Original Article

Functional Outcome of Minimally Invasive Percutaneous Plate Osteosynthesis in Distal Tibial Fracture

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ABSTRACT

Background: Traditional plating technique for distal tibia fractures may produce periosteal stripping and microcirculatory damage, which may frequently induce infection, nonunion or both. Treatment of these injuries using minimal invasive percutaneous plate osteosynthesis (MIPPO) technique may minimize soft tissue injury and damage to the vascular integrity of the fracture fragments. The objective of our study was to assess the clinical result of MIPPO for distal fracture of tibia.

Methods: A total of 30 patients of distal tibia fracture treated with MIPPO with Locking compression plate (LCP) Technique at National Trauma Center, Kathmandu were studied during a period of one year. Patients were followed up on 2nd post-operative week and then at an interval of 4 week till 6 months. Tenny and Weiss clinical assessment criteria was used in each follow up.

Results: In our study, mean age of the patients was 36.9 year with standard deviation ± 9.4 and majority of them were male (60%). The mean time for radiological union of bone was 17 weeks. In final follow up, 2 cases had excellent result, 23 cases had good result and 5 cases had fair result. No case had poor functional outcome.

Conclusion: MIPPO offers a reliable and reproducible technique for treating distal tibia fractures with intra-articular or peri-articular fracture extension. This technique avoids significant complications encountered with more commonly used internal and external fixation techniques for such injuries. This procedure is associated with good functional outcomes regarding the ankle range of motion.

Keywords: Distal tibia, MIPPO, Tenny and Weiss score

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INTRODUCTION

Distal tibial fractures, comprising 5-7 % of road traffic injuries are usually the result of combined compressive and shear forces [1]. They are prone to complications due to inherent instability, minimal soft tissue coverage, and poor blood supply. High rates of associated complications have been reported with conventional fixation methods [2,3]. Minimal invasive percutaneous plate osteosynthesis (MIPPO) shows highest respect to bone and soft tissues and achieves adequate reduction and plate fixation of fracture without inflicting additional trauma [4]. Measures like smaller incisions, less soft tissue dissection, less periosteal stripping to preserve local blood supply, improve the healing rate and reduce complications. Biological fixation is achieved with the lesser evacuation of osteogenic fracture hematoma [5]. Locking compression plate (LCP) function as internal-external fixators, providing stability in a bridging fashion to preserve the normal biomechanics of the knee and ankle joint [6,7]. Our study aimed to further establish the advantage of the MIPPO technique in distal tibia fractures. This study was planned to assess the union rate, deformity, leg length discrepancy, gait and ankle range of motion, return to previous daily and sports activities, and infections and other complications associated with distal tibial fracture treated via MIPPO technique.

METHODS

A prospective observational study was conducted at National Trauma Center, Kathmandu over a period of 12 months (January 2021 – December 2021).

The sample size of cases to be enrolled was calculated by using the formula

$$N = Z^2PQ / D^2 = \frac{1.96^2*0.085*0.915}{0.1^2} = 30$$

N: minimal sample size

Z: 1.96 at 95% level of confidence.

P: Functional outcome of MIPPO in distal tibia fracture (8.5%) [8].

Q:1-P (1-0.085) = 0.915

D: The maximum allowable deviation or error of the estimate (10%)

Minimum sample size = 30

The study included adults aged 20 to 60 years who presented with simple, closed fractures deemed unfavorable for interlocking nailing. Specifically, fractures classified according to the AO (Arbeitsgemeinschaft für Osteosynthesefragen) system as Type A, Type B, or Type C1, as well as open fractures classified as Gustilo and Anderson Type I and II, were eligible for inclusion.

Exclusion criteria were as follows: individuals with severe renal, cardiopulmonary, hepatic, or central nervous system disorders; those with pathological fractures; cases where the viability of the soft tissue is in question; with peripheral vascular disease; with a previous history of tibial fracture; patients experiencing neurovascular compromise; and individuals with concomitant ipsilateral lower extremity injuries.

Ethical clearance for the study was obtained from the Institutional Review Board (IRB) of the National Academy of Medical Sciences (NAMS). Informed consent was secured from all patients prior to their enrollment in the study. Initially, patients were managed with an above-knee post-slab and elevation until definitive fixation could be performed. Surgery was carried out as soon as possible, unless delays were necessitated by soft tissue swelling or anesthetic considerations.

A properly sized tourniquet, with adequate padding and set at twice the patient's systolic blood pressure, was applied to the mid-thigh. Fluoroscopy was used to confirm anatomical reduction before plate placement, and a 3.5 mm lag screw was used to stabilize the articular fragment if necessary. The length of the distal

tibia plate was determined by positioning it over the medial aspect of the tibia. An approximately 1.5 cm incision was made over the medial malleolus for the insertion of the plate extraperiosteally. The plate was temporarily fixed with a k-wire through the target hole and its position was confirmed using fluoroscopy [9].

Union was defined as bridging of three out of four cortices and disappearance of the fracture line on plain radiographs for patients who was able to bear full weight. A fracture that had not united at six months but was in the process of union was classified as delayed union. Malunion was defined as incongruity of the articular surface exceeding 2 mm or malalignment greater than 5 degrees in any plane [10].

Data was tabulated in pre-defined tables and was analyzed using appropriate statistical methods. SPSS version 22 was used to generate all desired values. P-value was calculated under the predetermined level of significance (0.05) and confidence interval of 95% will be constructed. Results were expressed as percentages, mean ± standard deviation, and median for variables.

RESULTS

In our study, the mean age of patients was 36.9 ± 9.4 years (range from 20-60 years). Maximum number of patients was in age group of 31-40. Out of total 30 patients 18(60%) were male and 12 (40%) were female. Most common mechanism of injury was road traffic accident (60%). The right tibia involved was involved in 60% whereas the left tibia in 40%. A total of 12 patients (40%) had associated fibula fracture and 9 of them were treated with open reduction and internal fixation with 1/3rd tubular plate.

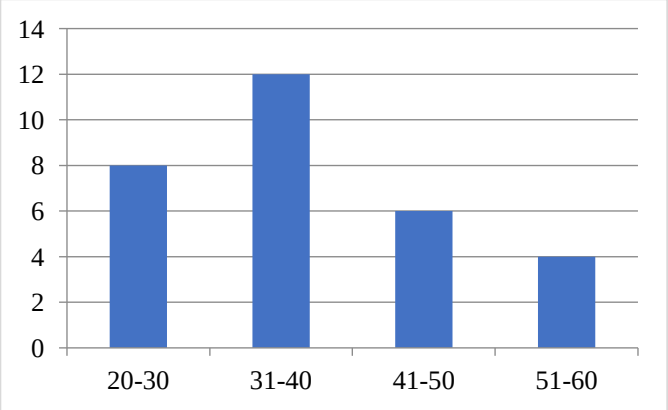


Figure 1: Age distribution of patients

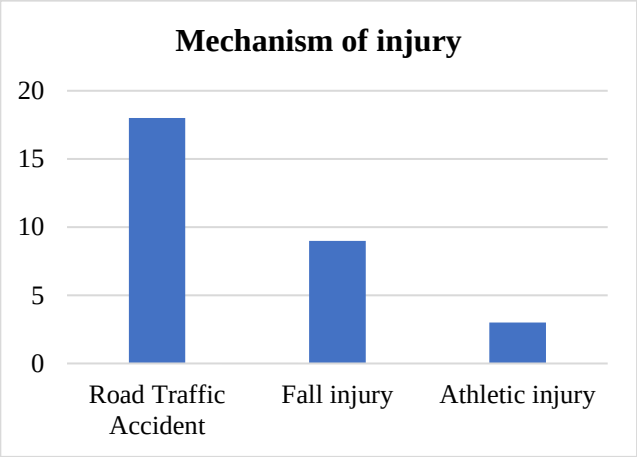


Figure 2: Mechanism of injury

The mean duration of the total hospital stay was 12.6 days, with the mean pre-operative and post-operative hospital stays being 6.3 and 6.4 days, respectively. The mean duration of surgery was 57.8±9.97 minutes. Most patients (21) experienced less than 10 ml of blood loss. There were 4 cases of complications: 2 instances of malleolar skin irritation, 1 case of superficial skin infection, and 1 case of hardware pain. No cases of mal-reduction or deep infection were reported.

The mean duration for radiological union of the fracture was 17 weeks, with most fractures (12) healing between 18 and 19 weeks. There were no cases of delayed union or non-union. On average, patients achieved 34.1 degrees of plantar flexion. Of the cases, 93% (28) achieved greater than 30 degrees of plantar flexion, while 2 cases achieved between 10 and 30 degrees. No cases showed less than 10 degrees of plantar flexion or equinus contracture.

All patients were able to walk more than 6 blocks without limitations. The mean Tenny and Weiss score at the final follow-up was 85, with scores of 86.08 for females and 84.28 for males. There was no significant difference in scores between genders.

Table 1: Time of fracture union (N = 30)

Duration (weeks)	Number	Percentages
14-15	6	20%
16-17	8	26%
18-19	12	40%
20-21	3	10%
22-23	1	3%

Table 2: Plantar range of motion (N = 30)

Plantar range of motion	Number	%
Greater than 30°	28	93%
Greater than 10°	2	7%
Less than 10°, or presence of equines contracture	0	0

Table 3: Dorsal range of motion (N = 30)

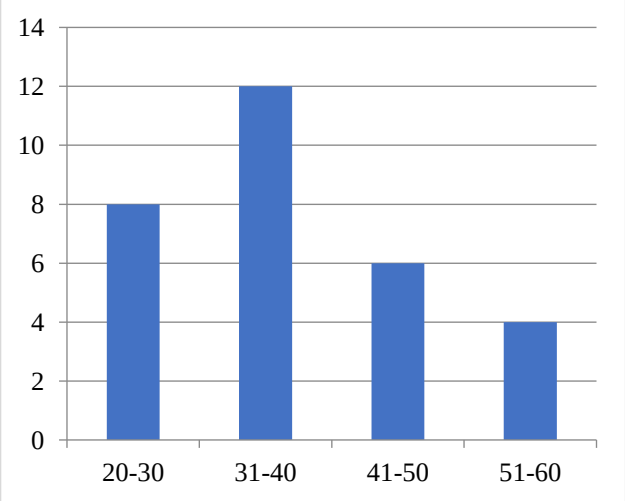
Dorsal range of motion	N	Percent
Greater than or equal to 15°	15	50 %
Greater than or equal to 10°, less than 15°	12	40 %
Greater than or equal to 0°, less than 10°	3	10 %

Table 4: Functional Outcome (According to Tenny and Weiss Criteria)

Result	Number		Percent
	Male	Female	
Excellent	2	0	6
Good	13	10	77
Fair	3	2	17
Poor	0	0	0
Total	18	12	100

DISCUSSION

In our study, the mean age of patients was 36.9 ± 9.4 years (range from 20-60 years). Maximum number of patients was in age group of 31-40. Out of total 30 patients 18(60%) were male and 12 (40%) were female. Most common mechanism of injury was road traffic accident (60%). The right tibia involved was involved in 60% whereas the left tibia in 40%. A total of 12 patients (40%) had associated fibula fracture and 9 of them were treated with open reduction and internal fixation with 1/3rd tubular plate.



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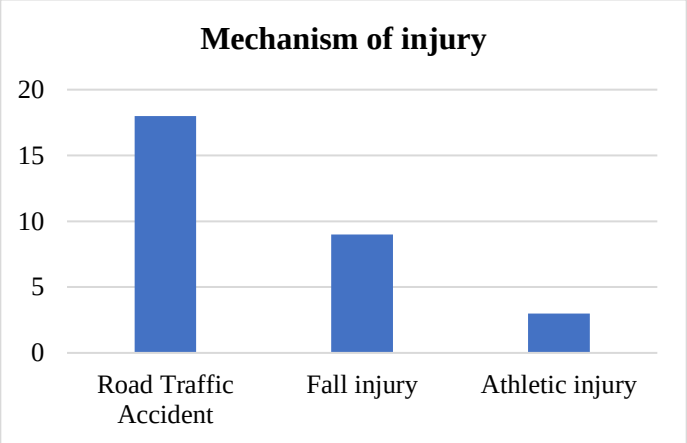

Figure 2: Mechanism of injury

There was no significant difference in functional outcomes between patients with fibular fractures and those with isolated tibial fractures. Out of the total fractures, 4 were open and 26 were closed. Among the open fractures, 3 were classified as

Gustilo and Anderson (GA) Type I, and 1 as GA Type II. The mean duration of the total hospital stay was 12.6 days, with the mean pre-operative and post-operative hospital stays being 6.3 and 6.4 days, respectively. The mean duration of surgery was 57.8±9.97 minutes. Most patients (21) experienced less than 10 ml of blood loss. There were 4 cases of complications: 2 instances of malleolar skin irritation, 1 case of superficial skin infection, and 1 case of hardware pain. No cases of mal-reduction or deep infection were reported.

The mean duration for radiological union of the fracture was 17 weeks, with most fractures (12) healing between 18 and 19 weeks. There were no cases of delayed union or non-union. On average, patients achieved 34.1 degrees of plantar flexion. Of the cases, 93% (28) achieved greater than 30 degrees of plantar flexion, while 2 cases achieved between 10 and 30 degrees. No cases showed less than 10 degrees of plantar flexion or equinus contracture.

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Result	Number		Percentages
	Male	Female	
Excellent	2	0	6
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Fair	3	2	17
Poor	0	0	0
Total	18	12	100

DISCUSSION

The mean age in our study was 36.9 year with standard deviation ± 9.4 which was similar to study conducted by Shukla et al [11] with their associates where their mean age was 36.9 year (range 20-55 years) and 55.4 years (range 38-70 years), for male and female, respectively. This suggests that fractures are more common in working-age group.

The most common mechanism of injury in our study was road traffic accident as in study by Piper et al [12]. The majority of patients in such accident were male (70%), and the mode of injury was motorbike accident (83.3%). Majority of Nepalese drivers are male, and most vehicular accidents are motorbike accidents. In addition, majority of patients who met with road traffic accidents (70%) were seen in patients aged less than 40. Similarly, majority of patients who had fall injury (75%) were aged above 40. women were more frequently (81.8%) involved in household falls than men.

The mean hospital stay was 12.6 days, with a standard deviation ± 3.6. Mean

preoperative stay was 6.3 days with standard deviation ± 2.39. and post-operative was 6.4 days with standard deviation ± 1.9. Mean preoperative stay was similar to results of study conducted by Gupta et al [13]. Surgery was undertaken on next available theater list and delayed if soft tissue status or anesthetic concern dictates. There were 4 cases of open fractures. The mean operative day in such case was 10 days compared to overall preoperative stay of 6.3 days. However, there was no significant difference in post-operative stay as well as post-operative complication in that group.

In our study, the average duration of radiological union was 17 weeks, with the earliest union occurring at 14 weeks and the latest at 23 weeks. This finding was similar to those of Yadav et al [14] and Onta et al [15], who observed radiological union by 16 weeks and 17.175 weeks, respectively. There was no case of delayed union or nonunion in our study, similar to Onta et al [15].

We assessed the functional outcome in our study by Tenny and Weiss criteria where the mean score at final follow up was 85 which were further 86.08 and 84.28 for female and male, respectively. 2 patients had excellent result, 23 had good result and 5 patients had fair result. None of our patients had poor result. However, other studies have shown better functional outcomes compared to ours. Yadav et al [14] evaluated as per clinical scoring by Teeny and Weiss criteria. 8(26.7%) had excellent outcome, 17(56.7%) good Outcome, 3(10%) fair outcome and 2(6.7%) had poor outcome. Ravindra and Paramesh K [16] evaluated 20 cases of which 10(50%) patients had excellent outcome, 4 (20%) had good outcome, 4(20%) had fair outcome and 2 (10%) had poor outcome. Dhakar et al [17] used American Orthopedic Foot and Ankle Society (AOFAS) scores for evaluation of functional outcome which had excellent results were obtained in 33, good in 14 and fair in 3 cases. Sivakumar et al [18] based on Tenny and Weiss scoring criteria for the ankle nineteen patients (90%) had good and excellent results. Though we had no patients with poor outcome, the mean score was increasing in each subsequent follow up. Our results were not as encouraging as those of authors mentioned above. We assume this is due to shorter follow-up time in our study, which is only for 26 weeks, compared to 1 and half year by other authors.

In our study on 4 cases landed in complications which was 2 cases of malleolar skin irritation, 1 of each case of superficial skin infection and hardware prominence which was relatively better compare to other studies. Kundu et al [8] had superficial wound infections were seen in 2 cases, surgical wound breakdown with implant exposure in 1 case and prominent hardware in 1 case. In Asif et al [19] study, there were 2 cases of superficial infection, treated successfully with antibiotics. No deep infection, wound dehiscence and hardware failure was noted. Dhakar et al [17] found postoperatively, 2 patients developed superficial skin infection, 2 patients developed deep infection and 3 patients developed ankle stiffness due to loss of postoperative protocol and 4 patients had implant failure in form of screw breakage.

The study was conducted at a single center, potentially limiting the applicability of the results to other settings with different patient demographics or surgical expertise. Additionally, the small sample size and the lack of a randomized controlled trial are notable limitations.

CONCLUSION

MIPPO offers a reliable and reproducible technique in the treatment of distal tibia fracture with intraarticular extensions. This technique avoids significant complications encountered with more commonly used technique of internal fixation and external fixation in such injuries. Our observation reinforced the finding of different authors that the procedure is associated with good functional outcome. The complications like infections, malreduction, angular deformity are

less frequent when the distal tibia fracture are treated with LCP.

Author contributions: BG, PDK, DD and SP conceptualized and designed the research and reviewed the literature; BG, PDK, KJS and TSK did data collection, analysis and prepare result, BG, PDK, RT and SBL drafted the manuscript; and all authors reviewed the manuscript and approved the final version of the manuscript. All authors agreed to be accountable for all aspects of the research work. Note: BG, PDK, RT, SBL, KJS, TSK, DD and SP are abbreviated names of the authors.

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Ethical approval: This research was approved by Institutional Review Board of National Academy of Medical Sciences with the reference number of 650/2077/78 on 20 December 2020.

Consent and/or assent: Written informed consent was obtained from all the participants.
Name of Registry and Registration number: Not applicable
Data availability: The data that support the findings of this study are available from the corresponding author upon reasonable request.
Conflicts of interest: The authors declare that there is no competing interest.
Source of funding: The authors received no external fund for this research

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