

ORIGINAL ARTICLE

Functional Outcome of Distal Third Tibia Fractures Treated with Minimally Invasive Plate OsteosynthesisMUHAMMAD NADEEM KASHMIRI¹, RAJA ADNAN ASHRAF², MUHAMMAD SHEHRYAR ZIA³, ASIF KHAN⁴¹Associate Professor Orthopaedics, Watim Medical College Rawat, Rawalpindi²Assistant Professor Orthopaedics, Pakistan Railway General Hospital, Rawalpindi³Fellow, Hip & Knee Arthroplasty, Department Of Orthopaedics, Combined Military Hospital, Rawalpindi⁴Assistant Professor, Department of Orthopaedics, Avicenna Medical College and Hospital, LahoreCorresponding author: Raja Adnan Ashraf, Email: dr.add179@yahoo.com**ABSTRACT****Background:** As the highest number of complications are associated with the distal tibia fracture it is one of the most challenging condition to treat. Minimally invasive plate osteosynthesis techniques are more feasible. As the disappointing results were obtained from the traditional techniques therefore this method was gradually evolved.**Study design:** It is a prospective study conducted in Pakistan Railway General Hospital, Rawalpindi for the duration of one year from January 2022 to December 2022.**Material and Methods:** The study comprised of 49 patients who fulfilled the inclusion criteria. Among 49 patients there were 23 males and 26 female patients. The patients that were not fulfilling the inclusion criteria were excluded from the study.**Results:** 40% of the patients had problem in the right leg and 60% had it in their left side. There were 24 patients that reported about fibula plating the remaining 52% had no fibula plating experienced. The mean time of surgery was 7 days ranging from 3 to 8 days. Based on the classification of fracture, 72% patients were included in the 43A category and 43B included 28% patients.**Conclusion:** For distal tibia fractures, minimally invasive plate osteosynthesis has better radiological and functional outcomes and is quite better than other treatment methods. The invasive method can cure these fractures with fewer complications and in a short union time.**Keywords:** distal tibia fractures and soft tissue.**INTRODUCTION**

Distal tibial fracture is also called plafond fracture or pilon fractures. This is mostly occur in the weight bearing distal tibia region. The tibial fracture is 5-10% of these fractures. Distal third tibia fracture is common in those bones which are subcutaneous with depleted muscular cover.¹⁻³ Distal tibia fractures are mainly as the consequences of collaborate shear and compacting forces. It may occur as the result of metaphysis instability, and soft bone injury. These fractures are complicate to treat because the poor vascularity, lack of muscle cover and complexity of injury. These fractures are also increases due to higher rate of accidents. There are many treatments for distal tibia fracture which include IM nailing, ORIF, external fixing and minimally-invasive plate osteosynthesis (MIPO)⁴⁻⁵. The one of the common and most useful method is minimally-invasive plate osteosynthesis. This technique enable stable fixation and indirect reduction with minimum biological footprints. External fixation of distal tibia fracture is linked with high incidence of problems. MIPO successfully treat distal femoral fractures. MIPO is used to accomplish the correct limb length, alignment without disturbing facture hematoma. Formation of callus from fracture hematoma and periosteum helps in the occurrence of healing. Non-surgical treatment is available for closed fractures. As the highest number of complications are associated with the distal tibia fracture it is one of the most challenging condition to treat. This techniques is more feasible. As the disappointing results were obtained from the traditional techniques therefore this method was gradually evolved⁶⁻⁸. In this technique the associated fibular fracture are fixed by internal fixation and conventional open reduction technique. Later on the external fixation of tibia is done temporarily. It is followed by the limited reduction of displaced articular fragments. On the day of admission of the patient the triangular external fixator placement is done.⁹ For the soft tissue traction the external fixation is proved to be very advantageous and feasible. But the different complications are also associated with the external fixation such as pin tract infection and non-union. Though few studied have reported that intramedullary nailing is an effective method but still few studies have raised the concern about the regular use of intramedullary nailing. The other traditionally used method for the reduction of articular fragments is ORIF. But it is considered as ineffective because of the soft tissue stripping and higher number of

complications are associated with the ORIF technique.¹⁰ Therefore the alternative technique are the stable fixation and indirect reduction of distal tibia fracture is MIPO. The study aimed to determine the outcome associated with MIPO in treatment of distal tibia fracture.

MATERIAL AND METHODS

The study comprised of 49 patients who fulfilled the inclusion criteria. Among 49 patients there were 23 males and 26 female patients. The patients that were not fulfilling the inclusion criteria were excluded from the study. According to the inclusion criteria following patients who were treated at the tertiary care hospital were selected for the study;

- The patient must be of age greater than 18 years
- The patient who signed the consent willingly
- The patient with the extra articular distal tibia fracture

According to the exclusion criteria following patients who were treated at the tertiary care hospital were excluded from the study;

- The patients with the intraarticular fragments
- The patients who had open fracture
- The patients with the pathological fracture.

All patients underwent the surgery. The American orthopaedics foot and ankle score was used to determine the functional outcomes. The data was collected and statistical analysis was performed by using the renowned software SPSS.

RESULTS

The average age of patients was 44.5± 12.2 as shown in table no.1. There were 23 males and 26 females in our study. 40% of the patients had problem in the right leg and 60% had it in their left side. There were 24 patients that reported about fibula plating the remaining 52% had no fibula plating experienced. The mean time of surgery was 7 days ranging from 3 to 8 days. Based on the classification of fracture, 72% patients were included in the 43A category and 43B included 28% patients.

Table 2 shows type of injury or mechanism of injury, there were 40% cases where the patients had fall injury, followed by twisting injury and RTA in case of 28% and 24% patients respectively. 4% patients suffered from direct and sports injury as per data.

Table 1: Demographic features and clinical parameters of patients

Factors	No. of patients n=49
Average age (years)	44.5± 12.2
Male/female	23/26
Side	
Right	20 (40%)
Left	29 (60%)
Fibula plating	
Yes	24 (48%)
No	25 (52%)
Mean time of surgery (days)	7.31 (3-8)
Classification of fracture	
43A	36 (72%)
43B	14 (28%)

Table 2: Type of injury

Type of injury	No. of patients n=49
Fall injury	19 (40%)
Twisting injury	14 (28%)
RTA	12 (24%)
Direct injury	2 (4%)
Sports injury	2 (4%)
Total	49

A clinical assessment of the ankle was also carried out by criteria of Merchant and Dietz after a complete follow-up of one year.



Figure 1: case example

Distal and proximal screw insertion and X-ray images: It gives 40 points to function of ankle, 10 for the gait 40 for the pain and 10

for the range of activity or motion it produce. If score comes between 85-100 that means results are excellent, 84-70 shows good results and 60-69 represents fair results. Score under 60 shows poor results. Most of the results fall under good results category in our study as per table no.3.

Table 3: Assessment of ankle based on the criteria of Merchant and Dietz

Alignment	MIPO	
	No. of cases	% of Patients
Excellent	-	-
Good	30	60%
Fair	6	12%
Poor	-	-

Functional outcome was made as per Johner and Wruhs criteria. And most of the patients (77%) fall under good results category.

Table 4: Functional outcome based on the criteria of Johner and Wruhs

Results	MIPO	
	No. of cases	% of patients
Excellent	-	-
Good	24	77%
Fair	8	22%
Poor	-	-

DISCUSSION

The treatment method for the tibia is quite challenging because of the soft tissues surrounding it and high-energy trauma. For the treatment of fractures in the distal tibia, a number of treatment methods are employed i.e. intramedullary nailing, open plating, and MIPO. Among all these treatment methods MIPO is of particular importance because it does not cause any complications in soft tissues and maintains hematoma for the healing process. The literature survey does not provide any evidence for this hypothesis of superiority. In this work evaluation of the treatment of fractures by invasive plates was done¹¹⁻¹².

A survey of 49 patients including 23 males and 26 females was analyzed and among them, 48% of patients had fibula plating while the rest ones have no surgery. Most of the patients included in this study had a fracture due to fall injuries and RTA (roadside accidents). The 40% of patients included in this study had issues in the right leg and 60 % of patients had issues in the left leg. Two types of fracture classifications were studied i.e. 43A and 43B. The surgery time was from 3 to 8 days while the average union time for the fracture was 22 weeks and this time period is quite close to the time period mentioned in the literature which is 16 to 24 weeks. The much longer time for the union of bone is not clearly understood because the study does not tell about the length of plates and the density of joining screws. The length of plates and joining screws are the critical parameters for the healing time period of fractures¹³⁻¹⁵.

If the injury of the distal tibia occurs in the subcutaneous region, then it leads to the blood supply in this region, and soft tissues are highly vulnerable after injury and surgery. Usually, endosteal and periosteal are involved in the blood supply in the tibia zone. Whenever an injury or fracture takes place then the supply of blood by the endosteal system is disrupted, only the periosteal system is involved in the blood supply. At this time the tibia region suffers from an insufficient supply of nutrients and other essential ions, this may be the best possible reason for the delayed union of bone after a fracture. However, the invasive technique of fixation has an advantage over the classic plating method, as it avoids the unnecessary issues of the long time period for healing and tissue disruption. The literature survey has the comparison of the MIPO method with other methods of bone fixation. When the comparison of plating and MIPO was done, it was observed that this method is more suitable for a number of skin issues, surgery time, union time, and proper alignment¹⁶. Minimal invasive risks are by intramedullary interlocking nailing but there are some issues with regard to stabilization in the fixation of

the medullary canal of the tibia and there are high risks of its disunion. However, some studies of such fractures show a comparison in function and radiological results of nailing, invasive plating, and other open surgeries. Usually, disunion and excessive pain in the knee region is observed in the case of nailing. The nailing treatment is only suitable for the fractures in the proximal region but beyond this line, this nailing method is more complicated¹⁷⁻¹⁹. The function of the ankle was assessed by the criteria of Merchant and Dietz. According to these criteria, 60% of the patients included in this study show good results, and 12% showed fair results after their fractured tibia treatment. The mean ankle score was good by this criteria. After it, functional results were also predicted by the criteria of Jhoner and Wruhs. Most patients give good results, and 22% fall under the fair result category for functional outcomes²⁰.

The MIPO method is useful in the case of vascular injection, it preserves blood supply to the fractured bone as compared to plating, which causes much more disruption of surrounding tissues, and blood supply and ultimately leads to a slow healing process and disunion. This study also shows some limitations such as a small sample size and a single study arm. With a broad population size, the conclusion would be more elaborated²¹⁻²².

CONCLUSION

For distal tibia fractures, minimally invasive plate osteosynthesis has better radiological and functional outcomes and is quite better than other treatment methods. As this invasive plate method reduces the initiation of damage to soft tissues associated with the fracture site. The invasive method can cure these fractures with fewer complications and in a short union time. However, this study was done on small population size, so there is a need for a more elaborated study for further analysis of the efficiency of invasive plating.

REFERENCES

1. Jose RS, Vivek K, Bava NK, Moosa MS. Functional outcome of intramedullary interlocking nailing versus minimally invasive percutaneous plate osteosynthesis in distal tibia fracture. *Journal of Orthopaedic Diseases and Traumatology*. 2023 Jan 1;6(1):66.
2. Papadakis SA, Pallis D, Tsivelekas K, Ampadiotaki MM, Segos D. Screw Fixation as the Primary and Definitive Treatment of an Isolated Uncommon Fracture of the Anterior Margin of the Distal Tibia. *Cureus*. 2023 Jan 6;15(1).
3. Kalyanpur V, Kumar NV, Yadav PA. Functional outcome of tibial pilon fractures treated with minimally invasive plate osteosynthesis in adults. *International Journal of Orthopaedics*. 2022;8(3):322-5.
4. Bandaru H, Shanthappa AH. Plating for Intra-articular Fractures of the Distal Femur: Functional and Radiological Outcomes. *Cureus*. 2023 Jan 1;15(1).
5. Stake IK, Ræder BW, Gregersen MG, Molund M, Wang J, Madsen JE, Husebye EE. Higher complication rate after nail compared with plate fixation of ankle fractures in patients aged 60 years or older: a prospective, randomized controlled trial. *The Bone & Joint Journal*. 2023 Jan 1;105(1):72-81.
6. Zachariou Z, Fischerauer EE, Weinberg AM. Pediatric Orthopedic Trauma. In *Pediatric Surgery 2023* (pp. 273-294). Springer, Cham.
7. Manandhar R. Functional outcome of fractures of the distal third tibia treated with minimally invasive plate osteosynthesis. *Nepal Orthopaedic Association Journal*. 2021;7(2).
8. Sivanandan MH, Jose L, Manoharan AE. Functional outcomes of distal tibia fractures treated using the minimally invasive percutaneous plate osteosynthesis technique with a locking compression plate.
9. Jitprapaikulsum S, Chantarapanich N, Gromprasit A, Mahaisavariya C, Sukha K, Chiawchan S. Dual plating for fixation failure of the distal femur: Finite element analysis and a clinical series. *Medical Engineering & Physics*. 2023 Jan 1;111:103926.
10. Kc, K.M., Pangen, B.R., Marahatta, S.B., Sigdel, A. and Amuda, K.C., 2022. Comparative study between intramedullary interlocking nailing and minimally invasive percutaneous plate osteosynthesis for distal tibia extra-articular fractures. *Chinese Journal of Traumatology*, 25(2), pp.90-94.
11. Dhakar A, Annappa R, Gupta M, Harshwardhan H, Kotian P, Suresh PK. Minimally invasive plate osteosynthesis with locking plates for distal tibia fractures. *Journal of clinical and diagnostic research: JCDR*. 2016 Mar;10(3):RC01.
12. Shrestha D, Acharya BM, Shrestha PM. Minimally invasive plate osteosynthesis with locking compression plate for distal diaphyseal tibia fracture. *Kathmandu University Medical Journal*. 2011;9(2):62-8.
13. Toogood P, Huang A, Siebuhr K, Miclau T. Minimally invasive plate osteosynthesis versus conventional open insertion techniques for osteosynthesis. *Injury*. 2018 Jun 1;49:S19-23.
14. Wei XM, Sun ZZ, Rui YJ, Song XJ. Minimally invasive plate osteosynthesis for distal radius fractures. *Indian Journal of orthopaedics*. 2014 Feb;48(1):20-4.
15. Kim JW, Kim HU, Oh CW, Kim JW, Park KC. A Prospective Randomized Study on Operative Treatment for Simple Distal Tibial Fractures—Minimally Invasive Plate Osteosynthesis Versus Minimal Open Reduction and Internal Fixation. *Journal of Orthopaedic Trauma*. 2018 Jan 1;32(1):e19-24.
16. Hasenboehler E, Rikli D, Babst R. Locking compression plate with minimally invasive plate osteosynthesis in diaphyseal and distal tibial fracture: a retrospective study of 32 patients. *Injury*. 2007 Mar 1;38(3):365-70.
17. Kim JW, Oh CW, Jung WJ, Kim JS. Minimally invasive plate osteosynthesis for open fractures of the proximal tibia. *Clinics in orthopedic surgery*. 2012 Dec 1;4(4):313-20.
18. Kang H, Rho JY, Song JK, Choi J, suk Kwon Y, Choi S. Comparison between intramedullary nailing and minimally invasive plate osteosynthesis for tibial shaft fractures. *Injury*. 2021 Apr 1;52(4):1011-6.
19. Kariya A, Jain P, Patond K, Mundra A. Outcome and complications of distal tibia fractures treated with intramedullary nails versus minimally invasive plate osteosynthesis and the role of fibula fixation. *European Journal of Orthopaedic Surgery & Traumatology*. 2020 Dec;30(8):1487-98.
20. Anuar-Ramdhan IM, Azahari IM. Minimally invasive plate osteosynthesis with conventional compression plate for diaphyseal tibia fracture. *Malaysian orthopaedic journal*. 2014 Nov;8(3):33.
21. Baroncelli AB, Peirone B, Winter MD, Reese DJ, Pozzi A. Retrospective comparison between minimally invasive plate osteosynthesis and open plating for tibial fractures in dogs. *Veterinary and Comparative Orthopaedics and Traumatology*. 2012;25(05):410-7.
22. Natarajan GB, Srinivasan DK, Vijayaraghavan PV. Comparison of clinical, radiological, and functional outcome of closed fracture of distal third tibia treated with nailing and plate osteosynthesis. *African Journal of Trauma*. 2014 Jul 1;3(2):68.