

COMPARISON OF FUNCTIONAL OUTCOMES BETWEEN OPEN REDUCTION AND INTERNAL FIXATION (ORIF) VERSUS MINIMALLY INVASIVE PERCUTANEOUS PLATE OSTEOSYNTHESIS (MIPPO) IN DISTAL TIBIAL FRACTURES

Samra Farooq¹, Robia Khanum^{*2}, Attiqah Khan³, Shaban Shafique⁴, Muhammad Abuzar⁵, Shoaib Ishtiaq⁶

¹MBBS, Demonstrator in Pathology Mohhi Ud Din Medical College

^{*2}MBBS, House Officer Divisional Headquarters Teaching Hospital Mirpur AJK

³MBBS, House Officer, CMH Rawalakot AJK

⁴MBBS, Medical Officer Al-Maida Hospital Tatta Pani District Kotli AJK

⁵MBBS From Shaikh Zayed Medical College Lahore

⁶MBBS, Civil Medical Officer THQ Chakswari, Mirpur AK

^{*2}robiakhanum2@gmail.com

DOI: <https://doi.org/10.5281/zenodo.15560836>

Keywords

Distal tibial fractures, ORIF, MIPPO, Functional outcomes, Fracture healing, Pain relief, Complications.

Article History

Received on 22 April 2025

Accepted on 22 May 2025

Published on 31 May 2025

Copyright @Author

Corresponding Author: *

Robia Khanum

Abstract

Background: Distal tibial fractures are a common and challenging injury, often resulting from high-energy trauma or falls. They require effective treatment to restore function, prevent complications, and ensure long-term recovery.

Objective: The objective of this study was to evaluate and compare the functional outcomes, including fracture healing, pain relief, complications, and recovery, of ORIF and MIPPO in patients with distal tibial fractures.

Study Design and Setting: A prospective comparative study was conducted at DHQ Teaching Hospital Mirpur AJK.

Methodology: The study involved 140 patients with distal tibial fractures, divided into two groups: 70 patients underwent ORIF, and 70 patients received MIPPO. Patients were randomly assigned to either the ORIF or MIPPO group. The fracture healing was assessed radiologically, and functional outcomes were evaluated using the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle Hindfoot Score and Visual Analog Scale (VAS) for pain at 3, 6, and 12 months post-surgery. Complications such as infection, nonunion, malunion, and hardware-related issues were recorded.

Results: The ORIF group showed a higher healing rate (93%) compared to MIPPO (86%). The ORIF group had better functional outcomes, with a higher AOFAS score, and showed greater pain relief at 12 months. The complication rate was also lower in the ORIF group (14%) compared to MIPPO (19%).

Conclusion: ORIF demonstrated superior healing and functional outcomes compared to MIPPO in treating distal tibial fractures, though MIPPO remains a viable option with fewer surgical complications.

INTRODUCTION

Distal tibial fractures, which occur at the lower end of the tibia near the ankle, are common injuries, particularly in trauma cases.¹ These fractures often result from high-energy impacts, such as motor vehicle accidents, or low-energy impacts in elderly patients with osteoporotic bones.^{2,3} Distal tibial fractures present unique challenges in treatment due to the complex anatomy of the region, the risk of complications, and the functional demands of the area. Proper management of these fractures is crucial to restore optimal function, minimize complications, and ensure the patient's quality of life.⁴ The two most widely used surgical techniques for the fixation of distal tibial fractures are Open Reduction and Internal Fixation (ORIF) and Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO).⁵

Open Reduction and Internal Fixation (ORIF) has long been the gold standard in managing displaced distal tibial fractures. The technique involves a surgical approach that allows for direct visualization of the fracture site, which facilitates accurate reduction and stable internal fixation using screws, plates, or rods.⁶ ORIF offers excellent control over the fracture alignment and is commonly employed for fractures with significant displacement, comminution, or those requiring precise realignment. However, ORIF carries inherent risks, such as soft tissue damage, infection, and delayed wound healing, particularly in the distal tibia due to the region's limited soft tissue coverage and blood supply.^{7,8}

In recent years, Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) has emerged as a less invasive alternative. MIPPO involves the insertion of a plate through small percutaneous incisions, minimizing disruption to the surrounding soft tissues. The technique aims to achieve stable fixation while preserving the periosteal blood supply, which is crucial for fracture healing. MIPPO has shown promise in reducing complications such as wound infection, non-union, and malunion.^{8,9} Additionally, MIPPO tends to result in less post-operative pain, shorter hospital stays, and quicker recovery times compared to traditional open techniques. However, the technique requires a high level of surgical skill and is often preferred for fractures that are less comminuted or not severely displaced.^{9,10,11}

The choice between ORIF and MIPPO in treating distal tibial fractures is still a matter of considerable debate among orthopedic surgeons. Both techniques aim to restore function and prevent complications, but they offer different trade-offs in terms of surgical invasiveness, healing times, and risk of complications. This comparison of functional outcomes between ORIF and MIPPO seeks to evaluate the efficacy, safety, and long-term results of each approach, considering factors such as fracture healing time, incidence of complications, post-operative pain, functional recovery, and patient satisfaction. By analyzing these factors, this study aims to provide evidence that can guide clinical decision-making and improve patient outcomes in the management of distal tibial fractures.

MATERIALS AND METHODS

A prospective comparative study was conducted at DHQ Teaching Hospital Mirpur AJK from November 2023 to April 2025. A total of 140 patients with distal tibial fractures were included in the study, with 70 patients in the ORIF group and 70 patients in the MIPPO group. The inclusion criteria for the study were adult patients aged 18-65 years, diagnosed with distal tibial fractures, and willing to provide informed consent. Exclusion criteria included patients with fractures of the proximal tibia, fractures with extensive soft tissue injury, open fractures, or fractures associated with significant neurovascular injury. Additionally, patients with a history of metabolic bone disease or those who had prior surgeries in the affected limb were excluded from the study.

The sample size of 140 patients was calculated based on an anticipated effect size of 0.5 for functional outcomes between the two groups. A significance level of 0.05 and a power of 80% were used to determine the required sample size. The power analysis indicated that a total of 140 patients (70 per group) would provide sufficient power to detect a significant difference between the two treatment modalities.

All patients underwent surgery within 48 hours of admission. In the ORIF group, the fractures were exposed through a standard open incision, the fractures were reduced, and internal fixation was

achieved using a plate and screws. In the MIPPO group, a minimally invasive approach was used, with the plate being inserted through small percutaneous incisions, and the fracture was reduced indirectly. Both groups received similar post-operative care, including intravenous antibiotics for 24 hours, followed by oral antibiotics, and early mobilization with weight-bearing as tolerated, typically starting at 6 weeks post-operatively.

Functional outcomes were assessed at 3, 6, and 12 months post-operatively using the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle Hindfoot Score and the Visual Analog Scale (VAS) for pain. Fracture healing was evaluated radiologically at each follow-up visit, and complications, including infection, malunion, nonunion, and hardware-related issues, were recorded. Statistical analysis was performed using SPSS software, with comparisons made between the two groups using the t-test for continuous variables and the chi-square test for categorical variables. A p-value of less than 0.05 was considered statistically significant. Ethical approval was obtained from the institutional review board, and informed consent was acquired from all participants prior to inclusion in the study.

STUDY RESULTS

Table 1 presents the demographic details of the patients in both treatment groups. There were 70 patients in each group, with a mean age of 42.3 ± 6.5 years in the ORIF (surgical) group and 41.5 ± 7.1 years in the MIPPO (minimally invasive) group. The male to female ratio was similar in both groups, with 57% males and 43% females in the ORIF group, and 54% males and 46% females in the MIPPO group.

Table 2 shows the fracture healing rate at 12 months. The ORIF group had a higher healing rate, with

93% of patients achieving fracture union, compared to 86% in the MIPPO group. 7% of ORIF patients and 14% of MIPPO patients did not heal within the 12-month period.

Table 3 presents the functional outcomes as measured by the AOFAS Ankle Hindfoot Score at 12 months. The ORIF group had a higher mean score of 92.3 ± 4.1 , with 64% of patients achieving excellent outcomes and 29% showing good results. In contrast, the MIPPO group had a mean score of 88.1 ± 5.2 , with 54% achieving excellent outcomes and 31% showing good results. This indicates that the ORIF group had better functional recovery compared to the MIPPO group.

Table 4 compares pain relief between the two groups at 1, 6, and 12 months using the Visual Analog Scale (VAS). The ORIF group experienced a greater reduction in pain, with a mean VAS score of 1.1 ± 0.5 at 12 months, compared to 1.6 ± 0.8 in the MIPPO group. Both groups had significant pain reduction, but the ORIF group showed more substantial improvement.

Table 5 details the complications and side effects observed in both groups. The ORIF group had 6% incidence of infection, 3% of malunion, and 1% of nonunion, with 4% experiencing hardware-related issues. In contrast, the MIPPO group had 3% incidence of infection, 4% of malunion, 3% of nonunion, and 6% experiencing hardware-related issues. The ORIF group had a higher proportion of patients without complications (86%) compared to the MIPPO group (81%). These results suggest that while both ORIF and MIPPO were effective in treating distal tibial fractures, ORIF was associated with better functional outcomes, higher healing rates, and fewer complications. However, MIPPO was still a viable option with less surgical trauma and similar outcomes in some areas, such as pain reduction.

Table 1: Demographic Characteristics of Patients in ORIF and MIPPO Groups

Variable	ORIF Group (n = 70)	MIPPO Group (n = 70)
Mean Age (years)	42.3 ± 6.5	41.5 ± 7.1
Male	40 (57%)	38 (54%)
Female	30 (43%)	32 (46%)

Table 2: Fracture Healing Rates at 12 Months

Outcome	ORIF Group (n = 70)	MIPPO Group (n = 70)
Fracture Healed	65 (93%)	60 (86%)
Not Healed	5 (7%)	10 (14%)

Table 3: AOFAS Ankle-Hindfoot Score at 12 Months

Outcome Category	ORIF Group (n = 70)	MIPPO Group (n = 70)
Mean Score	92.3 ± 4.1	88.1 ± 5.2
Excellent Outcome	45 (64%)	38 (54%)
Good Outcome	20 (29%)	22 (31%)
Fair/Poor Outcome	5 (7%)	10 (15%)

Table 4: Pain Assessment (VAS Score) at Different Intervals

Time Point	ORIF Group (Mean ± SD)	MIPPO Group (Mean ± SD)
1 Month	4.8 ± 1.2	5.1 ± 1.4
6 Months	2.3 ± 0.9	2.7 ± 1.0
12 Months	1.1 ± 0.5	1.6 ± 0.8

Table 5: Complications in ORIF and MIPPO Groups

Complication Type	ORIF Group (n = 70)	MIPPO Group (n = 70)
Infection	4 (6%)	2 (3%)
Malunion	2 (3%)	3 (4%)
Nonunion	1 (1%)	2 (3%)
Hardware Issues	3 (4%)	4 (6%)
No Complications	60 (86%)	57 (81%)

DISCUSSION

Distal tibial fractures, often resulting from high-energy trauma or low-energy falls, are a common yet complex injury requiring precise treatment for optimal recovery.^{12,13} The two primary surgical techniques for managing these fractures are Open Reduction and Internal Fixation (ORIF) and Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO). While ORIF has been the traditional method for treating displaced fractures, MIPPO has gained popularity due to its minimally invasive approach.^{14,15} This study compares the functional outcomes of these two methods in terms of healing, pain relief, complications, and recovery times, aiming to determine the most effective treatment for distal tibial fractures.

In this study, we compared the functional outcomes of Open Reduction and Internal Fixation (ORIF) and Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) in patients with distal tibial fractures. Our findings regarding fracture healing,

functional outcomes, and complications align with and expand upon results from previous studies.

Ullah et al. (2024) reported a fracture healing rate of 92.1% in the MIPPO group at a follow-up of 9±5.3 months.¹⁶ Similarly, our MIPPO group showed an 86% healing rate, although slightly lower than that in Ullah's study.¹⁶ This difference may be attributed to variations in fracture types, sample sizes, or follow-up periods. Our study also observed functional outcomes using the AOFAS Ankle Hindfoot Score, where the ORIF group had superior scores (92.3 ± 4.1) compared to the MIPPO group (88.1 ± 5.2), which is consistent with the findings of Farhat et al. (2013), where 42.3% of ORIF patients achieved excellent outcomes compared to 67.3% in the Ilizarov group. While Farhat et al. used a different fixation technique (Ilizarov), the general trend shows that more invasive methods tend to result in better functional outcomes, possibly due to more precise fracture alignment.¹⁹

Khan et al. (2022) found no significant difference in fracture union duration between the MIPPO and IMIL groups, but noted that the MIPPO group had less hospital stay duration (6.82 ± 1.27 days vs. 6.40 ± 1.19 days). In our study, we found that the hospital stay was comparable between the ORIF and MIPPO groups, but MIPPO did offer reduced surgical trauma. This finding aligns with the benefits of minimally invasive techniques, which typically result in quicker recovery and fewer complications.¹⁷

Inam et al. (2023) reported a complication rate of 16.7% in their cohort, with 83.3% of patients having no complications. In our study, complications were recorded in both groups, but the ORIF group had fewer complications (14%) compared to the MIPPO group (19%). This suggests that while MIPPO offers advantages such as reduced soft tissue damage, it may still be associated with a slightly higher risk of complications, which has been observed in other studies as well.^{18,20}

Overall, the results from our study support the notion that ORIF tends to offer superior healing rates and functional outcomes compared to MIPPO. However, MIPPO remains a viable option, especially for patients requiring less invasive procedures and quicker recovery. Future studies with longer follow-up and larger sample sizes are necessary to validate these findings and better understand the long-term outcomes and complications associated with both techniques.

The strength of this study lies in its large sample size of 140 patients, ensuring robust and reliable results. Random assignment of patients to ORIF and MIPPO groups reduces selection bias and enhances the study's validity. However, the study's limitation is the relatively short follow-up period of 12 months, which may not capture long-term outcomes such as late complications or recurrence. Additionally, the study does not account for variations in fracture patterns, which could influence the treatment effectiveness. Finally, the results may be affected by surgeon experience and technique, which were not standardized across all participants.

CONCLUSION

Both ORIF and MIPPO showed effectiveness in treating distal tibial fractures, with ORIF achieving higher healing rates and better functional outcomes.

MIPPO, however, offered the advantage of a less invasive approach with comparable pain relief and recovery times. Further studies with extended follow-up periods are needed to assess long-term outcomes and complications.

REFERENCES

- Ekman E, Lehtimäki K, Syvänen J, Saltychev M. Comparison between nailing and plating in the treatment of distal tibial fractures: a meta-analysis. *Scandinavian Journal of Surgery*. 2021 Jun;110(2):115-22.
- Hu L, Xiong Y, Mi B, Panayi AC, Zhou W, Liu Y, Liu J, Xue H, Yan C, Abududilibaier A, Chen L. Comparison of intramedullary nailing and plate fixation in distal tibial fractures with metaphyseal damage: a meta-analysis of randomized controlled trials. *Journal of orthopaedic surgery and research*. 2019 Dec;14:1-1.
- Jalkanen J, Sinikumpu JJ, Puhakka J, Laaksonen T, Nietosvaara Y, Kosola J, Stenroos A. Physeal fractures of distal tibia: a systematic review and meta-analysis. *Journal of Pediatric Orthopaedics*. 2021 Aug 1;41(7):e506-11.
- Rammelt S, Bartoniček J, Schepers T, Kroker L. Fixation of anterolateral distal tibial fractures: the anterior malleolus. *Operative Orthopädie Und Traumatologie*. 2021 Mar 22;33(2):125-38.
- Elnewishy A, Elkholy M, Hamada A, Salem M, Salem Jr M. Comparing minimally invasive percutaneous plate osteosynthesis with interlocking intramedullary nail fixation for the management of adult extra-articular distal tibial fractures: a comprehensive systematic review and meta-analysis. *Cureus*. 2023 Nov 21;15(11).
- Giannoudis VP, Ewins E, Taylor DM, Foster P, Harwood P. Clinical and functional outcomes in patients with distal tibial fracture treated by circular external fixation: a retrospective cohort study. *Strategies in Trauma and Limb Reconstruction*. 2021 May;16(2):86.

- Messori M, Touloupakis G, Gilli A, Theodorakis E, Pozzi P, Ghirardelli S, Antonini G. The risk of infection in open distal tibial fracture: the DANGER score. *European Journal of Orthopaedic Surgery & Traumatology*. 2023 Oct;33(7):2965-70.
- Naude JJ, Manjra MA, Birkholtz F, Barnard AC, Tetsworth K, Glatt V, Hohmann E. Functional outcomes and quality of life following complex tibial fractures treated with circular external fixation: a comparison between proximal, midshaft, and distal tibial fractures. *Strategies in trauma and limb reconstruction*. 2021 Jan;16(1):32.
- Chaudhry YP, Gutierrez-Naranjo JM, Raad M, Ghanem D, Salazar LM, Goodrum JT, Luksameearunothai K, Zelle BA, Hasenboehler EA. Risk factors for malalignment after intramedullary nail treatment of distal tibia fractures with associated fibula fractures. *European Journal of Orthopaedic Surgery & Traumatology*. 2024 Aug;34(6):3265-73.
- Gao F, Wang XH, Xia SL, Zhou XX, Wang MH, Fu BG, Yi CG, Guo SY. Intramedullary nail fixation by suprapatellar and infrapatellar approaches for treatment of distal tibial fractures. *Orthopaedic Surgery*. 2022 Sep;14(9):2350-60.
- Hague M, Teixeira D, Anderson T, Williamson M, Trompeter A. Nailing distal tibial fractures: does entry technique affect distal alignment?. *European Journal of Orthopaedic Surgery & Traumatology*. 2023 Jan:1-6.
- Greenfield J, Appelman P, Wunderlich F, Mehler D, Rommens PM, Kuhn S. Retrograde tibial nailing of far distal tibia fractures: a biomechanical evaluation of double-versus triple-distal interlocking. *European Journal of Trauma and Emergency Surgery*. 2022 Oct 1:1-8.
- Liu H, Lin W, Xu W, Xiong Y, Zhang J, Wu J. Comparison of retrograde and antegrade tibial intramedullary nail in the treatment of extra-articular distal tibial fractures. *International Orthopaedics*. 2025 Jan;49(1):219-27.
- Hu Y, Lian Q, Cao F, Hou X, Li H, Xing L, Wang M, Tian F, Zhang L. Estrogen deficiency impedes fracture healing despite eliminating the excessive absorption of the posterior callus in a semi-fixed distal tibial fracture mouse model. *BMC Musculoskeletal Disorders*. 2023 Oct 10;24(1):803.
- Bleeker NJ, van Veelen NM, van de Wall BJ, Sierevelt IN, Link BC, Babst R, Knobe M, Beeres FJ. MIPO vs. intra-medullary nailing for extra-articular distal tibia fractures and the efficacy of intra-operative alignment control: a retrospective cohort of 135 patients. *European Journal of Trauma and Emergency Surgery*. 2022 Oct;48(5):3683-91.
- Ullah N, Mian AA, Bukhari SI, Shah FA. Radiological and functional outcome of minimally invasive plate osteosynthesis (MIPO) in closed fractures of tibia. *Gomal Journal of Medical Sciences*. 2024 Oct 22;22(3):208-12.
- Khan Ar, Soomro Zi, Palh Hb, Solangi Na, Bhatti Sh, Chandio Ms, Keerio NH. Comparison of Plating Versus Intramedullary Nailing for the Treatment of Distal Tibial Metaphyseal Fractures: A Longitudinal Study. *Pak J Med Health Sci*. 2022;16(1):1363-67.
- Inam M, Asadullah M, Dawood S, Rahman WU. Minimal Invasive Plate Osteosynthesis for Distal Tibia Fractures. *National Journal of Health Sciences*, 2023, 8, 158-161.
- Farhat MF, Nazim ZK, Osama M, Ahmad H, Razzaq B, Khan M. A Comparison of Functional Outcome of Open Reduction Internal Fixation Versus Ilizarov External Fixation in Complex Proximal Tibial Fractures: Randomized Controlled Trial. *Journal of Islamabad Medical & Dental College*. 2023;12(4):262-9.
- Kashmiri MN, Ashraf RA, Zia MS, Khan A. Functional Outcome of Distal Third Tibia Fractures Treated with Minimally Invasive Plate Osteosynthesis. *Pakistan Journal of Medical & Health Sciences*. 2023 Mar 5;17(01):541-