

## Retrospective Study Evaluating the Results of Minimally Invasive Plate Osteosynthesis (MIPO) in Management of Distal Tibial Fractures

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### ABSTRACT

**Background:** Minimally Invasive Plate Osteosynthesis is widely accepted as a good option for the management of fractures of the distal tibia as it preserves the fracture biology leading to improved outcomes. The study aimed to find out the efficacy of MIPO in the treatment of extra-articular fractures of the distal tibia.

**Patients and Methods:** Thirty patients who presented with fractures of distal tibia treated with MIPO were retrospectively reviewed. The mean age was 40.3 years, (21 males and 9 females). 24 patients had closed fractures and 6 patients had open fractures. Patients were followed up clinically and radiologically for 1 year and the AOFAS score for ankle and hind foot was used to assess the functional outcome.

**Results:** Twenty three (67.7%) patients had a peaceful fracture healing, 5 patients (16.7%) showed delayed healing, and non-union was detected in two patients (6.6%). 4 patients (13.3%) had wound infection and 3 patients (10%) had a plate irritation problems. The average AOFAS score was 83.3.

**Conclusions:** MIPO technique is an effective method in the management of distal tibia fractures with good functional outcomes but its complications raise the need for good preoperative planning to avoid the complications as much as possible.

**Keywords:** Distal tibia fractures; MIPO distal tibia; osteosynthesis distal tibia; minimally invasive technique.

### INTRODUCTION

Fractures of distal tibia represent a challenge to orthopedic surgeons because of poor blood supply, deficient soft tissue coverage, and proximity to ankle joint.<sup>1</sup>

Because of problems of soft tissue that are associated with ORIF and the high rates of malalignment with IMN, MIPO technique became a popular option for treatment of the fractures in the distal 1/3 of tibia.<sup>2,3</sup>

The advantages of MIPO include the keeping of fracture hematoma, stable fixation with early mobilization, and periosteum preservation with respecting the soft tissue.<sup>4</sup> But there are several concerns about the complications associated with MIPO in treatment of distal tibial fractures as soft tissue complications, hardware irritation, and malalignment.<sup>5</sup>

The aim of the study was to evaluate the clinical and functional outcomes of minimally invasive plating (MIPO) in the management of fractures affecting distal tibia.

### PATIENTS AND METHODS

In this retrospective study, thirty cases suffering from extra-articular fractures of distal tibia that treated using the MIPO technique have been analyzed. There were 21 male patients and 9 female with an average age of 40.30 (range from 19 to 67 years old). The right side was affected in 19 patients and the left side in 11 patients.

The inclusion criteria were:

Patients aged 18 years old or older with extra-articular distal tibial fractures that were fit for surgery.

The Exclusion criteria were:

Patients less than 18 years old, Intra-articular fractures of the distal tibia, Pathological fracture, and open fractures grade 3 according to gustillo classification.

According to AO fracture classification, most of the fractures were 43-A2 in 12 patients followed by 43-A1 in 10 patients while 8 patients had a 43-A3 fracture. 24 patients presented with closed fractures

while 6 patients presented with open fractures. Nine patients had associated chronic diseases (4 Diabetes mellitus, 4 hypertension & 1 liver cell failure).

RTA was the prime cause of fractures (20 patients) followed by fall from a height (5 patients), twisting injury (4 patients) & sports injury in 1 patient. The fibula was fractured in 24 patients (86.7%).

The average interval between injury and surgery was 7.7 days.

#### *Surgical Technique:*

The patients were put in a supine situation on a table which is radiolucent to allow access to the image intensifier with complete draping of the affected limb. The leg was positioned on a pad, and a tourniquet is applied on the thigh. The image intensifier is applied opposite to the injured limb.

Fibular osteosynthesis was performed in 21 (70%) patients, 19 patients (out of the 21 patients) had open reduction and internal fixation using a one third tubular plate through a posterolateral skin incision to get a good skin bridge between medial and lateral incisions. The concept of the fibular fixation was to use it as a tool in achieving adequate reduction and stability in fractures, also restoration of the fibular length helps to avoid valgus deformity of the tibial plafond, while 2 patients had closed reduction with intramedullary k-wire, 5 patients didn't receive fibular fixation because of the presence of an extra-articular fracture in which stabilization was unnecessary to reach an anatomical reduction.

Preliminary manual traction with application of pointed forceps, then confirmation of reduction the image intensifier. A slightly curved skin incision on the medial aspect of the distal tibia (along posterior border of medial malleolus) was used. The incision is about 3-5 cm long and starts at the level of the tibial plafond outspreading proximally along medial part of distal tibia. The dissection is done down into the periosteum with preserving the great saphenous vein and saphenous nerve. The periosteum is preserved and a subcutaneous channel is formed in the epiperiosteal space by the blunt tip of the plate towards the diaphysis. At the site of proximal part of the plate, we did a small incision. The plate must be equivalent to the posterior end of the distal tibia & plate site is viewed by the image intensifier for right position.

Once the right position of the plate has been achieved temporary fixation can be done with K-wires, then a screw is implanted in one of the distal holes to allow positioning of the plate nearby to the bone to avoid irritation of the soft tissue which may occur due to plate. Small stab incisions are enough for completing the fixation with screws and the position of the screws can be identified either by image intensifier or by externally placed identical plate.

The type of plate used in the study was 4.5 distal tibial locked plate.

After sutures removal at 2 weeks, follow-up was done at 6, 10 and 14 weeks, and then at interims of 6-

8 weeks until 12 weeks. They were examined clinically and radiographically.

Clinical and radiographic results were evaluated. Mal-alignment was defined as over 5° of angular deformity. Healing time from 6 - 9 months was well-thought-out as delayed union. Non-union was demarcated as a failure of the fracture to heal after 9 months from the operation.

The American Orthopedic Foot and Ankle surgery (AOFAS) scoring system for hind foot<sup>6</sup> was used for the assessment of patients. It was considered that excellent when scores ranging from 90 -100 points, it also considered good when scores ranging from 80 – 89, it considered fair when scores ranging from 60 – 79 and considered poor when scores were less than 60 points.<sup>7</sup>



**Fig. 1:** intra-operative photograph of MIPO technique

## RESULTS

The period of follow-up was 1 year. Union was achieved in all but two patients being classified as non-union, one patient with a non-union has been undergone plate removal and intramedullary nailing, the other patient has been operated for bone grafting.

Delayed union was seen in six patients (20%). The average period for the union which detected radiological was 17.5 weeks.

Four patients (13.3%) had wound problems. One of them had a closed fracture with a history of diabetes mellitus while the remaining three patients had open fractures. In 2 patients healing of the wound was achieved by local wound care with oral antibiotics after obtaining culture & sensitivity for a wound swab. One patient needed surgical debridement of the wound to eradicate the infection and the wound was healed later on with parenteral antibiotics according to the result of culture & sensitivity of the obtained

specimen from the wound. The remaining patient needed flap coverage of the wound after plate removal and external fixation and assurance of infection eradication.

Two patients of the infected cases had delayed fracture healing and one of these two patients ended finally with malunion that needed a further operation to restore a good alignment.

Two patients (6.7%) had angular deformity over 5 degrees. One of them had 10 degrees of varus deformity while the other patient had 10 degrees of valgus deformity alongside with 10 degrees of forward deformity.

Plate irritation was noted in three patients (10%) in the form of superficial infection around distal and proximal screws; none of them responded to local wound care and oral antibiotics after culture and sensitivity from wound and needed plate removal.

The average operation time was (105.80±19.10 minutes).

The average AOFAS for ankle & hind foot was 83.3. (43.3%) showed excellent results, eleven patients (36.7%) showed good results, two patients (6.7%) showed fair results, and four patients (13.3%) showed poor results.

Satisfactory results were obtained in 24 patients (80%), while 6 patients (20%) showed unsatisfactory results.



**Fig. 2:** A male patient aged 24 years old had a fracture in distal tibia after RTA that was classified as 43-A3 according to AO classification. Operated using the MIPO technique with post-operative radiographs and follow-up after one year X-ray showing complete union of the fracture.

**DISCUSSION**

Often, it's not easy to treat the distal tibial fractures due to the superficial location of the distal tibia with fair bloody nourishment, proximity to ankle joint alongside with soft tissue problems that usually accompany the injury. There are different methods and techniques to manage fractures affecting the distal tibia surgically, including IMN, external fixation, ORIF, and MIPO. Each one of them has its advantages and disadvantages but there is no agreement on which one of them is the best modality.

MIPO technique has many advantages like less surgical trauma, maintains periosteal blood supply and fracture hematoma, and keeps good environment for fracture healing.<sup>8</sup>

primitive clinical trials using these technique revealed good results with lower degrees of infection and nonunion, however it causes many complications such as angular deformities and hardware failure.<sup>9</sup>

The aim of this study was to analyze the outcomes of distal tibial non-articular fractures managed by the MIPO technique. The study questioned whether this technique is clinically and functionally effective or not. Also, it asked if this method allows early healing and union with early functional improvement. There are some restrictions to the study. Firstly the type of the study which was retrospective. Also, the absence of a control group so that the results couldn't be compared to formulate a definitive statement and guidelines.

In the study , the majority of the patients were in the age group between 30 and 40 years with the mean age of 40.30 years, there were 21 males (70%) and 9 females (30%). Road Traffic Accidents (RTA) were the most common manner of trauma (66.7%) followed by a fall from height (16.7%).

The right side was affected more than the left (63.3%). Excellent results were seen in (43.3%), good in (36.7%), fair in (6.7%), and poor in (13.3%) according to AOFAS score for ankle and hindfoot. The average score of the AOFAS score for ankle and hind foot in the study was (83.3). Rafiq Bhat and colleagues<sup>10</sup> reported case sequences of 25 patients with closed distal tibial fractures with a mean age of 41.16 years and results graded as excellent (84%), good (8%), and satisfactory 8% with average

Variable	Number of patients	
<b>Bone results</b>		
a) <b>Union</b>	28/30	93.3%
b) <b>Angular deformities &gt;5 degrees</b>	2/30	6.7%
c) <b>Leg length discrepancy</b>	0/30	0%
<b>Functional results</b>		
a) <b>Limping</b>	19/30	63.3%
b) <b>range of motion of ankle 30 degrees or more</b>	21/30	70%
c) <b>returned to pre-injury activities</b>	11/30	36.7%
d) <b>infection</b>	4/30	13.3%
e) <b>Plate irritation</b>	3/30	10%
f) <b>Pain during walking</b>	22/30	73.3%

**Table 1:** Results regarding to bone and functional parameters

AOFAS score of 83.6. Bingol and colleagues<sup>8</sup> reported a case series of 30 patients, the mean age was 44.26 years and the results were excellent (60%), good (23.3%), fair (10%), and poor (6.7%) with an average AOFAS score of 88.3.

28 patients (93.4%) had shown radiological union while 2 patients (6.6%) of cases went into non-union. (59.3%) of the cases showed radiological union in time up to 20 weeks while (22.2%) it was in 21 to 24 weeks and in (18.5%) it needed more than 24 weeks. The radiological union needed 17.5 weeks in average to appear. Rafiq Bhat and colleagues<sup>10</sup> reported a case series of 25 patients in which all the fractures united at an average period of (16.8 weeks) ranging from 12 to 30 weeks. Ahmad MA and colleagues<sup>11</sup> reported that 16 of 18 patients achieved union. 12 patients (66.7%) showed union in period up to 24 weeks while (11.1%) needed up to 28 weeks to unite while the other cases (22.2%) needed more than 28 weeks. The average time needed to unite was 32 weeks in the smokers and in the nonsmokers was 15.3 weeks.

Only 2 cases (6.7%) had deformity  $>5^\circ$  or shortening  $>1\text{cm}$ , one had  $10^\circ$  valgus &  $10^\circ$  forward deformity and the other had  $10^\circ$  varus deformity. Rafiq Bhat and colleagues<sup>14</sup> reported 2 cases (8%) with angular deformity more than  $5^\circ$ . Shukla R and colleagues<sup>12</sup> reported that among 30 patients, malunion was noticed in one patient (3.3%) with valgus angulation of over 5 degrees.

Complications were revealed as follows: 4 patients (13.3%) had wound complications and infection and one of them needed plate removal & application of external fixator and later on he needed flap coverage of the wound. Plate irritation was observed in 3 patients (10%) in the form of superficial infection around distal and proximal screws; none of them responded to local wound care and oral antibiotics after culture and sensitivity from wound and needed plate removal. Two cases (6.7%) were reported to have nonunion. Limping was reported in nineteen patients (63.3%) which varied from marked in 5 patients (16.7%) to slight limping after fatigue in 11 patients (36.7%) with 1 patient (3.3%) had mild constant limping and 2 patients (6.7%) had moderate constant limping. Rafiq Bhat and colleagues<sup>10</sup> reported that all cases had fracture union with no reported cases of non-union, infection was reported in 4 cases (16%), and plate irritation in 3 patients (12%). Vidović D and colleagues<sup>13</sup> reported a case series of 24 patients in which 1 patient had suffered from infection and 3 patients had plate irritation.

### CONCLUSION

Based on the finding of this study, it can be concluded that the MIPO technique provides good to excellent clinical outcomes with accepted functional results for the management of distal tibial fractures. Being minimally invasive, it reserves the biological environment by preserving the soft tissue and reduces the incidence of scar obstacles. The MIPO method is a convincing treatment modality with lesser complications with the following advantages.

It delivers significant structural stability with reservation of the soft tissue envelope and blood nourishment in comparison to other types of fixation; it provides a higher percentage of union and return to function, less wound complications, it allows early ankle motion helping to restore the joint motion with reduced surgical time and smaller incisions.

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