

## ORIGINAL ARTICLE

**Comparison of Plating Versus Intramedullary Nailing for the Treatment of Distal Tibial Metaphyseal Fractures: A Longitudinal Study**

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**ABSTRACT**

**Aim:** To evaluate the functional outcomes of intramedullary interlocking nailing and minimally invasive percutaneous plate osteosynthesis.

**Study design:** A longitudinal study

**Place and Duration:** This study was conducted at Dow University of Health sciences Karachi Pakistan from January 2019 to January 2021.

**Methodology:** A total of 100 patients were recruited for surgical procedures. All the patients were asked to visit the hospital at the 6th week, 3rd month, and 6th month of surgery for radiography assessment and for analyzing the knee and joint movements. When callus became visible on radiographs patients were allowed for partial weight-bearing. When callus was visible in 3 to 4 quadrants we considered it as fracture union on both anteroposterior and lateral views with no pain and mobility. Bone grafting was considered in case of fractures nonunion. Functional assessment was taken place after one year of surgery.

**Results:** We observed that the IMIL group attained fracture union in an average duration of 25.90. But no statistical difference was observed between both groups. IMIL procedure has less duration of hospital stay when compared with MIPPO (6.40 (4–9) ± 1.19 vs 6.82 (5–10) ± 1.27. We observed 5° malunion in the MIPPO group whereas the IMIL group reported 10° malunion with a significant difference of 0.001.

**Conclusion:** Our study concluded that the plating technique can better restore the distal tibia alignment but also has chances of postoperative complications which would be manageable.

**Keywords:** Intramedullary interlocking nailing, minimally invasive percutaneous plate osteosynthesis, distal tibia

**INTRODUCTION**

Distal tibial fractures are comprised of subcutaneous anatomical fractures that arise in the distal region between 4 to 12 cm from the tibia plafond.<sup>1</sup> The management of these fractures becomes challenging for many orthopedics due to their uniqueness of the location and poor blood supply. Many complications have been seen during management in the form of nonunion and delayed union. Wound dehiscence and infections are also persistent in these fractures.<sup>2</sup> However, different treatments are available for managing the distal tibial metaphyseal fractures including open reduction and internal fixation (ORIF), intramedullary nailing technique, minimally invasive percutaneous plate osteosynthesis (MIPPO) technique, and external fixation.<sup>3,4</sup> However, no satisfactory results had been obtained in previous years.<sup>3,4</sup> Though open reduction and internal fixation method with plating provide early mobilization and reduction still it cannot be considered as the first-line treatment due to extensive soft tissue injury.<sup>5</sup> On the other side, intramedullary nailing (IMIL) provides stability to heal the fracture along with avoiding soft-tissue insult and preserving the biological environment around the fracture site.<sup>6</sup> On the contrary, this

IMIL method also has some drawbacks in the form of malunion and knee pain.<sup>5,6</sup> Recently MIPPO technique gain the attention of many researchers due to preserving the ability of periosteal tissue and hematoma around the fracture. MIPPO technique also provides a stable biochemical construct to the fracture site without any severe complications of wound problems.<sup>7,8</sup> This study was specifically designed to evaluate the functional outcomes of intramedullary interlocking nailing and minimally invasive percutaneous plate osteosynthesis. We aimed to compare the duration of fracture union and examine the postoperative complications of both techniques.

**METHODOLOGY**

This longitudinal study was conducted at Dow University of Health sciences Karachi Pakistan from January 2019 to January 2021. During this timeframe, 100 patients were recruited for surgical procedures. The research was initiated after the ethical approvals were taken from the institutional review board. Patients were randomly allocated into two groups, each containing 50 patients. The first group of 50 patients was treated with minimally invasive percutaneous plate osteosynthesis (MIPPO) technique

while the rest 50 were prepared for intramedullary interlocking nailing (shortened) procedure. Inclusion criteria consisted of patients who had 2 weeks old OA type A1, A2, or A3 fractures and aged above 18 at the time of admission. We only included patients with the presence of at least 3cm distal fragment without articular incongruity. We further assured that the vascular and neurological status of patients were maintained and they meet all the routine medical standards. While we excluded all the cases of compound fractures, intra-articular extension fractures. In case of any vascular injuries associated with fractures, patients were immediately excluded. Pathological traumas and poly traumas were not entertained. Written consent was taken from all the participants after declaring all the research objectives and consequences. We calculated our sample size with a probability of a 30% difference among both groups. The value of alpha error was set as 5% and 80% statistical power was used for sample size. We included anteroposterior and lateral radiographs of fractures with knee and ankle as preoperative examination. The stability of patients was thoroughly examined before radiological assessment. Till the surgery, we applied a posterior slab for immobilization. Regular dressing and limb elevation were used for patients with precarious skin conditions. After the appearance of wrinkle sign within two weeks of trauma we initiated our surgical procedure.

After application of tourniquet patient leg was prepared from toes to mid-thigh for the MIPPO technique. Preventing the saphenous nerve and vein injury we made an incision of 3-4 cm over the distal tibia metaphysis. A blunt retractor was used to make an epiperiosteal tunnel for the insertion of long plates towards the diaphysis through the point of incision. After assuring the fracture reduction and manipulation we positioned the anatomical pre-contoured on the anteromedial aspect of the tibia shaft. This step was depending on the fracture pattern. An acceptable criterion was formed to analyze the reduction; achieving <5°varus-valgus angulation, <10° anteroposterior angulation, and < 10 mm shortening. The plate was fixed with K wire temporarily along with one locking screw we fixed the proximal fragment after insertion of a plate and examined the reduction. A combination of cortical nonlocking and locking screws were used to complete the procedure of distal fragment fixation. The fibula was not fixed unless the fracture was within the syndesmosis region.

Meanwhile, a vertical incision of 5cm was made on the anterior aspect of the knee from the distal tip of the patella to the proximal aspect of the tibial tuberosity. We made the entry portal after cracking the patella tendon. This entry portal was made in the bare area of the tibial extra-articularly around 2 cm proximal to the tibial tuberosity. After provisional reduction, a ball tip wire was inserted to the distal end of the tibia through the entry point. Later on, pointed bone holding forceps was done to fix the shortened length IMIL nail. The interlocking screw was used to enhance the stability and alignment of fractures. After surgery fractures of both groups were supported with a posterior slab for 2 weeks. Immediately after surgery patient's leg was assessed via radiography (anteroposterior and lateral views). After one day of surgery, we recommended calf strengthening exercises. Antibiotics were provided to every patient for three days to minimize

the risk of postoperative infections. However, patients were discharged after one week if their wound was dry.

All the patients were asked to visit the hospital at the 6th week, 3rd month, and 6th month of surgery for radiography assessment and for analyzing the knee and joint movements. When callus became visible on radiographs patients were allowed for partial weight-bearing. When callus was visible in 3 to 4 quadrants we considered it as fracture union on both anteroposterior and lateral views with no pain and mobility. Bone grafting was considered in case of fractures nonunion. Functional assessment was taken place after one year of surgery or once the complete union of fracture has occurred using the American Orthopedic Foot and Ankle Society (AOFAS) score.

For statistical analysis, SPSS Version 23.0 was used. Mean and standard deviations were used for quantitative variables. Independent student t-test was used for comparing the quantitative variables while qualitative variables were analyzed by using Chi-square and Fisher exact test. We set a 0.05 p-value to determine the statistical significance.

## RESULTS

For this study total of 100 patients were recruited which were equally and randomly allocated into two groups. Out of these 100 patients, 54 (54%) were male and 46 (46%) were females. The mean age of the plating group was observed as 41.14 years while the average age of the nailing group was reported as 37.34 years. In the plating group we observed 36 cases of OA type 1, 12 cases were diagnosed as type 2 and only 2 cases were identified under the category of OA type 3. Meanwhile, in the nailing group 38 cases of type 1, 11 were of type 2 and a single case of type 3 were managed. We observed 18 cases of fibula fractures in the plating group and 20 fibula fractures in the nailing group.

Table 1: Demographic information and treatment outcomes of both groups

Variables	IMIL nailing (N=50)	MIPPO (N=50)	p-value
Age	37.34 (19–68) ±11.21	41.14 (18–61) ±10.52	0.084
Gender			0.908
Male	26	28	
Female	24	22	
Hospital stay (days)	6.40 (4–9) ± 1.19	6.82 (5–10) ± 1.27	0.092
Surgical time	60.80 (44–80) ± 8.59	59.42 (40–80) ± 8.97	0.854
Duration of fracture union	25.90 (18–46) ± 5.19	26.06 (19–48) ± 5.35	
Weight-bearing duration	7.02 (5–10) ± 1.55	7.32 (6–11) ± 1.49	0.092
Fluoroscopy time (min)	14.12 ± 1.22	15.31 ± 1.28	0.854
Final stage AOFAs score	83.84 (61–98) ± 8.87	84.16 (60–98) ± 8.80	0.855
Malunion	10.22 (8–14) ± 2.04	5 (3–7) ± 1.41	0.001

The mean duration of surgery was reported as 60.80 ± 8.59 hours in the nailing group while 59.42 ± 8.97 hours

in the plating group with no statistical difference. We observed that the IMIL group attained fracture union in an average duration of 25.90. But no statistical difference was observed between both groups. IMIL procedure has less duration of hospital stay when compared with MIPPO (6.40 (4–9)  $\pm$  1.19 vs 6.82 (5–10)  $\pm$  1.27. We observed 5° malunion in the MIPPO group whereas the IMIL group reported 10° malunion with a significant difference of 0.001. The average duration of weight-bearing was reported as 7.32 in plating and 7.02 in the nailing group (As shown in Table 1). In Table 2 we mentioned postoperative outcomes in which we observed that 5 (10%) cases of the IMIL group reported knee pain with a statistical difference of 0.024 between both groups. We also reported a high rate of the delayed union in the nailing group (12% vs 14%). Patients treated with plating were more prone to superficial infections (8% vs 4%).

Table 2: Postoperative complications in study participants

Complications	IMIL technique	MIPPO technique	P-value
Superficial infection	2 (4%)	4 (8%)	0.04
Delayed union	7 (14%)	6 (12%)	0.769
Deep infection	1 (2%)	1 (2%)	0.1
Nonunion	3 (6%)	1 (2%)	0.04
Knee pain	5 (10%)	1 (2%)	0.024

## DISCUSSION

Distal tibia metaphyseal fractures are one of the challenging fractures for many orthopedic surgeons due to the paucity of soft tissue coverage. The unconventional location of these fractures and bony comminution causes obstacles in managing distal tibial metaphyseal fractures. However, surgical intervention is highly appreciated to restore the alignment and provide stability with less probability of complications. Postoperative stability of these fractures also encourages early mobilization and reduces the risk of soft tissue and devascularization.<sup>2</sup> In recent years intramedullary interlocking nailing was considered the best treatment for managing distal tibial fractures.<sup>10</sup> Studies reported that IMIL is a minimally invasive technique that enhanced the healing procedure and allows early weight-bearing.<sup>2,11</sup> They further observed less intraoperative blood loss, fewer postoperative complications, and decreased periosteal stripping.<sup>2,11</sup> The distal tibia has a wide circular intramedullary cavity with a thin cortex as compared to the diaphysis so the intramedullary nail which is designed for diaphysis does not provide stability in the distal region.<sup>10</sup> The availability of the MIPPO technique challenged the intramedullary nailing by providing better angular stability at the screw plate interface. MIPPO also preserved the periosteal blood supply around the fracture. Therefore, we designed this study to compare the outcomes of both techniques.<sup>2, 11</sup> In this study, the major variables of comparison were nonunion and delayed union outcomes, surgical complications in terms of knee pain, and infection. AOFAS score was also one of the major outcomes of the comparison. However, we did not observe any significant difference between the AOFAS scores of both groups. Meanwhile, IMIL procedure has less duration of hospital stay when compared with MIPPO (6.40 (4–9)  $\pm$  1.19 vs 6.82 (5–10)  $\pm$  1.27. We observed that the

IMIL technique provides better outcomes in terms of weight-bearing and duration of fracture union. Patients treated with MIPPO reported less surgical duration than IMIL. We observed 5° malunion in the MIPPO group whereas the IMIL group reported 10° malunion with a significant difference of 0.001. Comparing the postoperative variables we observed 2% cases of knee pain after MIPPO while 10% cases of IMIL reported knee pain with a statistical difference of 0.001. Contrastingly, the MIPPO group reported higher superficial infection than IMIL (8% vs 4%). Interestingly, the success rate of MIPPO was better than IMIL as we reported only 1 case of nonunion while IMIL reported 6% nonunion. Comparing these results with the past literature we observed similar coherence of our findings with meta-analysis of Hu et al.<sup>1</sup> In his meta-analysis, he also observed fewer cases of knee pain and malunion in the MIPPO group however foot function index was better in the IMIL group along with fewer cases of superficial infection. Meanwhile, the meta-analysis of Lin et al.,<sup>3</sup> suggested IMIL for managing distal tibia due to a lower risk of wound complications. In the past, huge variations have been observed regarding the comparison of IMIL nailing and the MIPPO technique. A study by Vallier et al.,<sup>12</sup> revealed a high incidence of malunion in the IMIL group than plate fixation. Variations in the study of Vallier arise due to poor reduction, inadequate distal locking screw, and distal location of the fracture. Nailing techniques provide better fixation stability and reduction to avoid the malunion of the distal tibia fractures than plating.<sup>13</sup> Furthermore, the study of Bong et al.<sup>14</sup> provides inverse results in which they reported that lack of adequate distal locking enhances the chances of malunion and loss reduction. However, the availability of poller screws can provide better stability and maintenance reduction.<sup>15</sup> The study of Ali<sup>16</sup> reported less surgical duration and faster healing in the nailing group when compared with MIPPO. In terms of surgical duration, these results are in contradiction to our results. Some studies reported that plate fixation reduced the risk of infection which is somehow similar to our results.<sup>9, 17</sup> Even though MIPPO can restore the alignment in the distal tibia region still study by Collinge et al.,<sup>18</sup> suggested bone marrow injection and bone grafting in cases of delayed union. Various studies examined 3.8% to 35% delayed union in the MIPPO group and prolonged the healing duration. Therefore, the delayed union can be prevented by using an inter-fragmentary screw.<sup>18, 19, 20</sup>

## CONCLUSION

We observed the reliability of both procedures in managing the distal tibia fractures. Both procedures provide a favorable environment for healing fracture sites by preserving the bony vascularity and fracture hematoma. However, our study concluded that the plating technique can better restore the distal tibia alignment but also had chances of postoperative complications which would be manageable.

**Funding source:** None

**Conflict of interest:** None

**Permission:** It was taken from the ethical review committee of the institute

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