

## Original Research Article

# Retrospective analysis of minimal invasive plating versus intramedullary nailing for the treatment of extra-articular distal tibia fracture

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### ABSTRACT

**Background:** The volume of cases of distal tibia fractures at the trauma care centre are quite high in the Indian scenario. This type of fracture often creates a dilemma for the orthopaedic surgeons over the choice of the implant for the management. The aim of our study was to compare intramedullary interlocking nail (IMILN) and minimally invasive percutaneous plate osteosynthesis (MIPPO) based on various parameters.

**Methods:** We collected data of 40 patients with extra-articular distal tibial fractures (within 2 muller square from tibial plafond). Patients were divided into two groups: IMILN and MIPPO. We compared the 2 groups for demographic variables, union time, complication rate and functional score.

**Results:** There was no statistical difference in union time, complication rate, functional outcome and other demographic variables among the groups. Only 2 patients developed non-union and two patients had an infection. Overall 38 patients obtained excellent or good results (95%) and two patient had fair outcomes (5%).

**Conclusions:** The overall analysis suggested that both MIPPO and IMILN treatment options are comparable with consideration of all the parameters. Detailed results indicate a superiority of MIPPO over IMILN in terms of better anatomical reductions of the fracture with less incidence of malalignment while IMILN is better in terms of having lower rates of infections.

**Keywords:** IMILN, MIPPO, Extra-articular distal tibia, Olerud Molander ankle score

### INTRODUCTION

The volume of cases of distal tibia fractures at the trauma care centre are quite high in India. It is frequently associated with high energy trauma cases.<sup>1</sup> This type of fracture often creates a dilemma for the orthopaedic surgeons over the choice of the implant for the management. These injuries are particularly difficult to manage due to the limited soft tissue coverage, poor vascularity of the area and proximity of the fracture to the ankle joint. Infection delayed union, non-union and

malalignment are well-recognized complications of a distal tibia fracture. For displaced extra-articular distal tibia fracture, currently two modalities of treatment options are well accepted worldwide, intramedullary interlocking nailing (IMILN) and biological plating in form of minimally invasive percutaneous plate osteosynthesis (MIPPO).

IMILN provides excellent healing of the fracture but its use is limited by the difficulty in maintaining the reduction and stable fixation because of a wide medullary cavity and

short distal fragment.<sup>2,3</sup> Ultimately resulting in complications like malalignment.<sup>4,5</sup> Expert tibia nail and poller screw technique developed to solve this issue have helped up to some extent.<sup>6,7</sup>

Open reduction and internal fixation with medial plate provide an anatomic reduction but soft tissue compromise resulting in wound dehiscence and infection is a frequent complication.<sup>8</sup> MIPO technique performed through indirect reduction and small stab incisions provides stable fixation without evacuation of the fracture hematoma and less skin related complication.<sup>9</sup>

In our study, we have compared the functional and radiological outcome and the various complications associated with both the modalities for the management of extra-articular distal third tibia fractures.

## METHODS

A retrospective observational study was conducted at B.Y.L. Nair charitable Hospital, Mumbai with a collection of data for the patients operated from June 2015 to June 2019. A distal tibial fracture was defined as a fracture extending within 2 “muller squares” of the ankle joint. Muller defined a square based upon the widest measurement of the distal tibial metaphysis.<sup>10</sup> This roughly represents 4-11 cm distance from the fracture line.<sup>11</sup> Patients were divided into two groups: the IMILN group and the MIPPO group. Inclusion criteria were: young adults (18-55 years) with an acute (less than 2 weeks), displaced and extra-articular fracture of the distal tibia. Exclusion criteria were: all poly-trauma patients, paediatric fractures, segmental fractures, open fractures, pathological (including osteoporotic) fractures, intra-articular extension, tibial plafond fractures, associated with a neurovascular injury.

Demographic data for all the patients in form of age, sex, the timing of injury and mode of fixation were noted from the patient history sheet. The time period between injury and the surgical procedure was noted for each patient. Radiological evaluation of preoperative x-rays was performed and the distance between the fracture line and the joint line was measured. The fracture patterns (type A1, A2, A3) were classified based on AO/OTA classification of fractures of the distal tibia.

For IMILN, a standard nailing approach was followed using a patellar tendon split approach and fixation with 2 proximal and 2 distal static screws. Poller screw was used whenever required to prevent the malalignment. For MIPPO, closed reduction by manipulative traction was performed under fluoroscopy to restore the length and coronal alignment of the leg. An optimum length of the distal tibia locking plate was applied on the medial surface through a small incision. Then an extraperiosteal space tunnel towards the diaphysis was made and plate was slid through this space. The plate position was adjusted when the reduction was achieved. The plate was fixed with

screws proximally and distally using stab incisions. The lag screw was used wherever necessary. The fibula was fixed with rush nail or plate whenever seemed necessary.

A standard postoperative follow-up protocol was followed for all the patients. The active knee and ankle range of movements were started on the second postoperative day. Patients were followed up at 6 weeks, 12 weeks then at 4 weeks interval till union achieved and thereafter at 6 months and 1 year. The postoperative radiographic assessment included union confirmation, alignment check and time taken for a complete union. Union was defined as continuity of three or more cortices on radiography and lack of pain on weight bearing without assistance.<sup>12</sup> Patients were allowed partial weight bearing (toe touch) at 8 weeks and full weight bearing when union was achieved. Malalignment was defined as a varus or valgus of more than 5 degrees in the coronal plane and procurvatum or recurvatum greater than 10 degrees in the sagittal plane.<sup>13</sup> Delayed union and non-union were defined as a failure of fracture union after six and nine months of surgery respectively. Any complication during the surgery and follow-up period was recorded. Any secondary interventions like debridement, revision implant and bone grafting were also recorded.

At the final follow-up, a clinical and radiological examination was done and patients were assessed by Olerud Molander Ankle Score (OMAS). This score has a questionnaire including pain (25 points), stiffness (10 points), swelling (10 points), stair climbing (10 points), running (5 points), jumping (5 points), squatting (5 points), supports (10 points) and activity level (20 points) with a maximum score up to 100 points.<sup>14</sup> A value greater than 90 points is considered an excellent result, 61 to 90 is considered good, 31 to 60 is considered fair, and less than 30 is considered poor.

Mean, standard deviation and percentage were used for data descriptive statistics. The comparison of quantitative variables was performed by using the student t-test. A Chi-square test was used for qualitative data analysis. A p value less than 0.05 was considered statistically significant.

## RESULTS

A total of 113 patients of distal tibia fracture operated during the study period were selected in the study. 45 patients were excluded as they did not fit into our inclusion criteria. Out of 68 patients, only 40 patient's data were complete with all the relevant x-rays and document. 26 patients were male and 14 were female. The mean age was 34.2 years (range 19-52). According to AO classification, 22 (55%) patients had A1 type, 12 (30%) had A2 type and 6 (15%) patients had A3 type fracture. The mean fracture distance from joint the line was 7.07 cm. The mean time gap between injury and surgery was 4.5 days (range 1-9). Mean union time was 24.9 weeks (range 19-42). A fibular fracture was associated in 34 cases and it was fixed in 27 (67.5%) cases. Demographic data comparison of both the

groups are described in Table 1. 23 (17 male/6 female) were operated with MIPPO and 17 (9 male/8 female) with IMILN. The clinical and radiological outcome of the two groups is described in Table 2. The mean time between the injury and the surgery was 4.7 days for the MIPPO group and 4.2 for the IMILN without being statistically significant (p value 0.54). The mean fracture distance from the ankle joint line was 5.9 cm for the MIPPO group and 8.6 for the IMILN, being statistically significant (p value <0.0001). The mean union time was 23.9 weeks for the MIPPO group and 24 weeks for the IMILN group. This difference in union time was not statistically significant (p value 0.41). At one year follow-up, the average OMPS was 80.8 in the MIPPO group and 77.2 in the IMILN group. There was no significant difference in functional scores among both groups (p value 0.33).

**Table 1: Demographic data comparison of both groups.**

Parameter	Overall	MIPPO group	IMILN group
Number of patients	40	23	17
Mean age (years)	34.2	33.9	35.2
Sex	Male	17	9
	Female	6	8
AO type	A1	11	11
	A2	8	4
	A3	4	2

**Table 2: Comparison of clinical and radiological outcome of the two groups.**

Parameter	Overall	MIPPO group	IMILN group
Distance from joint line (cm)	7.07	5.9	8.6
Timing of surgery from injury (days)	4.52	4.7	4.2
Union time (weeks)	24	23.9	24
Fibula fixation	27	17	10
OMAS	79.27	80.8	77.2

Data related to complications are reported in Table 3. There was no significant difference in both the groups (p value 0.71). In MIPPO group, 1 patient developed malalignment in form of procurvatum deformity. In IMILN group, 3 patients developed malalignment-two valgus deformity, one procurvatum deformity. One patient in each of the groups developed delayed union which did not require any surgical intervention and healed around 28th week. Both the groups had one case of non-union. MIPPO patient required surgical intervention in form of secondary bone grafting while IMILN patient was treated with dynamization. Infection occurred during early postoperative period in two patients of MIPPO group which was treated with debridement and subsequently healed. Overall 10 patients had an excellent result (25%),

28 patients obtained a good result (70%) and 2 patients (5%) had fair result (Table 4).

**Table 3: Comparison of complications in both the groups.**

Complication	MIPPO group	IMILN group
Malalignment	1	3
Delayed union	1	1
Non union	1	1
Infection	2	0

**Table 4: Functional outcome in terms of OMAS for two groups.**

OMAS	Overall	MIPPO group	IMILN group
>90 (excellent)	10	8	2
61-90 (good)	28	14	14
31-60 (fair)	2	1	1
<30 (poor)	0	0	0



**Figure 1: Preoperative radiograph of distal tibia fracture.**



**Figure 2: Postoperative radiograph of distal tibia fracture (MIPPO).**



**Figure 3: Preoperative & postoperative radiograph of distal tibia fracture (IMILN).**

## DISCUSSION

Management of extra-articular distal tibia fractures is a challenge due to several factors like poor vascularity, less soft tissue coverage and small distal fragment. It is very difficult to obtain anatomical alignment and good stability with minimizing osseous and soft tissue complications. Open reduction and internal fixation with plating was a common practice in the past but skin related complication and the delayed union were quite frequent. With the advent of the nailing technique, many surgeons preferred IMILN technique over plating to minimize this complication. IMILN has an advantage over other methods because of its minimal invasive fixation technique with early weight bearing and good union rate. However higher rate of malalignment has been reported because of difficulty to control the small distal fragment.<sup>15-17</sup> In the last 2-3 decades or so, MIPPO technique has been popularized for this type of fracture which allows biological fixation and preserve fracture hematoma with less soft tissue complications.<sup>18</sup> Recent studies suggest that the outcome results with MIPPO technique are comparable with that of IMILN.<sup>10,23</sup> However there is no clear cut consensus about the superiority of either of this technique.

In our study, we have made an attempt to analyze the advantage and disadvantages of these two techniques on the basis of various parameters like union rate, incidence of malalignment, rate of complications and functional outcome retrospectively.

A large number of patients were selected for the study but being retrospective nature of study most of patients were left out due to incomplete data. In our study, the patients were in the range of 19 to 52 years, with mean age being 34.2 years. Patient with age above 55 years were not included to avoid old age related confounding factor. Of the 40 patients, 23 were males and 17 were females. The predominant gender of the patients was male as in our country they are mainly involved in outdoor activities as

compared to females in the Indian population. This pattern was also seen in other Indian studies like Kumar et al, Pawar et al and Daolagupu et al.<sup>19-21</sup>

On retrospective analysis, we found that out of 40 patients, 23 were operated with MIPPO technique in comparison of to 17 patients of IMILN. On further evaluation it was found that more the distal fracture, MIPPO was performed and more the proximal fracture, IMILN was performed. The likely explanation for this choice was to avoid the difficulty in managing fractures with a smaller distal fragment with IMILN. The mean time gap between injury and surgery was 4.52 days in our study in comparison to 6.83 days by Pawar et al and there was no statistical difference of gap between the groups.<sup>20</sup>

In our study, the average period of radiological union was found to be 23.9 weeks for the plating group and 24 weeks among the nailing group. Our results were not statistically significant for the union time between the two groups as similarly shown in multiple studies done by Kumar et al, Lakhotia et al, Janssen et al, Bisaccia et al and Barcak et al.<sup>19,13,22-24</sup> However there are some studies like Guo et al and Pawar et al which showed shorter union time in IMILN group.<sup>20,25</sup>

In our series, fibula fixation was performed in 27 cases out of 40 (17/23 MIPPO, 10/17 IMILN). It was done only for the cases where fibula fracture was at or below the level of a tibia fracture. There was no significant difference to fibula fixation among the groups (p value 0.72). However there were two interesting findings that in all the malalignment cases fibula was not fixed and both the infected patients had their fibula plated.

Our study shows that there was no significant difference in overall rate of complication in both groups. This was comparable to studies by Janseen et al, Nork et al and Guo et al.<sup>12,22,25</sup> Studies have shown that MIPPO plating provides a more anatomical and fixed reduction of the fracture, while intramedullary nailing treatment mainly permits minimal movements of the bone fragments in turn more cases of malalignment.<sup>16,17</sup> In our study also we found malalignment more commonly in IMILN group. There were only 2 cases of infection overall which were with MIPPO plating and healed with debridement and oral antibiotics. None of the IMILN patient had infection. Both the groups had one case of non-union & delayed union. There was no significant difference.

Functional outcome according to OMAS was measured in our study and the mean score was 79.27 (80.8 in MIPPO group and 77.2 in IMILN group) without any significant difference among the groups (p value 0.33). The results of our study showed that both MIPPO and intramedullary nailing are equally effective in terms of functional outcome as shown in previous studies by Guo et al, Vallier et al and Janssen et al.<sup>16,22,25</sup> Out of 40 patients, 38 had excellent or good outcome. Only 2 had a fair outcomes (one in each of the groups).

## CONCLUSION

The overall analysis suggest that both MIPPO and IMILN treatment option are comparable with consideration of all the parameters. Detailed results indicate a superiority of MIPPO over IMILN in terms of better anatomical reductions of the fracture with less number of malalignment while IMILN is better in a terms of having lower rates of infections. The two treatments yielded comparable results in terms of union time and functional outcomes.

The limitation of our study was small sample size because of dropout of large number of patients owing to retrospective analysis. However it is very difficult to perform a prospective study in government centres with shortage of manpower. There may be a subjective bias of implant selection as it was not randomized and was chosen by the operating surgeon as per his convenience. We feel that a future study with proper double blinded randomization, large sample size and longer follow-up can overcome this loopholes and can provide a better detailed assessment of techniques.

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