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International Journal of Recent Surgical and Medical Sciences

Original Article

Distal Tibial Fractures – Surgical Outcome Following Minimally Invasive Percutaneous Plate Osteosynthesis

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Received: 16 August 2022

Accepted: 24 January 2023

EPub Ahead of Print:
14 September 2023

Published: 22 December 2023

DOI
10.25259/IJRSMS-2022-8-5

Quick Response Code:

ABSTRACT

Objectives: With preservation of the vascularity of the bone, preservation of the soft tissue envelope and containment of the fracture haematoma, minimally invasive procedures provide fixation in a biologically sound manner. With these in view, this study was conducted to evaluate the technique of surgical management in distal tibial fractures treated by internal fixation with locking compression plate (LCP) and screws through the minimally invasive percutaneous plate osteosynthesis (MIPPO) technique.

Material and Methods: In this cohort study, 21 patients with distal tibial fractures who were admitted to the hospital between November 2014 and August 2016 were tracked for at least 10 weeks and up to 39 weeks. Adults who were fit enough for surgery, both male and female, participated in the study. MIPPO procedures were followed for every case. In this investigation, a total of 21 cases were examined.

Results: 86% of cases with proper bone union were able to bear their full weight at or before the 18-week mark. Complete weight bearing was permitted for the final three patients (14%) at or before 39 weeks. Ninety per cent of patients had fracture union rates that were satisfactory to excellent at 23 weeks. Also, delayed unions were noted in three individuals; two cases experienced ankle stiffness, one as a result of prolonged immobilization and the other as a result of an intra-articular fracture. There were no infections or wound breakdowns during this trial.

Conclusion: The MIPPO technique with LCP plates is a good choice when intramedullary nailing is inadequate for metaphyseal and distal tibia shaft fractures. Also, early fracture union is easily accomplished using the MIPPO technique and careful application of these plates.

Keywords: MIPPO, Tibial fractures, Outcome, Follow-up

INTRODUCTION

A management issue might arise from unstable fractures of the distal tibia, whether or not there is intra-articular fracture extension. With traditional methods of fixation, high rates of related problems have been observed.[1,2] The unusual anatomical features of the distal diametaphyseal tibia fracture, including its subcutaneous location with a tenuous blood supply and close proximity to the ankle joint, make treatment, whether with or without articular extension, difficult. Surgical intervention, such as closed reduction and intramedullary interlocking (IMIL) nailing, open reduction and internal fixation (ORIF) with plating, closed reduction and percutaneous plating or external fixators, is used to treat the majority of these fractures. Each of these methods has

advantages and disadvantages of its own. It has been noted that IMIL nailing has a greater rate of malunion because it is challenging to install two distally locking screws.[3,4] Some of the issues with traditional osteosynthesis with plates include wound infection, skin disintegration and delayed or non-union needing further treatments such as bone grafting.[5,6] Similar complications with external fixators include pin tract infection, pin loosening, malunion and non-union leading to osteomyelitis; these complications make them unsuitable as a means of final fixation.[7–9]

Minimally invasive percutaneous plate osteosynthesis (MIPPO) might have biological benefits. One of the key benefits of MIPPO is that there is less soft tissue dissection and exposure, which leads to less surgical trauma and preservation of blood supply. Less osteogenic fracture haematoma is evacuated in order to accomplish biological fixation.[10] A stable construction is provided by LCPs. They perform a bridging internal–external fixator function.[11,12] Recent studies have shown more benefits on distal tibial LCP's, This led to surgeons having more interest towards them.[13,14] In order to enable indirect reduction of the fracture, this plate is side-specific and pre-contoured to fit the shape of the medial portion of the tibia. Through a short (2 cm) skin incision and along the medial portion of the tibia, the plate is tunneled subcutaneously but extraperiosteally and it is then fastened with locking screws. A stable, fixed-angle device is produced by the device's ability to permit the screws to lock to the plate.[15]

Displaced distal tibial fractures, unstable metaphyseal fractures that are too distal for safe stabilization with intramedullary nails[2] and fractures with intra-articular extensions are all indications for minimally invasive plate osteosynthesis of distal tibial fractures. With these in view, this study was conducted to evaluate the technique of surgical management in distal tibial fractures treated by internal fixation with LCP and screws through the MIPPO technique.

MATERIAL AND METHODS

The study was initiated after obtaining approval from the institutional human ethics committee. Informed consent was obtained from all patients before being included in this study. In this cohort study, 21 patients who arrived at the hospital with distal tibial fractures between November 2014 and August 2016 were followed-up for at least 10 weeks. The study involved both male and female adults who were healthy enough for surgery. Exclusion criteria for the study included cases with multiple medical comorbidities, non-ambulatory patients due to cerebrovascular accident (CVA), pathological fractures, non-union, malunion and segmental fractures. Anatomic reduction of the fracture, preservation of the soft tissue envelope, stable fixation and early mobilization to prevent ankle joint stiffness are all components of treatment. Every case underwent MIPPO procedures.

Antibiotic prophylaxis was given while the patient was lying supine on a radiolucent table, and standard intraoperative fluoroscopy was employed throughout the procedure. The fracture was carefully positioned to be visible on the anteroposterior and lateral views. Both the injured and uninjured limbs were ready and draped above the knee, enabling intraoperative alignment comparisons with the healthy limb. By elevating the wounded limb on radiolucent trays, interference from the other leg is minimized and a good lateral view is made possible. On the skin, the knee and ankle joint lines were distinct and pronounced. The fracture was minimized by using manual traction or a single Steinman pin put into the calcaneus. To obtain reduction, a pointed reduction clamp might be utilized if necessary. A fibula fracture, if existent, was plated using a one-third tubular plate to give lateral stability, restore the proper length and minimize undue distraction at the fracture site, depending on the quality of the tibial fracture reduction achieved. Percutaneously or by separate stab incisions, the distal tibia's major fracture fragments were aligned, reduced and fixed with unique lag screws.

After the fracture had been sufficiently reduced, a subcutaneous tunnel was formed and a sufficient transverse incision was made distal to the medial malleolus. An LCP crossed the fracture site as it traveled through the tube. In order to anchor at least two bicortical screws through the ad hoc holes proximal and distal to the fracture, the plate chosen had to span the metaphyseal zone. Comparison with the other limb was used to determine whether the right rotation was established. Then, as many additional screws as required were placed percutaneously, with a minimum of two bicortical screws at each end. The typical low contact plate was restricted in the number of screws that could be inserted in a short distal fragment. The locking distal tibial plate, which has nine distal holes instead of the typical low-contact plate's four, has been used to solve this issue. The latter function enables more exact control of fixation firmness. The working length mostly affected axial stiffness and torsional rigidity. The construct gained roughly double the amount of flexibility in compression and torsion by leaving out one screw hole on either side of the crack.

Long plates were employed, with few cortical purchases. Screw toggle was prohibited by the Morse cone mismatch between the plate and the screw. Stability was also considerably impacted by the quantity of screws. However, more than three screws per fragment did not significantly improve axial stiffness, and four screws did not improve

torsional rigidity. The distance between the plate as well as the bone was kept short and lengthy plates were employed to give enough axial stiffness, which is another element that influences the stability of the build. The ideal plate-to-bone surface distance was kept at 2 mm or less. Stab wounds were treated and conventional suction drains were used to seal them. The limb was cast in a Plaster of Paris (POP) cast that extended below the knee.

At one month after surgery, partial weight bearing began. The minimal amount of time that patients were followed-up was 10 weeks and it lasted up to 39 weeks. Patients had a clinical and radiological evaluation once every three weeks. Clinically, the improvement in range of motion and the decrease in pain were reported. Radiologically, callus formation was noted. The Tenny and Weiss scoring method was used to evaluate all patients. Patients who wanted the implant removed had to wait until the callus had consolidated and been seen on radiographs, which is typically not before 18 months after surgery. SPSS version 17 was used to analyze the data.

RESULTS

Patients in the research ranged in age from 18 to 65, with a 44.42 ± 20.3 year average at the time of surgery. There were 21 patients, with a male preponderance of 57% and a female preponderance of 43%. When the side of the fracture was determined, 11 and 10, respectively, of the patients suffered tibial fractures on the right and left side. Road traffic accident (RTA) (57.14%) and falls (38.1%) were the two leading causes of fractures (4.8%). Six intra-articular fractures and 15 extra-articular fractures were present among the 21 individuals. Seven individuals had other injuries in addition to the two complex fractures. This demonstrates that intra-articular fractures were primarily caused by RTA.

In the current study, 15.7 weeks on average passed after surgery before 85% of the fractures had joined. Three patients had delayed union out of which two delayed unions were due to complex and intra-articular fractures and 1 delayed union was caused by excessive traction in the limb prior to fixation, which distracted the fracture site. By keeping apposition at the fracture sites during surgery, this can be fixed. But after nine months, all fractures were healed.

In addition, 90% of patients either had no union angulation or it was less than 5 degrees. Both of the patients had 10 degrees of recurvatum and 10 degrees of varus, but neither had a clinical deformity. Proportion of cases with fibular fracture and angular deformities is shown in Table 1 and proportion of cases with respect to degrees of plantar and dorsiflexion is shown in Table 2.

At or before 18 weeks, 18 patients (86%) with normal bone union were permitted to bear their complete weight. At or before 39 weeks, complete weight bearing was permitted for the remaining three patients (14%) as well. At 23 weeks, 19 patients (90%) experienced satisfactory to excellent fracture union rates. Two patients had reasonable outcomes. One was brought on by the foot's accompanying injuries from the crushing accident, while the other was brought on by aging and protracted immobilization.

In this study after follow-up, three patients' delayed unions may have been brought on by excessive intraoperative traction and comminution. In addition, we removed implants at 18 months in two cases where the implants were pressing on the skin. Ankle stiffness affected two individuals, one from protracted immobilization and the other from an intra-articular fracture. In this trial, there were no infections or wound breakdowns [Table 3].

Table 1: Proportion of cases with fibular fracture and angular deformities.

Description	Frequency	Percentage
Patients with fibula fractures	20	95.2
Fibula fractures fixed	6	28.6
Clinical angulations	0	0
Radiological angulations	2	9.5
Angular deformities with fixed fibulas	0	0
Angular deformities with fibula not fixed	2	14

Table 2: Proportion of cases with respect to degrees of plantar and dorsiflexion.

Degrees	Frequency	Percentage
Plantar flexion		
>30 degrees	13	61
11–30 degrees	7	33.33
0–10 degrees	1	4.8
Dorsiflexion		
>15 degrees	11	52.4
11–15 degrees	8	38.1
0–10 degrees	2	9.5

Table 3: Proportion of cases with complications.

Complications	Frequency	Percentage
Non-union	0	0
Delayed union	3	14.0
Infection	0	0
Skin necrosis	0	0
Skin impingement	2	9.5
Implant failure	0	0
Neurovascular complications	0	0
Ankle stiffness	2	9.5

DISCUSSION

In order to evaluate the kind of fracture union in fractures treated with LCP using MIPPO technique and to examine any problems resulting from this treatment, Shankar *et al*.[16] conducted a study. They stated that all fractures finally fused, even the two that took longer. The remaining 21 fractures healed in an average of 20 weeks. In all, we experienced six problems, including one superficial infection, two deep infections, one iatrogenic fracture and one delayed union. We did not experience any issues that were solely implant-related, such as screw loosening, screw fracture or plate failure.

Shrestha *et al*.[17] evaluated the efficacy of MIPPO with LCP for distal diametaphyseal tibia fracture, taking into account complications and union time, and compared it to other therapy approaches that were documented in the literature. With the exception of one case of delayed union, which was treated with a percutaneous bone marrow injection, they reported that all fractures fused within an average time of 18.5 weeks. There was no non-union identified, although two patients had union with valgus angulation of less than 5 degrees. There were three post-operative wound infections: two were superficial and one was profound. In addition to recurrent debridement for deep infections, all infections were treated for a prolonged length of time with intravenous antibiotics. Eight patients had implants removed, and six (30%) of them suffered malleolar skin irritation and pain from protruding hardware. They came to the conclusion that MIPPO with LCP is a successful treatment option for distal diametaphyseal tibia fracture in terms of union time and complications' rate. Inflammation of the malleolar skin is a typical issue caused by visible hardware.

In another study, conducted by Nayak *et al*.,[18] 31 cases participated and they assessed the effectiveness of MIPPO treatment for distal femoral fractures. They noted that the average operating time, according to their assessment, was 70 minutes. The typical hospital stay was nine days. A union took an average of 3.7 months to occur. An average 18-month follow-up duration was used. Twenty-nine of the patients achieved satisfactory or outstanding results at 1-year check-up. No patient exhibited an angular or rotational deformity greater than 10 degrees. At 10 weeks, an implant in an osteoporotic lady with a type-A1 fracture failed, necessitating revision surgery. Another patient with a type-A1 fracture underwent implant removal at 22 months after experiencing ongoing pain on the lateral side of the distal thigh. Deep infection, malunion or non-union did not occur in any patients. They came to the conclusion that MIPPO with an LCP successfully fixes distal femoral fractures biologically while posing little problems. Even in cases of metaphyseal comminution, bone grafting is not necessary. To avoid difficulties, careful patient selection and preoperative preparation are crucial.

The clinical viability and potential risks of minimally invasive plate osteosynthesis of the distal fibula are assessed by Hess *et al*.[19] According to their findings, 17 tibia fractures with internal fixation had complication-free healing after an average of nine weeks. Three aseptic non-unions were noted, two of which involved substantial closed soft tissue damage: one in a pilon fracture and one in a distal lower leg fracture. The third one involved a dislocated ankle that required delayed medical attention and insufficient fibula fracture reduction. They came to the conclusion that even though this method is similar to minimally invasive plate osteosynthesis in the tibia or femur, it seems more challenging due to the small bone size. In light of this, we save this approach for specific difficult fractures of the distal fibula that have serious soft tissue issues.

According to Pasupuleti NK *et al*.,[20] all fractures in their investigation finally fused, even the two that had a delayed union. We experienced a total of six problems, including delayed union, complex regional pain syndrome and superficial and deep infections. The patient sample roughly corresponded to the typical trauma cases we saw at our setup. MIPPO-treated fractures experienced quick secondary healing and robust bone union across the fracture site.

Pre-contoured metaphyseal LCP was used in 20 instances operated with the MIPPO approach, according to Kundu *et al*.[21] With a mean age of 38.95 years, there were 15 males and 5 females. Type A extra-articular fractures occurred in 17 patients, Type B partial-articular fractures occurred in two and Type C total-articular fracture occurred in one. Thirteen fractures were caused by the predominance of high-energy trauma. The average time between trauma surgeries was 12 days. Patients were monitored for at least six months. Infections of the skin's surface were observed in two cases, surgical wound collapse and implant exposure in one and conspicuous hardware in one. Seventeen patients (or 85%) had excellent or good outcomes, whereas the outcomes for three cases with problems were fair to bad. They came to the conclusion that MIPPO is a reliable and secure method for treating distal tibial fractures with the least amount of soft tissue harm and no intra-articular comminution. By establishing a balance between mechanical excellence and devascularization, it protects bone biology.

According to Mushtaq *et al*.,[22] their patient sample roughly corresponded to the typical trauma patients we see at our facility. MIPPO-treated fractures recovered quickly by secondary fracture union, resulting in a solid bone union throughout the fracture site. Biological fixation of fractures was simpler with the LCP system than it was with traditional

plates. Even in osteoporotic bone, locking head screws had excellent anchoring. In cases of complicated fractures, where alternative implants have limited use, we also validated its demonstrated efficacy.

CONCLUSION

When intramedullary nailing is ineffective for metaphyseal and distal tibia shaft fractures, the MIPPO procedure with LCP plates is a solid option. The distal tibial LCP is a side-specific, low-profile plate that has been pre-contoured. Fixation techniques more frequently utilized in such accidents decrease the soft tissue complications, malalignment and knee discomfort issues. We discovered that in order to accomplish early union in these injuries, the technique of administration of these plates is highly determined by the fracture anatomy. After attaining compression at the fracture site, the plate should be employed as a neutralizing device in simple, non-comminuted fractures. However, these plates should be utilized as a bridge device to stabilize fractures in complex comminuted fractures. With careful application of these plates and the MIPPO technique, early fracture union can be achieved with little difficulties. We are unable to draw any firm conclusions from our preliminary findings because of the limited number of patients who participated in our study, but we do think they provide an important starting point for future research.

Acknowledgments

No financial support obtained.

Ethical approval

The research/study complied with the Helsinki Declaration of 1964.

Declaration of patients consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

None declared.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

REFERENCES

1. Fisher WD, Hambledon DL. Problems and pitfalls of compression fixation of long bone fractures: a review of results and complications. Injury 1978;10:99–107.
2. Olerud S, Karlstrom G. Tibial fractures treated by AO compression osteosynthesis. Acta Orthop Scand Suppl 1972;1:1–104.
3. Mosheiff R, Safran O, Segal D, Liebergall M. The unreamed tibial nail in the treatment of distal metaphyseal fractures. Injury 1999;30:83–90.
4. Kneifel T, Buckley R. A comparison of one versus two distal locking screws in tibial fractures treated with unreamed tibial nails: a prospective randomized clinical trial. Injury 1996;27:271–3.
5. Vallier HA, Le TT, Bedi A. Radiographic and clinical comparisons of distal tibia shaffractures (4 to 11 cm proximal to the plafond): plating versus intramedullary nailing. J Orthop Trauma 2008;22:307–11.
6. Yang SW, Tzeng HM, Chou YJ, Teng HP, Liu HH, Wong CY. Treatment of distal tibial metaphyseal fractures: Plating versus shortened intramedullary nailing. Injury 2006;37:531–5.
7. Guo JJ, Tang N, Yang HL, Tang TS. A prospective, randomised trial comparing closed intramedullary nailing with percutaneous plating in the treatment of distal metaphyseal fractures of the tibia. J Bone Joint Surg Br 2010;92–B:984–8.
8. 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;38:365–70.
9. Gun-Il Im, Suk-Kee Ta. Distal metaphyseal fractures of tibia: A prospective randomized trial of closed reduction and intramedullary nail versus open reduction and plate and screws fixation. J Trauma 2005;59:1219–23.
10. Farouk O, Krettek C, Miclau T, Schandelmaier P, Guy P, Tscherne H. Minimally invasive plate osteosynthesis and vascularity: preliminary results of a cadaver injection study. Injury 1997;28:SA7–12.
11. Toms AD, McMurtie A, Maffulli N. Percutaneous plating of the distal tibia. J Foot Ankle Surg 2004;43:199–203.
12. Tornetta P III, Weiner L, Bergman M, Watnik N, Steuer J, Kelly M, *et al*. Pilon fractures: treatment with combined internal and external fixation. J Orthop Trauma 1993;7:489–96.
13. Collinge CA, Sanders RW. Percutaneous plating in the lower extremity. J Am Acad Orthop Surg 2000;8:211–6.
14. Khoury A, Liebergall M, London E, Mosheiff R. Percutaneous plating of distal tibial fractures. Foot Ankle Int 2002;23: 818–24.
15. Frigg R. Development of the locking compression plate. Injury 2003;34:B6–10.
16. Shankar V. A study of results of surgical management of distal tibia fractures treated by mippo tehnique with locking compression plate. Int Orthop 2019;5:653–7.
17. Shrestha D, Acharya BM, Shrestha PM. Minimally invasive plate osteosynthesis with locking compression plate for distal

diametaphyseal tibia fracture. Kathmandu Univ Med J (KUMJ) 2011;9:62–8.
18. Nayak RM, Koichade RM, Umre AN, Ingle MV. Minimally invasive plate osteosynthesis using a locking compression plate for distal femoral fractures. J Orthop Surg 2011;19:185–90.
19. Hess F, Sommer C. Minimally invasive plate osteosynthesis of the distal fibula with the locking compression plate: First experience of 20 cases. J Orthop Trauma 2011;25:110–5.
20. Pasupuleti NK, Feng X. Functional evaluation following operative management of extra articular distal tibia fractures with precontoured medial distal tibial locking compression plate by MIPPO technique. IOSR J Dent Med Sci 2018;17: 68–88.
21. Kundu AK, Phuljhele S, Jain M, Sahare KK. Outcome of minimaly invasive plate osteosynthesis (MIPO) technique with locking compression plate in distal tibial fracture management. Indian J Orthop Surg 2015;1:138–45.
22. Mushtaq A, Shahid R, Asif M, Maqsood M. Distal tibial fracture fixation with locking compression plate (LCP) using the minimally invasive percutaneous osteosynthesis (MIPO) technique. Eur J Trauma Emerg Surg 2009;35:159–64.

How to cite this article: Sajeed M, Nisha N, Sivaraman D, Prabhu T. Distal Tibial Fractures – Surgical Outcome Following Minimally Invasive Percutaneous Plate Osteosynthesis. Int J Recent Sur Med Sci. 2023;9: 83–8. doi: 10.25259/IJRSMS-2022-8-5