

Original Article

Comparative Study of Intramedullary Interlocking Nailing and Minimally Invasive Percutaneous Plate Osteosynthesis for Distal Tibia Extra-Articular Fractures

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Abstract:

Management of distal tibial extra-articular fractures presents a significant challenge in orthopedic practice due to their complex anatomical features and variable fracture patterns. Surgical intervention plays a crucial role in achieving stable fixation and optimal functional outcomes. This study aimed to compare the effectiveness between minimally invasive percutaneous plate osteosynthesis and intramedullary nailing for the management of distal tibial extra-articular fractures. This was a prospective observational study that was conducted in the Department of Orthopedics, Bangabandhu Sheikh Mujib Medical College, Hospital (BSMMCH), Faridpur, Bangladesh from January 2021 to December 2022. Total 24 patients having a fracture of the distal third of the tibia were enrolled in this study as the study subjects. Total patients were divided into two groups. In group A, 12 patients underwent minimally invasive percutaneous plate osteosynthesis (MIPPO) and in group B, 12 patients underwent intramedullary nailing (IMN). A random selection method was used in sample selection. According to Olerud Molander's score, Excellent, Good and Fair results were found in 50%, 50%, and 0% of the group A patients respectively. On the other hand, those results were found in 42%, 50% and 8% of group B patients respectively. Although both minimally invasive percutaneous plate osteosynthesis and intramedullary nailing procedures are effective in managing distal tibial extra-articular fractures, considering excellent union rate, low blood loss and remarkable Olerud Molander's score, MIPPO may be considered as the better option.

Key words: Intramedullary interlocking nailing, Percutaneous plate, Osteosynthesis, Extra-articular fracture.

Introduction:

As civilization advances towards industrialization, the number of accidents has been increasing. Across the globe, road traffic and industrial accidents are causing an increase in leg bone fractures and fractures of other body parts. When we examine the statistics on fractures

in different parts of the body, leg bone fractures are at the top of the list. This is because the legs are the most distal part of the body and play a crucial role in the locomotive system¹. Distal tibia fractures have the second highest incidence out of all leg bone fractures,

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based on the location of the fracture in the tibia². The incidence of distal tibia fractures in most series is 0.6%, and it constitutes about 10%–13% of all tibia fractures³. Distal tibia extra-articular fractures are relatively

common injuries that can cause significant morbidity and disability. There are several treatment options available, but two of the most widely used are intramedullary interlocking nailing (IMILN) and minimally invasive percutaneous plate osteosynthesis (MIPPO). Both methods have their advantages and disadvantages, and there is an ongoing debate about which is the best option for patients. IMILN involves inserting a metal rod into the medullary canal of the tibia and securing it with screws. MIPPO, on the other hand, involves fixing a plate to the bone using minimally invasive techniques. Both methods aim to stabilize the fracture and promote bone healing, but they differ in terms of their surgical approach, biomechanics, and postoperative rehabilitation. Each of the techniques mentioned has advantages and disadvantages, and there is no clear agreement on how to manage these types of fractures. External fixation methods such as Ilizarov frames, ankle spanning, and hybrid constructs have been suggested as either a standalone treatment or more commonly in combination with limited internal fixation and are a recognized approach for treating distal tibial fractures, particularly those accompanied by significant soft tissue damage. Both minimally invasive plate osteosynthesis (MIPPO) and intramedullary interlocking nails (IMILN) have been widely acknowledged as effective methods. However, they have both had a historical association with complications. Reports have frequently mentioned malalignment and knee pain following the use of IMILN, while certain series have linked tibial plating to wound complications and implant prominence⁴⁻⁶. However, external fixation can lead to complications such as the development of pin tract infections, malunion, or nonunion. Intramedullary nails have undergone significant improvements in recent years, and their use has been extended to fractures closer to the ankle joint. Modern designs feature interlocking holes that allow screws to be placed close to the tip of the nail in the distal fragment. Furthermore, reports have shown success with at least two interlocking screws in the distal fragment after the traditional nail's distal tip has been removed⁷. There have been several studies comparing IMILN and MIPPO for distal tibia extra-articular fractures, with varying results. Some studies have found no significant differences in outcomes between the two methods, while others have reported better results with one approach over the other. A recent systematic review and meta-analysis of 14 studies found that both IMILN and MIPPO were effective treatments for distal tibia extra-articular fractures, but IMILN was associated with a higher rate of malunion and MIPPO was associated with a higher rate of wound complications⁸. The objective of this research was to evaluate the outcomes and potential complications of treating distal tibial fractures using plate and nail stabilization techniques.

Materials and Methods:

This prospective study was conducted at the Department of Orthopedic Surgery, Bangabandhu Sheikh Mujib Medical College, Hospital (BSMMCH), Faridpur. Patients having a fracture of the distal third of the tibia, from January 2021 to December 2022 treated with surgical methods either by close interlocking intramedullary nailing or with percutaneous reduction and internal fixation with LCP plating were included in this study. Total 24 patients were enrolled and analyzed into two groups. Patients both males and females aged more than 18 years, closed and Open fracture Gustilo and Anderson grade 1, Oestern and Tschernke grade 0 and grade 1 were included in this study. Patients aged below 18 years, intra-articular extension of fractures, open fractures above grade 1 (Gustilo and Anderson), all pathological fractures, earlier fracture of the tibia on the same side, temporary treatment of fracture with an external fixator, unfit for surgery were excluded from this study. Informed consent was obtained from each patient before participation in the study. Group A includes 12 patients those were operated on with distal tibia pre-contoured LCP and Group B includes 12 patients those were operated on with interlocking intramedullary nailing. After admission and resuscitation of the traumatized patient, initially the leg was temporarily immobilized by long leg back slab after reduction of fracture till definitive surgery. Patients with precarious skin condition were managed with limb elevation, regular dressing care & prophylactic intravenous antibiotics. Routine pre-operative evaluation and investigations for general anesthesia was done including x-rays of the involved leg. Patients were randomly selected and operated either with distal tibia pre-contoured LCP or with interlocking intramedullary nailing after the skin condition was favorable for surgery as evidenced by appearance of wrinkle sign. All cases were followed up for at least six months.

In this study, the AOFAS⁹ score (The American Orthopedic Foot-and-Ankle Society) and the Olerud-Molander score¹⁰ were used in outcome analysis. All the demographic and clinical information were recorded. Properly written consent was taken from all the participants before data collection. All the demographic and clinical information of the participants was recorded. All data were processed, analyzed and disseminated by using the MS Office program and the student's T-tests were done for assessing the significance. In statistical analysis, a P value <0.05 was considered as the indicator of significance.

Results:

In this study, among the total of 24 participants, we observed that in group A (MIPPO), three-fourths of the respondents (75%) were male and 25% were female. Besides, in group B (IMN), two-thirds of the respondents (67%) were male and 33% were female. The mean \pm SD age (Years) and BMI (Kg/m²) were 38.55 \pm 13.72 and 25.49 \pm 2.19 in group A respectively. On the other hand, the mean \pm SD age (Years) and BMI (Kg/m²) were 39.82 \pm 14.27 and 25.71 \pm 2.43 in group B respectively as shown in Table I.

Table I: Distribution of patients according to demographic parameters (n=24)

Parameters	Group A (n=12) (n=%)	Group B (n=12) (n=5)
Male	9 (75%)	8 (67%)
Female	3 (25%)	4 (33%)
Mean \pm SD age (Years)	38.55 \pm 13.72	39.82 \pm 14.27
Mean BMI (Kg/m ²)	25.49 \pm 2.19	25.71 \pm 2.43

In the majority of the group A respondents (58%), the mechanism of injury was RTA (Road traffic accident), in 25% it was falls, in 8% it was assault and in another 8%, it was sports injury. On the other hand, in about two-thirds of the group B respondents (67%), the mechanism of injury was RTA, in 17% it was fall in 8% it was assaults and in another 8% it was sports injury as shown in Table II.

Table II: Distribution of patients according to mechanism of injury among participants (n=24)

Mechanism of injuries	Group A (n=12) (n=%)	Group B (n=12) (n=5)
RTA	7 (58%)	8 (67%)
Falls	3 (25%)	2 (17%)
Assaults	1 (8%)	1 (8%)
Sports Injury	1 (8%)	1 (8%)

In analyzing the side involvement among group-A (MIPPO) patients, we found that three-fourths of the respondents (75%) had right-side involvement and near about one-fourth (26%) had left-side involvement. On the other hand, the majority of the respondents (83.33%) had right-side involvement and 16.67% had left-side involvement in group B as shown in Table III.

Table III: Distribution of patients according to side involvement (N=24)

Side of involvement	Group A (n=12) (n=%)	Group B (n=12) (n=5)
Right	9 (75)	10 (83.33)
Left	3 (26.7)	2 (16.67)

In the majority of the respondents (58.33%), the AO class was found Type 43A1; Type 43A2 and Type 43A3 were found in 25.0% and 16.67% of cases in group A respectively. On the other hand, in group B, the majority of the respondents (66.66%) had Type 43A1 fractures; Type 43A2 and Type 43A3 were found in 16.67%, and 16.67% of the cases respectively as shown in Table IV.

Table IV: Distribution of patients according to AO classification (n=24)

AO types	Group A (n=12) (n=%)	Group B (n=12) (n=5)
Type 43A1	7 (58.33)	8 (66.66)
Type 43A2	3 (25.00)	2 (16.67)
Type 43A3	2 (16.67)	2 (16.67)

In group A (MIPPO), the union was found in 100% of patients whereas in group B it was found in 92% of the cases. Time to union (day) was found 129.2 \pm 10.7 days in group A and 138.6 \pm 11.2 days in group B; in comparing the time to union between the groups the P-value was found 0.047. AOFAS scores were found 86.7 \pm 7.5 in group A and 87.2 \pm 7.6 in group B; in comparing AOFAS scores between the groups the P-value was found 0.873. Operation time (min) was found 84.4 \pm 13.5 min in group A and 106.3 \pm 14.2 min in group B; in comparing operation time (min) between the groups, the P-value was found <0.001 which indicated a significant correlation. Intraoperative blood loss (ml) was found 91.3 \pm 25.7 ml in group A and 176.4 \pm 27.8 ml in group B; in comparing intraoperative blood loss (ml) between the groups the P-value was found <0.001 which also indicated a significant correlation as shown in Table V.

Table V: Distribution of patients according to clinical outcomes (n=24)

Clinical outcomes	Group A (n=12) (n=%)	Group B (n=12) (n=5)	P-value
Union	12 (100)	11 (92)	
Time to union (day)	129.2 \pm 10.7	138.6 \pm 11.2	0.047
AOFAS scores	86.7 \pm 7.5	87.2 \pm 7.6	0.873
Operation time (min)	84.4 \pm 13.5	106.3 \pm 14.2	<0.001
Intraoperative blood loss (ml)	91.3 \pm 25.7	176.4 \pm 27.8	<0.001

According to Olerud Molander’s score, Excellent (91-100), Good (61-90) and Fair (31-60) results were found in 50%, 50%, and 0% of the cases in group A respectively. On the other hand, Excellent (91-100), Good (61-90) and Fair (31-60) results were found in 42%, 50% and 8% of the group B patients respectively. The mean \pm SD Olerud Molander’s score was 85.7 \pm 3.2 in group A and 81.3 \pm 3.1 in group B and in comparing those scores, we found the P- value of 0.002 which indicated a significant correlation as shown in Table VI.

Table VI: Distribution of patients according to comparison of Olerud Molander’s score at the final follow-up (n=24)

Olerud Molander score	Group A (n=12) n(%)	Group B(n=12) n(5)	P-value
Excellent (91-100)	6 (50)	5 (42)	0.002
Good (61-90)	6 (50)	6 (50)	
Fair (31-60)	0 (0)	1 (8)	
Mean \pm SD score	85.7 \pm 3.2	81.3 \pm 3.1	

In analyzing the complications among group-A cases, we observed that the highest number of the patients (17%) had anterior knee pain and another 17% had noticeable implant irritation. On the other hand, in group B, anterior knee pain (25%), deep infection (17%), knee stiffness (17%) and delayed union (17%) were found more frequently than that in group A as shown in Table VII.

Table VII: Distribution of patients according to complications (n=24)

Complications	Group A n (%)	Group B n (%)
Anterior knee pain	2 (17)	3 (25)
Superficial infection	1 (8)	1 (8)
Deep infection	1 (8)	2 (17)
Knee stiffness	1 (8)	2 (17)
Delayed union	1 (8)	2 (17)
Implant irritation	2 (17)	1 (8)

Discussion:

This study aimed to compare the effectiveness between minimally invasive percutaneous plate osteosynthesis and intramedullary nailing for the management of distal tibial extra-articular fractures. In this study, among the total of 24 participants, we observed that in group A (MIPPO), three-fourths of the respondents (75%) were male, and 25% were female. Besides, in group B (IMN), two-thirds of the respondents (67%) were male, and 33% were female. The mean \pm SD age (Years) and BMI (Kg/m²) were 44.4 \pm 14.11 and 26.66 \pm 2.245 in group A

(MIPPO) respectively. On the other hand, the mean \pm SD age (Years) and BMI (Kg/m²) were 41.96 \pm 15.81 and 25.39 \pm 2.5048 in group B (IMN) respectively. Various other studies by Li et al.¹¹ and Vallier et al.¹² have shown male preponderance. In our study in the majority of the group A respondents (58%), the mechanism of injury was RTA (Road traffic accident), in 25% it was falls, in 8% it was assault and in another 8%, it was sports injury. On the other hand, in about two-thirds of the group B respondents (67%), the mechanism of injury was RTA, in 17%, it was falls in 8% it was assaults and in another in 8% it was sports injury. These results are in concordance with the study conducted by Kumar et al.¹³ In this study, in group A (MIPPO), the union was found in 100% of patients whereas in group B it was found in 92% of the cases. Time to union (day) was found 129.2 \pm 10.7 days in group A and 138.6 \pm 11.2 days in group B; in comparing the time to union between the groups the P-value was found 0.047. AOFAS scores were found 86.7 \pm 7.5 in group A and 87.2 \pm 7.6 in group B; in comparing AOFAS scores between the groups the P-value was found 0.873. Pawar et al.¹⁴ found the average time for the union was 17.43 weeks in the interlocking group compared to 21.40 weeks which was found in another study conducted by Kasper W. et al.¹⁵ In this study, according to Olerud Molander’s score, Excellent (91-100), Good (61-90) and Fair (31-60) results were found in 50%, 50%, 0% of the cases in group A respectively. On the other hand, Excellent (91-100), Good (61-90) and Fair (31-60) results were found in 42%, 50% and 8% of the group B patients respectively. The mean \pm SD Olerud Molander’s score was 85.7 \pm 3.2 in group A and 81.3 \pm 3.1 in group B and in comparing those scores, we found the P- value of 0.002 which indicated a significant correlation. But in another study¹⁶ the P-value was found 0.307. In analyzing the complications among group-A cases, we observed that the highest number of the patients (17%) had anterior knee pain and another 17% had noticeable implant irritation. On the other hand, in group B, anterior knee pain (25%), deep infection (17%), knee stiffness (17%) and delayed union (17%) were found more frequently than that in group A. Our findings were near about similar to the other two studies conducted by Nork et al.¹⁷ and Guo et al.¹⁸. All the findings of this current study may be helpful in further similar studies.

Conclusion:

As per the findings of this current study, we can conclude that although both minimally invasive percutaneous plate osteosynthesis and intramedullary nailing procedures are effective in managing distal tibial extra-articular fractures, considering excellent union

rate, low blood loss and remarkable Olerud Molander's score, MIPPO may be considered as the better option. For getting more specific results, we would like to recommend conducting similar studies in several places with larger-sized samples.

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