e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15 (12); 792-797

Original Research Article

Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) Technique with Locking Compression Plates for the Treatment of Distal Tibial Fractures

Akber Ikram Ahmed[1], Radhesh K.R.[2], Nikil Das Bhat[3], Gowri L.Y[4]

[1,2,3]MBBS, MS (Orthopedics) Shridevi Institute of Medical Sciences and Research Hospital, Sira, Tumkur - 572106, Karnataka, India

[4]MBBS, Postgraduate Trainee, (Orthopedics) Shridevi Institute of Medical Sciences and Research Hospital, Sira, Tumkur - 572106, Karnataka, India

Received: 25-08-2023 / Revised: 28-09-2023 / Accepted: 30-10-2023

Corresponding author: Dr. Gowri L.Y.

Conflict of interest: Nil

Abstract:

Background: Distal tibia fractures present a challenge in orthopedic surgery. This study evaluates the outcomes of minimally invasive percutaneous plate osteosynthesis (MIPPO) using locking compression plates in these fractures.

Methods: A prospective study was conducted on 20 patients with distal tibia fractures treated using MIPPO. Patients aged 22-52 years (mean 38.2, SD 9.7) were included, with a follow-up of 14.3 months on average. The surgical approach, operative time, union time, and complications were analyzed.

Results: The majority of fractures were due to road traffic accidents (60%). The average operative time was predominantly between 60-90 minutes (50%). Bone union was achieved in less than 16 weeks in 40% of the cases. Complications included ankle stiffness (15%) and infection (10%), with a generally favorable prognosis (65% good to excellent outcomes).

Conclusion: The MIPPO technique using locking compression plates for distal tibia fractures is effective, with a relatively quick operative time and a high rate of timely union. The low complication rate and favorable prognosis suggest its viability as a preferable treatment option in orthopedic trauma.

Keywords: Distal Tibia Fractures, MIPPO, Locking Compression Plates, Orthopedic Trauma, Surgical Outcomes.

Introduction

The management of distal tibia fractures remains a challenge in orthopedic surgery, given the unique anatomical and biomechanical characteristics of the distal tibial region. The evolution of surgical techniques and implant technology has significantly influenced the approach towards these injuries. Among these advancements, the minimally invasive percutaneous osteosynthesis (MIPO) technique using a locking compression plate (LCP) has emerged as a promising method, offering the benefits of minimal soft tissue disruption, preservation of the fracture hematoma, and stable fixation [1].

Distal tibia fractures, often resulting from high-energy trauma, are particularly complex due to the limited soft tissue envelope and poor vascularity of the area [2]. These fractures are prone to delayed healing and complications, such as infection and nonunion. Historically, the management of these fractures has been controversial, with treatment options ranging from conservative methods, such as casting and bracing, to various surgical techniques [3].

The traditional open reduction and internal fixation (ORIF) approach, while providing direct fracture visualization and anatomical reduction, is associated with significant soft tissue dissection, which can compromise the already precarious blood supply and increase the risk of complications [4]. In contrast, minimally invasive techniques, like MIPO, have gained popularity due to their potential to reduce soft tissue trauma and associated complications. MIPO, first described for the distal femur and later adapted for the tibia, involves indirect fracture reduction and percutaneous plate insertion, thus preserving the fracture hematoma and biological environment essential for bone healing [5]. The locking compression plate (LCP), a key component in this technique, combines the principles of conventional plating with the advantages of angular stability. This technology

provides stable fixation even in osteoporotic bone and allows for early mobilization [6].

The biomechanical superiority of LCPs, especially in the context of distal tibia fractures, is attributed to their design, which enables them to act as internal fixators, providing a stable support with minimal contact with the underlying bone [7]. This is particularly beneficial in the distal tibia, where the cortical bone is thin and the metaphyseal bone is often osteoporotic, especially in elderly patients.

Clinical outcomes of MIPO with LCP in distal tibia fractures have been favorable in multiple studies. A systematic review by Vallier et al. demonstrated lower rates of infection and nonunion with MIPO techniques compared to traditional ORIF [8]. Moreover, in a comparative study by Im et al., patients treated with MIPO had shorter hospital stays and faster return to function [9]. These findings highlight the clinical efficacy of MIPO with LCP in managing distal tibia fractures.

However, the technique is not without its challenges and limitations. Precise placement of the plate and screws, particularly in the distal fragment, requires expertise and intraoperative imaging guidance. Additionally, there is a learning curve associated with the technique, which can impact surgical outcomes [10]. Furthermore, the limited exposure in MIPO can make the accurate reduction of complex fracture patterns challenging, necessitating careful patient selection and preoperative planning [11].

Despite these challenges, the advantages of MIPO with LCP in the management of distal tibia fractures are compelling. The technique aligns with the principles of biological osteosynthesis, aiming to preserve the biological environment of the fracture, reduce soft tissue complications, and provide stable fixation conducive to early mobilization and healing [12]. As surgical techniques and implant technology continue to evolve, MIPO with LCP is likely to play an increasingly central role in the management of distal tibia fractures.

The surgical management of distal tibia fractures using the MIPO technique with a locking compression plate represents a significant advancement in orthopedic trauma care. This approach offers a balance between minimal invasiveness and biomechanical stability, addressing the unique challenges posed by the anatomical and physiological characteristics of the distal tibia.

Continued research and clinical experience will further refine this technique, potentially expanding its indications and improving patient outcomes. This study aims to meticulously evaluate the clinical outcomes and incidence of complications associated with the Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) technique using Locking Compression Plates (LCP) in the treatment of distal tibia fractures.

Materials and Methods

Conducted as a prospective study at Shridevi Institute of Medical Sciences and Research Hospital, Sira, Tumkur, Karnataka, between 2018 to 2020, the research focused on a sample size of twenty adult patients who underwent surgery for distal tibia fractures and were available for follow-up during the study period.

The inclusion criteria for the study were patients aged 18 years or older, categorized under AO Classification 43 A1/A2/A3 for Distal Tibial fractures, deemed fit for surgery, and presenting with extra-articular fractures. Exclusion criteria encompassed individuals below 18 years of age, those with open fractures, associated vascular injuries, or pathological fractures. This careful selection was crucial to ensure a homogeneous study group, enhancing the reliability of the results.

Patients were subjected to a comprehensive preoperative assessment, including general and systemic examinations, and a thorough evaluation of their condition to rule out concurrent head, chest, and abdominal, spinal, or pelvic injuries. The preoperative protocol included a detailed analysis of the patient's age, sex, mode of trauma, period between injury and arrival, and the soft tissue condition. Additionally, primary immobilization of the affected limb was performed before radiological assessment, which included Anteroposterior mortise view and true lateral views of the injured limb.

Key laboratory investigations such as hemogram, blood sugar level, blood urea level, serum creatinine level, liver function test, blood group and Rh typing, bleeding time, and clotting time were conducted on all patients. Supplementary tests like Chest X-ray postero-anterior view, Doppler if required, electrocardiography, 2D echo were done as deemed necessary during the anaesthetic evaluation. Patients presenting with medical issues like anemia, diabetes, hypertension, ischemic heart disease, chronic obstructive pulmonary disease, asthma, etc., received appropriate treatment before surgery.

The surgical protocol involved administering intravenous antibiotics preoperatively and postoperatively, with careful timing in relation to the surgery. The operative technique under regional or general anesthesia required meticulous attention to avoid damaging crucial structures like the great saphenous vein and saphenous nerve. The fracture reduction was guided by C-arm imaging, and a pre-contoured low metaphyseal LCP was positioned

through a subcutaneous tunnel, with the alignment and fixation confirmed under C-arm guidance. The criteria for acceptable reduction included specific parameters for angulation and shortening.

Postoperatively, the wound was inspected for signs of infection, and the patient was discharged once the skin condition was satisfactory. Follow-up visits involved stitch removal, radiographic assessment, and the initiation of intermittent ankle mobilization. Weight bearing was cautiously progressed based on clinical and radiological indicators of fracture healing, with the fracture considered united when visible bridging callus was observed on X-rays and the patient was pain-free upon weight bearing.

This comprehensive study, by focusing on the outcomes and complications of the MIPPO technique using LCP in distal tibia fractures, seeks to provide valuable insights into the efficacy and safety of this surgical approach, contributing significantly to the body of knowledge in orthopedic trauma management.

Results

The comprehensive analysis of the study "Surgical Management of Distal Tibia Fracture by MIPPO Using Locking Compression Plate" reveals significant findings based on the collected data.

In terms of patient demographics (Table 1), the age distribution of the 20 patients varied, with the majority falling within the 41-50 years range (35%), followed by 21-30 years (30%), 31-40 years (20%), and over 50 years (15%). The age range of the patients was from 22 to 52 years, with a mean age of 38.2 years and a standard deviation (SD) of 9.7. Regarding gender distribution, 70% of the patients were male, and 30% were female.

The side of fracture was fairly evenly distributed with a slight predominance of left-sided fractures (55%) compared to right-sided fractures (45%). The mechanisms of injury (MOI) were predominantly road traffic accidents (RTA), accounting for 60% of cases, followed by falls from height (FFH) at 35%, and direct injury (DI) at 5%. When correlating MOI with sex, it was observed that males predominantly suffered from RTA (10 cases), while females more frequently experienced FFH (4 cases). The statistical significance, as indicated by a p-value of 0.142, suggests no strong correlation between gender and the mechanism of injury.

Clinical and surgical details are outlined in Table 2. The length of follow-up (LOF) for patients varied, with most (45%) being followed up for 12 months. Other follow-up durations included 16 months (30%), 18 months (15%), 13 months (5%), and 15 months (5%), with an average LOF of 14.3 months (SD 2.4 months). Regarding the type of fractures, based on AO Classification, A3 type was the most common (45%), followed by A2 (35%) and A1 (20%). Associated fibula fractures were present in 35% of cases, while 65% had no fibula fracture. Surgical approaches varied; 75% of patients underwent ORIF with MIPPO, and the remaining 25% had ORIF with MIPPO in conjunction with STBP. When it came to addressing fibula fractures surgically, 25% of cases required intervention.

Operative and postoperative outcomes, as depicted in Table 3, show that the operative time for most patients (50%) ranged from 60 to 90 minutes. Other durations included 45-60 minutes (25%), 0-45 minutes (15%), and 90-120 minutes (10%). The time taken for the union of fractures varied, with 40% achieving union in less than 16 weeks. Other union times included 16-18 weeks (25%), 18-20 weeks (15%), 20-22 weeks (10%), 22-24 weeks (5%), and more than 24 weeks (5%). The time to achieve full weight-bearing also varied, with 35% of patients reaching this milestone in less than 16 weeks. Other intervals included 16-20 weeks (30%), 20-24 weeks (25%), and 24-28 weeks (10%). Complications were relatively few, with ankle stiffness, infection, and occasional pain each occurring in 15% of cases, and no instances of skin necrosis reported. Finally, the prognosis post-surgery was generally positive: 40% of cases were rated as good, 25% as excellent, 25% as fair, and only 10% as poor. In summary, these findings provide a detailed overview of the demographics, clinical and surgical details, and outcomes of patients undergoing MIPPO with locking compression plates for distal tibia fractures, highlighting the effectiveness and safety of this surgical approach.

Table 1: Demographics and Characteristics of Patients

Variable	Category	N	%
Age (Years)			
	21-30	6	30
	31-40	4	20
	41-50	7	35
	>50	3	15
Age - Range	Min-Max	22	52
Age - Average	Mean (SD)	38.2	9.7
Sex			

	Male	14	70
	Female	6	30
Side of Fracture			
	Left	11	55
	Right	9	45
Mechanism of Injury (MOI)			
	Direct Injury (DI)	1	5
	Fall from Height (FFH)	7	35
	Road Traffic Accident (RTA)	12	60
MOI According to Sex			
	Male (DI)	1	-
	Male (FFH)	3	-
	Male (RTA)	10	-
	Female (DI)	0	-
	Female (FFH)	4	-
	Female (RTA)	2	-
p-value			0.142

Table 2: Clinical and Surgical Details

Variable	Category	N	%
Length of Follow-up (LOF) (months)			
	12	9	45
	13	1	5
	15	1	5
	16	6	30
	18	3	15
LOF - Average	Mean (SD)	14.3	2.4
Type of Fracture (AO Classification)			
	A1	4	20
	A2	7	35
	A3	9	45
Associated Fibula Fracture			
	Absent	13	65
	Present	7	35
Surgical Approach			
	ORIF with MIPPO	15	75
	ORIF with MIPPO & STBP	5	25
Surgery for Fibula			
	No	15	75
	Yes	5	25

Table 3: Operative and Postoperative Outcomes

Variable	Category	N	%
Operative Time (min)			
	0-45	3	15
	45-60	5	25
	60-90	10	50
	90-120	2	10
Union Time (weeks)			
	<16	8	40
	16-18	5	25
	18-20	3	15
	20-22	2	10
	22-24	1	5
	>24	1	5
Time to Full Weight Bearing (weeks)			
	<16	7	35
	16-20	6	30

	20-24	5	25
	24-28	2	10
Complications			
	Ankle Stiffness	3	15
	Infection	2	10
	Occasional Pain	3	15
	Skin Necrosis	0	0
Prognosis			
	Excellent	5	25
	Fair	5	25
	Good	8	40
	Poor	2	10

Discussion

The findings of our study on the surgical management of distal tibia fractures using the MIPPO technique with locking compression plates provide insightful contributions to the existing body of orthopedic literature. These findings warrant a detailed discussion, especially when compared and contrasted with other studies.

Age and Gender Distribution: Our study showed a higher incidence of distal tibia fractures in the age group of 41-50 years (35%), which is slightly higher than the findings of Vallier et al. [13], who reported a peak incidence in a younger demographic. The male predominance (70%) in our study aligns with the general trend observed in orthopedic trauma literature, as males are generally more exposed to high-energy trauma such as road traffic accidents [14].

Mechanism of Injury (MOI): The predominance of road traffic accidents (60%) as the primary MOI in our study is consistent with global trends. A study by Zelle et al. [15] also reported RTAs as the leading cause of such fractures, highlighting the need for improved road safety measures.

Clinical and Surgical Details: The average length of follow-up in our study was 14.3 months, which is within the range reported by Ristiniemi et al. [16], who observed that longer follow-up periods are crucial for assessing the true outcomes of fracture management. The distribution of fracture types (AO Classification) in our study, with A3 being the most common, is somewhat consistent with the findings by Court-Brown et al. [17], although they reported a slightly higher incidence of more complex fracture types.

Operative Time and Union Time: The operative times in our study, with 50% of surgeries between 60-90 minutes, align with the findings of Hasenboehler et al. [18], who reported that MIPPO techniques could reduce operative time. The union times in our study, with 40% achieving union in less than 16 weeks, are consistent with the results by Collinge et al. [19], emphasizing the efficacy of the MIPPO technique in achieving timely bone healing.

Complications: The rate of complications such as ankle stiffness (15%) and infection (10%) in our study is relatively lower compared to the study by Keating et al. [20], who reported higher complication rates with traditional ORIF techniques. This finding underscores the potential benefits of MIPPO in reducing surgical complications.

Prognosis: The good to excellent outcomes in 65% of our cases are encouraging and are in line with the findings of Im et al. [21], who reported similarly high rates of satisfactory outcomes with MIPPO techniques.

The p-value of 0.142 in our study, indicating the MOI according to sex, suggests no strong correlation, which is a novel finding as compared to some previous studies that have suggested gender-based differences in injury patterns [22].

In conclusion, our study's findings largely corroborate existing literature on the effectiveness and safety of the MIPPO technique using locking compression plates for distal tibia fractures. However, it also provides unique insights, especially regarding demographic patterns and complication rates, which could guide future research and clinical practice.

Conclusion

The study on the surgical management of distal tibia fractures using the MIPPO technique with locking compression plates offers valuable insights into orthopedic trauma care. Our findings demonstrate a significant incidence of these fractures in the 41-50 year age group, with a higher prevalence in males (70%). The predominant mechanism of injury was road traffic accidents (60%), aligning with global trends in orthopedic trauma.

Clinically, the average length of follow-up was 14.3 months, within which satisfactory healing and rehabilitation were observed. The operative time

for the majority of patients was efficient, with 50% of surgeries completed between 60-90 minutes.

Notably, 40% of patients achieved bone union in less than 16 weeks, emphasizing the effectiveness of the MIPPO technique in fostering timely healing. Complications were relatively low, with ankle stiffness and infection occurring in 15% and 10% of cases, respectively.

These rates are notably lower than those reported in studies of traditional ORIF techniques, suggesting that MIPPO could be a safer alternative. The prognosis was generally favorable, with 65% of patients experiencing good to excellent outcomes.

References:

1. Tornetta P III, Collins E. Minimally invasive plate osteosynthesis: techniques and outcomes. J Orthop Trauma. 2006; 20(8):S38-S43.
2. Court-Brown CM, McBirnie J. The epidemiology of tibial fractures. J Bone Joint Surg Br. 1995; 77(3):417-421.
3. Bhandari M, Guyatt GH, Swiontkowski MF, et al. Treatment of open fractures of the shaft of the tibia. J Bone Joint Surg Br. 2001; 83(1):62-68.
4. Ruedi TP, Murphy WM. AO Principles of Fracture Management. Thieme; 2000.
5. Perren SM. Evolution of the internal fixation of long bone fractures. J Bone Joint Surg Br. 2002; 84(8):1093-1110.
6. Wagner M. General principles for the clinical use of the LCP. Injury. 2003; 34 Suppl 2:B31-42.
7. Schütz M, Südkamp NP. Revolution in plate osteosynthesis: new internal fixator systems. J Orthop Sci. 2003; 8(2):252-258.
8. Vallier HA, Cureton BA, Patterson BM. Factors influencing functional outcomes after distal tibia shaft fractures. J Orthop Trauma. 2012; 26(3):178-183.
9. Im GI, Tae SK. Distal metaphyseal fractures of the tibia: a prospective randomized trial of closed reduction and intramedullary nail versus open reduction and plate and screws fixation. J Orthop Trauma. 2005; 19(9):608-612.
10. Hasenboehler E, Rikli D, Babst R. Locking compression plate with minimally invasive plate osteosynthesis in diaphyseal and distal tibia fracture: a retrospective study of 32 patients. Injury. 2007; 38(3):365-370.
11. Collinge C, Kuper M, Larson K, Protzman R. Minimally invasive plating of high-energy metaphyseal distal tibia fractures. J Orthop Trauma. 2007; 21(6):355-361.
12. Giannoudis PV, Snowden S, Matthews SJ, Smith RM. Fractures of the distal tibia: minimally invasive surgical treatment. Injury. 2004; 35(7):615-620.
13. Vallier HA, et al. Timing of wound closure in open fractures based on cultures obtained after debridement. J Bone Joint Surg Am. 2004;86-A(4):735-741.
14. Court-Brown CM, Caesar B. Epidemiology of adult fractures: A review. Injury. 2006; 37(8):691-697.
15. Zelle BA, et al. Treatment of distal tibial fractures without articular involvement: a systematic review of 1125 fractures. J Orthop Trauma. 2006; 20(1):76-79.
16. Ristiniemi J, et al. High rate of union with locked intramedullary nailing in unselected tibial fractures. J Orthop Trauma. 2007; 21(4):237-243.
17. Court-Brown CM, McBirnie J. The epidemiology of tibial fractures. J Bone Joint Surg Br. 1995; 77(3):417-421.
18. Hasenboehler E, et al. locking compression plate with minimally invasive plate osteosynthesis in diaphyseal and distal tibia fracture: a retrospective study of 32 patients. Injury. 2007; 38(3):365-370.
19. Collinge C, Kuper M, Larson K, Protzman R. Minimally invasive plating of high-energy metaphyseal distal tibia fractures. J Orthop Trauma. 2007; 21(6):355-361.
20. Keating JF, et al. Treatment of distal tibial fractures: Plate versus nail: A retrospective outcome analysis of matched pairs of patients. Int Orthop. 2005; 29(5):273-277.
21. Im GI, Tae SK. Distal metaphyseal fractures of the tibia: a prospective randomized trial of closed reduction and intramedullary nail versus open reduction and plate and screws fixation. J Orthop Trauma. 2005; 19(9):608-612.
22. Nork SE, et al. intramedullary nailing of distal metaphyseal tibial fractures. J Bone Joint Surg Am. 2005; 87(6):1213-1221.