Society (AOFAS) scale was used for functional assessment.

#### Results

Out of 33 there were twelve 43-A1, five A2, five A3, five B1, three B2, two C, one C2 fractures. There were 29 closed fracture and four open fracture (three type I and one type II). The overall mean time of union was 16.3 weeks. The mean AOFAS score was 93 points. In all 30 cases there were no wound problems, whereas three cases had superficial wound infection. No any cases needed secondary procedure for healing of bone.

#### Conclusion

The short-term results shows that minimally invasive locked plating is good solution for the challenging distal tibia fracture. This technique minimizes soft tissue complication and provides good union and functional outcome.

**Key words:** *Distal tibia fracture, Locked plate, Minimally invasive plate osteosynthesis.*

### Introduction

Treatment of fracture distal tibia is challenging because of the limited soft tissue, the subcutaneous location, and poor vascularity of distal tibia. Although many options are available for treatment of distal tibia fracture, the best one remains controversial [1,2]. External fixation with ilizarov frame, ankle spanning hybrid fixator

with or without minimal internal fixation is good option especially, if it is associated with extensive soft tissue injury. But it is associated with complications like pin-track infections malunions or nonunions [3], and inaccurate reduction [4], especially of intra-articular fractures. Classic open reduction and internal plate fixation requires extensive soft tissue dissection and causes

periosteal injury. That is why it is associated with high rates of complications, including infection (range 8.3–23%) and delayed union and nonunions (range 8.3–35%) [5].

Closed intramedullary nailing do not disturb fracture's hematoma and maintains the integrity of the soft tissue coverage, but it is technically difficult, unstable fixation and can lead to malunion [6]. MIPPO involves inserting a plate in a subcutaneous extraperiosteal tunnel, bridging the fracture site, which is then secured proximal and distal to the fracture zone. Minimally invasive plate osteosynthesis (MIPPO) aims to reduce iatrogenic soft-tissue injury and damage to bone vascularity and preserve the osteogenic fracture hematoma [7]. The locking compression plate device allows the screws to lock to the plate, therefore creating a stable, fixed-angle device [8,9]. The locking screw-plate interface allows fracture fixation without plate–bone adherence, thus preserving the fracture hematoma, and reduces the risk of nonunion by maintaining microvascular circulation within the cortex and its investing tissues [10,11].

The aim of our study was to assess short-term clinical and radiological results of treatment of extra-articular and simple intra-articular fracture of distal tibia with MIPPO technique using locking compression plates regarding time to union, complications, and functional outcome using the American Orthopaedic Foot and Ankle Society (AOFAS) ankle score [14].

### **Material & Methods**

This was a prospective study that was carried out between November 2011 to December 2015 in the orthopaedic department of Nobel medical college and teaching hospital, Biratnagar. This study was approved by the ethical committee. The written informed consent was taken

from all patients for participation in the study. This study included Gustilo-Anderson grade I and II open and closed injuries of the distal tibia fractures with extra-articular or simple intra-articular extension. Patients with type III open fractures as per Gustilo and Anderson classification, articular comminution (AO B3, C3), deformity existing before the fracture, ipsilateral proximal tibia fractures, pathological fractures and lower limbs with neurological deficits or vascular diseases were excluded.

The study initially included 35 patients with distal tibial fracture but two patients were lost during follow-up; thus only 33 patients were included in the final evaluation.

All the cases with fracture distal tibia who presented to orthopaedic outpatient or emergency department were evaluated clinically and plain radiographs of the distal tibia and the ankle were sent. A computed tomography scan of the distal tibia and the ankle was obtained in patients with extension of the fracture to the joint. Each injury was carefully evaluated for the extent of soft tissue injury, fracture pattern, bone comminution, bone loss, articular extension and the need for fixation of fibula. All cases were initially managed by temporary immobilization of limb by long leg posterior slab. Open injuries were treated with intravenous antibiotics, adequate wound debridement, and lavage before any definitive fixation. Definitive surgery was planned when the ankle swelling subsided, and the 'wrinkle sign' was present.

Fractures were classified according to the AO comprehensive classification system [12], whereas open injuries were classified according to the Gustilo and Anderson classification [13].

### **Operative technique**

Patients were operated upon under regional anesthesia on a standard radiolucent

orthopedic table. A pneumatic tourniquet was inflated on the thigh after giving intravenous antibiotic. Patients were positioned supine on the operative table. All the patients were treated with medial distal tibia anatomical locked plate using the MIPPO technique using image intensifier. We fixed the fibula fracture if it was syndesmotic, displaced infrasyndesmotic, or suprasyndesmotic associated with comminution, impaction, or shortening at the tibia fracture. It was fixed first by using MIPPO, open plating, or intramedullary thick K-wires before tibial fixation. The main fracture fragments of the distal tibia were aligned and reduced by manual traction. If the reduction was difficult, a dissector, Schanz screw, or periosteal elevator was used as a joystick to assist in reduction. Then the fracture fragments were fixed with individual percutaneously inserted lag screws if possible. Cannulated screws and K-wires were used before plating to fix the intra-articular extension of the fracture if required. An entry site is developed over the distal tibia through a 4 to 5 cm curved anteromedial incision centered over the medial malleolus, and the plate is then inserted from the distal to the proximal, through a tunnel between the periosteum and the intact overlying tissue. Compared with the other side, alignment, limb length, and rotation were assessed and adjusted before fixing the plate. It was reassessed after the plate was secured by one screw to the proximal and distal fragments. If satisfactory, the remaining screws were applied. At least three bicortical screws were inserted proximal to the fracture, whereas bicortical or unicortical screws were inserted distal to the metaphyseal fracture using as many of the distal plate holes as possible through small stab wounds. The stab incisions were irrigated and closed with routine skin sutures, and then the wound was dressed.

Postoperatively, the limb was maintained in the elevated position and immobilized by using a removable below knee back slab for 2 weeks. Parenteral antibiotics were continued for 3 days postoperatively, and then oral antibiotics were given for an additional week. Active range of motion and non-weight-bearing crutch walking while still in the hospital was allowed, and weight bearing as tolerated was allowed over time depending of the fracture pattern, fracture healing, and the stability of fracture fixation, but most patients could bear weight at least partially at 6 to 8 weeks. If the fracture was intra-articular, we kept the patients non-weight-bearing for the first 2 weeks, and asked them to start toe-touch weight bearing starting from the fourth postoperative week, and outpatient physiotherapy was carried out under supervision to maximize the range of motion of the foot and the ankle.

Patients were evaluated clinically, functionally, and radiologically (plain antero-posterior and lateral radiographs) at 2, 6 weeks and then every 6 weeks from surgery till union. Clinical and functional outcomes were assessed using the Clinical Rating Systems for the ankle-hindfoot developed by the American Orthopedic Foot and Ankle Society [14].

### **Statistical analyses**

Statistical analyses were done by using SPSS (version 18). Quantative variables were expressed as mean  $\pm$  SD. Categorical values were expressed as a percentage and compared using the  $\chi^2$ -test. *P* value less than 0.05 was considered significant.

### **Results**

Out of 33 patients available for complete follow up, there were 20 men and 13 women, with a mean age of 37 years (range 18-62 years). Twelve patients were injured in road traffic accidents, twelve

patients had fall from height and nine patients fracture due to slip and fall.

**Table 1. The ankle – hind foot scale for clinical rating [14]**

Item	Mean Score
Pain (40 points)	38
Functions (50 points)	
Activity limitation,	
support requirement(10)	8.5
Maximum walking	
distance blocks (5)	4.5
Walking surfaces (5)	4.5
Gait abnormality(8)	7.5
Saggital motion (8)	7.5
Hind –foot motion (6)	5
Ankle-hind foot stability(8)	8
Alignment (10)	9.5

According to the AO classification, there were twelve 43-A1, five A2, five A3, five B1, three B2, two C1, one C2 fractures. There were 29 closed fracture and four open fracture (three type I and one type II as per the Gustilo and Anderson classification). The duration between the initial trauma and surgery was  $7.5 \pm 3$  days (range 6-14 days), based on the soft tissue condition of the local area. The mean post operative stay in hospital for patient was 13 days (range 7-21 day).

There was associated fibular fractures in 15 cases, of which only eight cases were fixed by either one third tubular plate or reconstruction plates or k-wires. The average follows up period was 11 months (range 9-15 months). The mean time to full weight – bearing was  $11.5 \pm 2.5$  weeks (range 8-17 weeks). It was more in open fractures. Regarding fracture union, it was occurred in 29 cases (87.9%) between 12 and 18 weeks (average 16 weeks), whereas four (three closed and one open fracture) cases (12%) had union between

20 to 24 weeks. The overall union time was 16.3 weeks. No any patients required second operation to achieve union. A lag screw was inserted in six cases; the mean time to union in fractures with lag screw was 12 weeks compared with a mean time of 17 weeks in the fractures in which lag screw was not used ( $p=0.1$ ). **Figure 1 and 2** In all 30 cases wounds healed without problems, whereas three cases had superficial wound infection. The superficial infections were treated successfully with wound care and antibiotics and all achieved radiological union without any secondary procedures.

**Figures**



a.

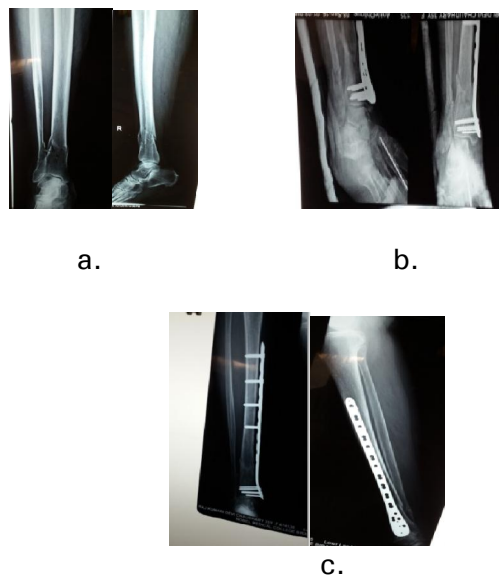


b.



c.

**Figure.1.a. showing AO 43-A2 fracture, b. immediate post –operative ,c. after 12 weeks x-ray of 60 years female with distal tibia fracture.**



**Figure 2.** a. thirty seven year female with 43-A1 fracture, b. post-operative, c. after 12 weeks of operation.

Five patients had angular deformities less than or equal to 5 degree- four varus, one valgus deformities. No patients had any rotational, recurvatum, procurvatum or implant failure. Limb length discrepancy of <1cm was found in three patients but all were asymptomatic. All patients had almost full ROM comparable to the other side of limb of same patients. In seven patients, the plate was prominent but this did not necessitate plate removal.

The AOFAS score was obtained at a minimum of 12 weeks after the start of full weight bearing. The mean score was 93 points (range 71 to 100 points). **Table 1**

### Discussion

Reports in the literature of outcome of ORIF of distal tibia fractures show high rates of infection [15]. Minimally invasive plating technique has many advantages like use of smaller incision, less soft tissue dissection, preservation of periosteal blood supply of bone, and use of intra-operative imaging reduce iatrogenic soft-tissue damage and damage to bone vascularity,

and preserve the osteogenic fracture hematoma. They are believed to improve healing rates and decrease complications [7,16,17].

In our study, the overall mean time for union was 16.3 weeks. These results are similar to those obtained by Oh et al. [18], who, reported a mean time to union of 15.2 weeks (range: 12–30 weeks) in 20 patients using contoured limited contact-dynamic compression plate. In addition, in 2004, Redfern et al. [19] reported a mean of 23 weeks (range: 18–29 weeks) to union with no complications in 20 patients with closed fractures of the distal tibia, which was more than our results. Collinge et al. [20] reported a longer mean time to union of 35 weeks (range: 12–112 weeks) in 26 patients with high energy distal tibial metaphyseal fractures, as their series included open and closed fractures with high soft-tissue injuries, which were not included in our study. On the other hand, Collinge and Protzman [21] reported a mean of 21 weeks (range: 9–60 weeks) in 38 patients with distal tibial low-energy metaphyseal fractures, which we found to be compatible with our results. Ahmad et al. [11] retrospectively reviewed 18 patients with distal tibial metaphyseal fractures treated with locked distal tibial plates and reported a rather lengthy average time to union of 23.1 weeks (range: 8–56 weeks). Although the technique used by Ahmad et al. [22] is the same as ours, we believe the discrepancy was due to the complexity of the fracture in their series and due to a rather smaller sample size. However, with time to union varying from one study to another, we believe MIPPO still provides a faster time to union than does open plating. In the study done by Yang et al. [23] reported an average of 27.8 weeks (range: 18–36 week) in 14 patients with 43A distal tibial fractures managed by using the open plating technique.

Oh et al. [18] used the Olerud and Molander ankle score to assess the functional outcome, which for all patients ranged from 80 to 100%. Ahmad et al. [22] reported an average AOFAS ankle score of 88.8. Collinge et al. [20] reported an average AOFAS ankle score of 83 (range: 65–100). In our study, the mean AOFAS ankle score was 93. However, our study did not include grade III open injuries, which was in contrast to the findings of Collinge et al. [20]. This difference in functional outcome shows the importance of the soft tissues in the MIPPO technique. We did not fix all fibular fractures. Our results are in agreement with that of a study by Gupta *et al.* [24], who did not fix the fibular fractures proximal to the syndesmosis when the tibia fracture was simple. But, with impaction, comminution, shortening of the tibia, the fibula should be fixed first to maintain the lateral column of the ankle, which helps in the reduction of the tibia fracture and prevents later collapse. We fixed 8 of 15 fractured fibulas. Three (9%) of our patients got less than 1 cm limb length discrepancy without any limp, whereas a study by Rongaet *al.* [1] reported limping in 8/19 (42%) patients. We did not find any case of non-union and deep infection which required any secondary procedure. Hasenboehler et al. [25] published a series of 32 patients with diaphyseal and distal tibial fractures treated with the MIPPO technique and reported one case of plate bending of more than 18° at 5 months postoperatively because of excessive weight bearing. Mushtaq et al. [26] reported one patient with implant failure, which was revised and ultimately healed with good functional outcome, whereas we did not have any cases of implant failure. Hasenboehler et al. [14] reported that 29 patients complained of local disturbance over the medial malleolus, which was caused by the high-plate profile. In our

study, although implant prominence was noted in seven patients but no one compell it for removal. These results are comparable to those of Bahariet *al.* [27] who found superficial tenderness or impingement over the medial aspect of the medial malleolus in five cases (of 42) and Rongaet *al.* [1] who found that the plate was palpable in the subcutaneous tissues in six out of 19 patients.

Our study showed that five patients (15%) had angular deformities, all of them less than 5°, where one case had valgus deformity and four cases showed varus deformity. No patient had a leg-length discrepancy greater than 1 cm. These results are comparable to other published studies of Rongaet *al.* [1], Collingeet *al.* [21], and Hasenboehleret *al.* [25].

In our study, we utilized the standard operative table, which necessitated the presence of an extra assistant to maintain reduction. We also used devices like the bone clamp to facilitate reduction. The anatomical plate itself was used as a mold. Percutaneous lag screws were applied whenever the fracture configuration allowed its insertion. This technique was described in most of the series we reviewed [18,22].

### **Conclusion**

Out of the fractures managed by this method, most of them showed uncomplicated healing within a reasonable period of time. Functional assessment using the AOFAS scoring system showed excellent outcomes. The complication rate was minimal. The MIPPO method can be used safely in the management of distal tibial fractures even with simple articular extension. The procedure, however, is technically demanding, requiring the availability of appropriate tools and surgical implants. Careful follow-up of the patients is recommended. This technique, as confirmed by our results, minimizes the

complication rate, promotes union within a reasonable period of time.

The limitation of our study was small sample size, shorter follow up and there were no comparison with other modalities of treatments.

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