

# Minimally Invasive Percutaneous Plate Osteosynthesis: A Reliable Technique in the Treatment of Distal Tibia Fractures

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## ABSTRACT

**INTRODUCTION:** Fractures of distal tibia pose a challenge due to limited soft tissue and poor vascularity. Treatment of these injuries using minimally invasive percutaneous plate osteosynthesis (MIPPO) technique minimizes soft tissue injury and maintains the vascular integrity of the fracture fragments preserving the biological environment. The objective of the study was to assess the clinical results of MIPPO for distal tibia fractures.

**METHODS:** This study was carried out over 16 months in a sample size of 30 patients at Bir hospital, Patan hospital and Shree Birendra hospital. All patients with skeletal maturity who had sustained distal tibia fractures including Gustilo Anderson I and II were included in the study. Data was entered and analyzed by SPSS version 16.

**RESULTS:** The mean time for bone union and full weight bearing was 14.7 weeks. There were 2 cases of ankle stiffness, 1 case of superficial skin infection and 1 case of hardware pain in the post-operative period. All patients attained functional ankle range of motion by 14<sup>th</sup> post-operative week and by 26<sup>th</sup> week mean ankle dorsiflexion was 18.63 degrees and plantar flexion was 35.4 degrees. Tenny Weiss score in the final follow up had 3 patients with excellent, 14 with good results, and 13 with fair results.

**CONCLUSION:** Minimally invasive percutaneous plate osteosynthesis offers a reliable and reproducible technique in the treatment distal tibia fractures with intra-articular or periarticular fracture extensions. This technique avoids significant complications and is associated with good functional outcome regarding the ankle range of motion.

**KEYWORDS:** MIPPO, Distal Tibia, Biological

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## INTRODUCTION

Fractures of the distal tibia are not suitable for intramedullary nailing as the ability to maintain a mechanically stable reduction becomes more difficult the farther the fracture extends distally. Classical surgical treatment may produce additional trauma like periosteal stripping and microcirculatory damage, which frequently induce infection, nonunion, or both.

MIPPO technique for distal tibial fractures is technically feasible and may be advantageous in that it minimizes soft tissue compromise and devascularization of the fracture fragments<sup>1,2</sup>. Indications for MIPPO include displaced fractures involving the tibial plafond and those unstable fractures too distal for safe stabilization with intramedullary nails<sup>3</sup>. This technique involves conventional open reduction and internal fixation of the associated fibular

fracture when present, followed by minimally invasive plate osteosynthesis of distal tibia utilizing precontoured plates and percutaneously placed screws. Post-operatively early active and passive range of motion is permitted while weight bearing gradually progresses. Minimally invasive techniques maintain alignment without compression. External fixation can be used as either a temporary or definitive method of treatment, especially in fractures with severe soft tissue injury<sup>4,5,6</sup>. However, malunion and delayed union continue to be the main problems with this method of fixation<sup>7,8</sup>. Conventional plate osteosynthesis with open reduction can further devitalize fragments and lead to higher incidence of nonunion, infection and implant failure<sup>9,10</sup>. Therefore, MIPPO offers the best option as it permits adequate fixation in a biological manner<sup>11</sup>. The objective of the study was to evaluate the clinical results of MIPPO technique for distal tibia fractures.

## METHODS

This was a prospective observational study conducted from October 2010 to February 2012 at Bir Hospital, Patan hospital and Shree Birendra hospital with a sample size of 30. Ethical clearance was taken from Institutional Review Board of National Academy of Medical Sciences before embarking upon the study. All patients with skeletal maturity who sustained distal tibia fractures including Gustilo Anderson I and II were enrolled in the study after an informed written consent explaining all the relevant details, its importance and implications. Patients with previous history of tibia fractures, concomitant ipsilateral lower extremity injury and neurovascular compromise of the affected limb were not included in the study.

Relevant history and examination findings were noted in a predesigned Performa. Surgery was undertaken on the next available theatre list and only delayed in cases of soft tissue concerns till they were addressed. Image intensifier was used intraoperatively. Post operatively, the limb was splinted with crepe bandage only. Early

non weight bearing ambulation in crutches was started from first post-operative day. On second post-operative day, gentle exercises for the ankle were begun. Active and passive range of motion of ankle and knee was done till radiological union of fracture occurred. Partial weight-bearing was started depending upon their pain tolerance and radiographic evaluation. Radiographs, including AP and lateral views were taken at 2 weeks, 6 weeks and then at an interval of every 4 weeks till 6th month to assess healing and alignment. Tenny and Weiss<sup>5</sup> clinical assessment criteria was used in each follow up. Union was defined as bridging of three of the four cortices and disappearance of the fracture line on the plain radiographs for a patient who was able to bear full weight. Data was tabulated in various pre-defined tables and all desired values were generated using SPSS version 16.



**Figure a.** Intraoperative use of image intensifier during plate positioning



**Figure b.** Skin incisions without violating the fracture site

**RESULTS**

The mean age of patients in our study was 38.97 years (Range: 18-60 years). Majority of patients were in age group 31-40 years. Of the 30 patients, 17 (56.7%) were male and 13 (43.3%) were female. Majority of the patients were from Kathmandu (63.3%). The most common mechanism of injury was road traffic accident (36.7%) followed by household falls (13.3%) as shown in Table 1. Among the patients who were injured in road traffic accidents, 8 patients were involved in motorbike accidents, 2 were hit by moving vehicles and 2 had sustained injuries in microbus accidents. Majority of patients with household falls were females (9 patients) and 10 male patients had met with a road traffic accidents.

**Table 1:** Mechanism of Injury in this Study

Mechanism of injury	Frequency	Percent
Household falls	11	36.7
Fall from Height	4	13.3
Athletic injuries	3	10.0
Road traffic accidents	12	40.0
Total	30	100.0

Most common side of tibia involved was right (53.3%). 11 patients (36.67%) had associated fibular fractures. Seven of them were fixed with open reduction and internal fixation with 1/3 tubular plate. Most of the associated fibular fractures were seen in male (7 patients). There were 4 open fractures, two each of Gustilo Anderson Type I and Type II. The mean duration of total hospital stay was 12.5 days, pre-operative and post-operative hospital being 6.13 and 6.37 days respectively.

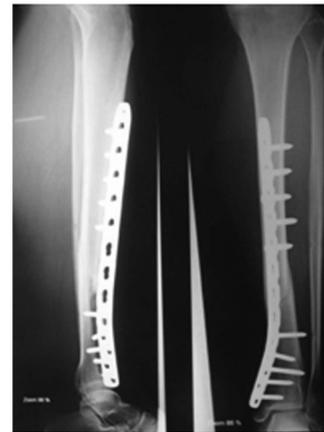
There were 4 complications. There was one case of superficial skin infection on 22<sup>nd</sup> week. Two patients developed ankle stiffness. One patient developed hardware related pain. The mean time for partial weight bearing was 7.2 weeks whereas that for full weight bearing was 14.27 weeks as shown in Table 2.

**Table 2:** Time for Partial and Full Weight Bearing in this Study

	Time of Partial Weight Bearing	Time of Full Weight Bearing
Mean	7.20	14.27
Minimum	6	10
Maximum	10	18



**Figure c.** Preoperative X-ray of 30 years old lady



**Figure d.** Postoperative X-ray of same patient at 12 weeks with radiological union

Majority of patients (24) had the surgical procedure completed in an hour. Majority of patients (21) had blood loss less than 10ml. There was statistical significance between the total time of surgery and amount of blood loss (P value 0.004 computed by Chi Square Test). The mean Tenny and Weiss score at final follow up was 85.82 and 83.08 for male and female patients respectively. On the final follow up 14 had good results as shown in Table 3

**Table 3:** Mean Tenny and Weiss Score in Final Follow up in this Study

Tenny and Weiss Score	Gender		Total
	Male	Female	
Excellent (>92points)	2	1	3
Good (87-92 points)	9	5	14
Fair (65-86 points)	6	7	13
Total	17	13	30

The mean ankle plantar flexion and dorsiflexion on follow up at 26 weeks was 35.4 degrees and 18.63 degrees. The most common complaint in 1st follow up was pain followed by swelling as shown in Table 4.

**Table 4:** Complaints in Follow Ups

Chief Complaints	2 weeks	6 weeks	10 weeks	14 weeks	18 weeks	22 weeks	26 weeks
Pain	21	5	1	1	1	2	1
Swelling	9	25	29	17	1	0	0
Stiffness	0	0	0	0	2	2	2
None	0	0	0	12	26	26	27
Total	30	30	30	30	30	30	30

## DISCUSSION

The distal tibia plate is pre-contoured to the anatomy of the distal tibia with locking holes that prevent disruption of fracture fragments and minimize plate-bone interface which in turn maintains the vascularity of the fracture site. There was no need of any specialized instrumentation and the method was less time consuming and cost effective as reported by previous authors<sup>12,13</sup>.

The mean age in our study was 38.97 years which is similar to study conducted by Redfern DJ<sup>14</sup> and Vallier HA<sup>15</sup> with their associates where their mean ages were 38.3 and 38 years respectively. This suggests that the fracture is more common in working age group. Other authors had similar results<sup>16</sup>. Majority of the patients were from Kathmandu valley (56.7%) which was due to ease of transportation to the hospital in the valley following injury.

The most common mechanism of injury in our study was road traffic accident (40%) as in

other studies<sup>17,18,19</sup>. The majority of patients in such accidents were male (83.3%) and majority had met with motorbike accidents (66.7%). This owes to the fact that majority of Nepalese people who drive vehicles are male and majority of vehicular accidents are motorbike accidents. Fibula fixation was done in comminuted fractures and majority of other fractures to maintain the second column of ankle so as to achieve indirect reduction and to prevent collapse of the fracture. Fixation of fibula also assisted in reduction of anterolateral fragment of distal tibia (Chaput fragment) and posterior malleolar fragment (Wagstaffe's fragment). Similar study was done by Gupta and Rohilla<sup>20</sup> where majority of fibular fractures were fixed with encouraging results. Intraoperative blood loss was usually less than 10ml using the MIPPO technique however the loss was more when the surgical duration was longer.

The mean hospital stay was 12.5 days. Mean preoperative stay was 6.13 days and postoperative was 6.37 days. Mean preoperative

stay was similar to results of study conducted by Gupta et al<sup>20</sup>. We noticed that the maximum duration of post-operative hospital stay was 14 days and seen in patients treated in Shree Birendra Hospital. This was due to the trend in Birendra hospital of discharging the patients only after suture removal unless they asked for leave earlier.

The average time of partial weight bearing was 7.2 weeks in this study. Similar finding was shown in a study conducted by Neeraj Mahajan where their mean was 6.1 weeks<sup>21</sup>. In another study conducted by Bahari and associates the mean age of partial weight bearing was 5.6 weeks<sup>22</sup>. Full weight bearing in our study was allowed only after radiological bone union. Radiological union was defined as bridging of three of the four cortices and disappearance of the fracture line on the plain radiographs. The fracture was considered to be united if the patient was able to bear full weight and had features of radiological union on xrays. Same parameters were taken for bony union by Gupta et al<sup>20</sup>. Thus our time of full weight bearing is the time of bony union. Time of full weight bearing (bony union) in this study was 14.27 weeks (range: 10-18 weeks). Borens et al. had similar findings in their study with a mean time of bone union in 14 weeks. It took a mean of 16 weeks for bone union in another study conducted by Liu<sup>24</sup>. Similarly Gupta et al, allowed full weight bearing at a mean of 16 weeks. Lau, Leung and Chan had a longer period for bone union in their study which was 18.7 weeks<sup>25</sup>.

Fractures of the distal tibia are often associated with significant soft tissue injury. The key point in management of this injury is to recognize the importance of the soft tissue component<sup>26,27</sup>. Infection rates in the MIPPO technique are better than in previously reported ORIF studies<sup>15,28,29,30,31,32,33</sup>. This was reflected in our study, with only one case (3.3%) of superficial wound infection, which completely resolved with appropriate antibiotics.

Ankle stiffness was seen in 2 patients. This is contrary to the study conducted by Bahari et al.<sup>22</sup> where they mentioned that ankle stiffness was not an issue. The patient who developed ankle stiffness in our study had a comminuted fracture (AO 43A3) and the other case had an intraarticular fracture (AO 43B1). In both the cases full weight bearing was delayed till 18 weeks postoperatively.

We assessed the functional outcome in our study by Tenny and Weiss criteria where 3 patients had excellent results, 14 had good results, and 13 had fair results. However in other studies functional outcome has shown to be better than ours. Leung and Law conducted a similar study in 52 patients with a 12 month follow up where they had 30 excellent results, 25 good results and 7 fair results<sup>34</sup>. In another study conducted by Borens et al.<sup>23</sup> with an average follow up of 17 months (range 6-29 months) eight patients (47%) had an excellent result; seven (41%) had a fair result whereas two (12%) had a poor result. Similarly in a study conducted by Neeraj Mahajan in 20 patients, 14 had excellent results, 4 had good results and 2 patients had fair results<sup>21</sup>. Though we had no patient with poor result and the mean score was increasing in each subsequent follow up our results were not as encouraging as those of authors mention above. We assume this due to the shorter follow up time in our study. Our follow up was only for 26 weeks whereas the studies mentioned above had follow up as long as 29 months.

## CONCLUSION

Whilst intramedullary nailing still remains the treatment of choice for most uncomplicated diaphyseal fractures of the tibia, MIPPO offers a relatively safe and efficacious modality of treatment for distal tibia fractures by a more biological fixation with least disruption of fracture hematoma. Our observations reinforced the findings of different authors that the procedure is associated with good functional outcome with few complications.

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