Trauma Mon. 2016 July; 21(3):e22131. doi: 10.5812/traumamon.22131.

Published online 2016 March 20. **Research Article**

# Complications of Minimally Invasive Percutaneous Plating for Distal Tibial Fractures

Nasir Muzaffar,[1,*] Rafiq Bhat,[1] and Mohammad Yasin[1]

[1]Hospital for Bone and Joint Surgery, Barzalla, India

[*]*Corresponding author*: Nasir Muzaffar, Hospital for Bone and Joint Surgery, Barzalla, India. Tel: +91-1942430155; +91-9858812593, Fax: +91-1942433730, E-mail: drnasir@in.com

**Received** 2014 July 17; **Revised** 2014 August 23; **Accepted** 2014 September 18.

## Abstract

**Background:** The management of distal tibia fractures continues to remain a source of controversy and debate.
**Objectives:** The aim of this study was to evaluate the various complications of minimally invasive percutaneous plate osteosynthesis (MIPPO) using a locking plate for closed fractures of distal tibia in a retrospective study.
**Patients and Methods:** Twenty-five patients with distal tibial fractures, treated by minimally invasive percutaneous plate osteosynthesis, were evaluated in a retrospective study. We studied the rate, probable etiological factors and preventive and corrective measures of various complications associated with minimally invasive plating of distal tibia.
**Results:** Mean age of the patients was 41.16 years (range 22 - 65). There were 13 male and 12 female patients. All fractures united at an average duration of 16.8 weeks. There were two cases of superficial and two cases of deep infection, and deep infections required removal of hardware for cure. There were four cases of ankle stiffness, most of them occurring in intra-articular fractures, three cases of palpable implant, three cases of malunion, one case of loss of reduction and one patient required reoperation. The average AO foot and ankle score was 83.6.
**Conclusions:** We found MIPPO using locking plate to be a safe and effective method for the treatment of distal tibial fractures in properly selected patients yet can result in a variety of complications if proper precautions before, during and after surgery are not taken care of.

*Keywords:* Distal, Tibia, Fractures, Minimally Invasive Percutaneous Plate Osteosynthesis, Complications

## 1. Background

The management of distal tibia fractures continues to remain a source of controversy and debate (1, 2). The methods of treatment include closed reduction and cast application, external fixation, open reduction and internal fixation, intramedullary nailing and minimally invasive plating with each method of treatment having its own merits and demerits (3, 4). The MIPPO in distal tibial fractures has an established role in present day orthopaedics. It has minimized a variety of complications especially those related to soft tissues in distal tibia fractures, but at the same time, this method of treatment is not without complications and hence is not an ideal solution for all distal tibial fractures. The MIPPO is associated with a number of complications like wound dehiscence, superficial and deep infection, ankle stiffness, malrotation, palpable implant, inadequate reduction and hardware failure (5, 6).

## 2. Objectives

The purpose of the current study was to find the incidence, etiology and preventive as well as corrective measures for complications associated with minimally invasive plating of distal tibia fractures.

## 3. Patients and Methods

This was a retrospective study consisting of 25 patients with closed distal tibia fractures treated by MIPPO. The study was approved by the ethics committee of our institute and a written informed consent was obtained from all patients before the operation. The fractures were either intra-articular or extra-articular fractures of distal tibia corresponding to OTA 43 A, B and C fractures. Pathological and open fractures and those with impending or established compartment syndrome were excluded from the study. The surgery was performed after the stabilization of skin and soft tissue conditions averaging 9.98 days, which ranged from 5 to 16 days in our study (1, 7, 8). All patients with fractures of distal tibia were initially assessed and stabilized at the emergency department of our hospital. After identifying and managing life-threatening emergencies, the fractured extremity was splinted and elevated in order to reduce swelling (1). Detailed radiographic evaluation in two perpendicular planes including knees and

Copyright © 2016, Trauma Monthly. This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (http://creativecommons.org/licenses/by-nc/4.0/) which permits copy and redistribute the material just in noncommercial usages, provided the original work is properly cited.

Archive of SID

www.SID.ir

ankles were done. Computerized tomography (CT) scan was done in case of complex intra-articular fractures (8, 9). Fractures were classified using orthopedic trauma association OTA classification (10). The surgery was performed by a single senior surgeon under spinal or general anesthesia, depending upon discretion of anesthetist on a standard radiographic tabulation under tourniquet control. Pre-operative prophylactic antibiotics were administered intravenously before surgery before inflation of tourniquet (1). Fractures were reduced using indirect means of reduction like manual traction, calcaneal pin traction, use of femoral distractor, using K wires as joy sticks or rarely by small incisions and application of percutaneous bone clamps (1, 2, 8, 11, 12). Associated fibula fractures, if deemed necessary for fixation, were fixed first (13, 14). After checking for reduction under fluoroscopy, a small, approximately 3 cm, incision was made over medial malleolus for passing the plate (1, 15). A subcutaneous extraperiosteal tunnel was created using a Cobb elevator or the blunt end of the plate (1, 16). Locally manufactured stainless steel distal tibial locking plate was fixed to the bone using locking or non-locking screws, proximally via stab incisions and distally via previous oblique incisions made for passage of the plate. The wound was closed and the limb was elevated in a removable splint, postoperatively. Intravenous antibiotics were continued for 24 hours after surgery (1, 17). Toe touch weight bearing was started postoperatively with the help of crutches as soon as pain and swelling subsided and the patient was fully out of anesthesia effect. Partial weight bearing was allowed at four to six weeks and full weight bearing at ten to twelve weeks, depending upon clinical and radiographic assessment of fracture healing. Use of postoperative removable or plaster of Paris brace was decided on patient and fracture related factors like commination and articular involvement as well as rigidity of fixation, as assessed intra-operatively (1, 2, 8, 11, 18). Delayed wound healing and superficial infection were defined as persistent drainage from the wound for at least two days or separation of wound edges to a width of > 1 cm and a length of > 1 cm (15, 19). The patients were followed up clinically, and radiographically was performed at two weekly intervals initially and then monthly till the fracture united, then every six months, and the final follow up was done one year post surgery. The patients were assessed objectively by physical and radiographic examination. The development of complications was carefully observed and documented at each follow up visit. The final outcome was assessed at the one-year follow up by the American orthopaedic foot and ankle score (11, 20).

### 3.1. Ethical Board Review Statement

This was to certify that the subjects gave informed consent to participate in the study and that the study was approved by an institutional review board. The author certified that his institute has approved or waived approval for the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of the research.

## 4. Results

All the patients were examined periodically and the final follow up was done at one year. All fractures united with average time to union of 16.8 weeks, ranging from 12 to 30 weeks with only one case of delayed union. The mean age of our patients was 41.16 years (22 - 65) and 52% were male.

There was one case of delayed union with fracture united at 30 weeks after surgery; this patient was a long oblique fracture loss of reduction because of long working length. Four of our patients developed infection; amongst these cases, two were superficial infections, which resolved with antibiotics and local wound care and two patients developed deep infection, both of them were of delayed onset occurring after two months after surgery and they were cured only after removal of hardware with further uneventful course. Removal of hardware was done at the time fractures were already united. Four of the patients developed ankle stiffness, three of which were having intra-articular fractures. Palpable implant was found in three patients. One patient was re-operated because of inadequate articular reduction after the first surgical attempt. There were three cases of malunion, two cases of external rotation deformity and one case of recurvatum. One patient had loss of reduction. The average AO foot and ankle score was 83.6 with 92% of the patients having a score greater than 60.

**Table 1.** Mode of Trauma

| Mode of Trauma | No. (%) |
|---|---|
| RTA | 11 (44) |
| Fall from height | 4 (16) |
| Fall | 9 (36) |
| Direct Impact | 1 (4) |

## 5. Discussion

Management of distal tibial fractures continues to be a source of controversy and debate because all long bone


Archive of SID
www.SID.ir

**Table 2.** OTA Fracture Type

| OTA Fracture type | No. (%) |
|---|---|
| **43A1** | 7 (28) |
| **43A2** | 8 (32) |
| **43A3** | 4 (16) |
| **43B1** | 4 (16) |
| **43B2** | 1 (4) |
| **43C3** | 1 (4) |

**Table 3.** Complications

| Complication | No. (%) |
|---|---|
| **Deep infection** | 2 (8) |
| **Superficial infection** | 2 (8) |
| **Palpable implant** | 3 (12) |
| **Delayed union** | 1 (4) |
| **Ankle stiffness** | 4 (16) |
| **Hardware failure** | 1 (4) |
| **Malunion** | 3 (12) |
| **Loss of reduction** | 1 (4) |

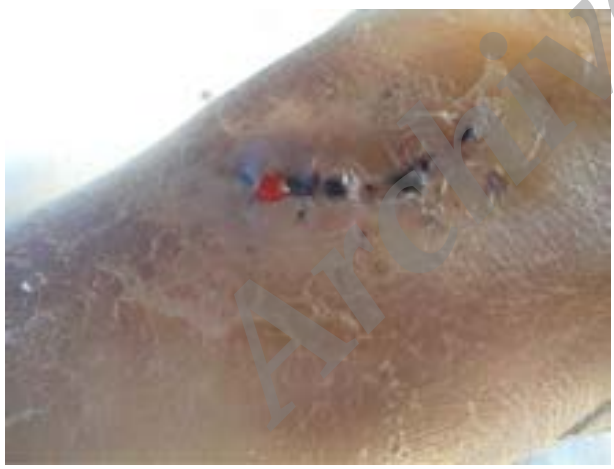

**Figure 1.** Superficial Infection

**Figure 2.** Malunion

fractures management of fractured tibia requires greatest experience and wisdom and best clinical judgment in order to choose the most appropriate treatment for a particular pattern of injury. With increased recognition of soft tissue status and importance of preventing additional trauma to soft tissue envelope due to ORIF and preservation of osteogenic fracture hematoma in fracture healing, MIPPO is establishing its role in a variety of fractures particularly in distal tibial fractures. Minimally invasive percutaneous plate osteosynthesis in distal tibia is proving to be a very safe and effective method of treatment in properly selected patients but it should be kept in mind that it is not a solution to every distal tibial fracture and can result in a variety of complications if proper precautions before, during and after surgery are not taken (2, 4, 7, 8, 21-24). The purpose of our study was to find the incidence, etiology, preventive and corrective measures for complications associated with minimally invasive plating of distal tibial fractures. Infection was the most common complication in our series seen in four patients; two of them being superficial wound infections associated with early onset and persistent wound drainage. These were cured by administration of culture specific antibiotics and local wound care with further uneventful course. The two deep infections were of delayed onset occurring after two months. They were not controlled with antibiotics. They were cured permanently only after removal of hardware, one on the 8th month and the other after 11 months. By that time, fractures in both patients were united and had



Archive of SID
www.SID.ir


**Figure 3.** Stiff Ankle

**Figure 4.** Skin Slough

**Figure 5.** Loss of Reduction

Archive of SID

further uneventful course. Deep infections were due to formation of biofilm over the implants, which were responsible for failure of antibiotics to cure infection and required removal of hardware for permanent cure. The implants were cultured after removal of hardware and both of the two cases yielded *Staphylococcus aureus* and their sensitivities were checked and appropriate antibiotics were administered postoperatively. Wound infections could be reduced by performing surgery after stabilization of soft tissue status, use of prophylactic antibiotics and maintaining complete asepsis during the surgical procedure. Deep infection was found in 14% of patients as reported by the study of Ronga et al. which required removal of hardware for control. Superficial infections were found in 28% of patients and cured by the administration of antibiotics and local wound care (2, 4, 8). Ankle stiffness was found in 16% of our patients, and in three out of four patients they were intra-articular; this might be due to inadequate intra-articular reduction, which is not visualized on standard fluoroscopy. Ankle stiffness can be prevented by achieving good intra-articular reduction, which may even require arthroscopic assisted reduction, early postoperative ankle range of motion exercises and minimizing post-


www.SID.ir


**Figure 6.** Healed Intra-Articular Fracture

operative immobilization. Ankle stiffness was seen in 24% of patients, in the study of Lau et al. (4). There was one case of delayed union with fracture united at 30 weeks, with no case of non-union. This patient was associated with poor reduction with increased gap between fracture ends. This patient was given suitable postoperative bracing and ample time and ultimately united at 30 weeks. Delay and nonunion can be prevented by achieving the best fracture reduction possible without compromising soft tissue envelope and osteogenic fracture hematoma (1, 2, 15). Palpable implant or implant site discomfort was found in 12% of our patients. None of the patients in our study were symptomatic to an extent that requires hardware removal; our implants were anatomic distal tibial low profile plates of stainless steel and hence the low profile nature of the implant is probably responsible for lower morbidity of our patients. Implant site discomfort can be prevented by proper preoperative contouring and templating of plate. Recently reports have been published on lateral side MIPPO for decreasing medial implant prominence (25). Palpable implants were seen in 7% of cases in the study of Bahari et al. all of which required removal of hardware (8). Maffulli et al. also found that anatomic metaphyseal locking plate minimized metal discomfort associated with distal tibial plating. However, Lau et al. found an incidence of 52% of metal discomfort even with distal tibial anatomic lock plating and approximately half of them required removal of hardware (4, 26, 27). One patient had to be re-operated because of inadequate intra-articular reduction after the first surgical attempt. Proper articular reduction should be achieved by using indirect as well as direct means of reduction if required (28, 29). Small arthrotomy incisions and use of K wires as joysticks or even arthroscopy-assisted reduction should be used in order to achieve good joint reduction. Difficult fracture reduction can be encountered intra-operatively, if fracture pattern is not studied well before hand hence fracture pattern must be studied well preoperatively in order to choose an appropriate reduction technique and implant size. Furthermore it should be kept in mind that MIPPO is not a solution to every distal tibial fracture (28) and locking intramedullary nail stabilization and external fixation combined with limited open reduction and absorbable internal fixation techniques are also efficient methods for treating distal tibia fractures depending upon the morphology of the fracture and the soft tissue status. In our case with the loss of reduction, the fracture was spiral and extended well into diaphysis; some screws were inadvertently put in the fracture resulting in less secure fixation and hence loss of reduction. There were three cases of malunion with two cases of external rotation and one case of recurvatum in our series and all the cases occurred in extra-articular fractures. All the three cases occurred in our earlier cases when we had not gained sufficient expertise in minimally invasive fixation. Malunion can be preserved to a large extent by a careful operative technique like preparation and draping of both fractured as well as non-fractured extremities for intra-operative comparison of rotation, comparing the position of the foot with respect to patella, use of intra operative fluoroscopy to check for alignment. All the patients with malunion had no major functional limitation but were mainly having cosmetic concerns. Malunion in frontal plane was seen in 6.25% and rotational malalignment greater than 10 degrees was seen in 25% of patients in the study of Sitnik et al. (1, 2, 13, 15, 27). The major limitation of our study was the lower number of cases, which lends to the credence that our results cannot be generalized. Further long-term studies with a larger cohort can be used for standardization of treatment with MIPPO.

## Footnotes

**Authors' Contribution:** Nasir Muzaffar wrote the manuscript and did the final drafting; Rafiq Bhat collected



Archive of SID
www.SID.ir

and analyzed the data and Mohammad Yasin contributed to the development of the protocol and abstracted the data.

**Conflict of Interest:** The author certifies that he has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article. No financial aid was received for this study.

## References


1. Redfern DJ, Syed SU, Davies SJ. Fractures of the distal tibia: minimally invasive plate osteosynthesis. *Injury.* 2004;**35**(6):615–20. doi: 10.1016/j.injury.2003.09.005. [PubMed: 15135282].
2. Ronga M, Longo UG, Maffulli N. Minimally invasive locked plating of distal tibia fractures is safe and effective. *Clin Orthop Relat Res.* 2010;**468**(4):975–82. doi: 10.1007/s11999-009-0991-7. [PubMed: 19641974].
3. Borrelli JJ, Prickett W, Song E, Becker D, Ricci W. Extraosseous blood supply of the tibia and the effects of different plating techniques: a human cadaveric study. *J Orthop Trauma.* 2002;**16**(10):691–5. [PubMed: 12439191].
4. Lau TW, Leung F, Chan CF, Chow SP. Wound complication of minimally invasive plate osteosynthesis in distal tibia fractures. *Int Orthop.* 2008;**32**(5):697–703. doi: 10.1007/s00264-007-0384-z. [PubMed: 17572892].
5. Toms AD, McMurtie A, Maffulli N. Percutaneous plating of the distal tibia. *J Foot Ankle Surg.* 2004;**43**(3):199–203. doi: 10.1053/j.jfas.2004.03.005. [PubMed: 15181439].
6. Whiteside LA, Lesker PA. The effects of extraperiosteal and subperiosteal dissection. II. On fracture healing. *J Bone Joint Surg Am.* 1978;**60**(1):26–30. [PubMed: 624757].
7. Mockford BJ, Ogonda L, Warnock D, Barr RJ, Andrews C. The early management of severe tibial pilon fractures using a temporary ring fixator. *Surgeon.* 2003;**1**(2):104–7. [PubMed: 15573630].
8. Bahari S, Lenehan B, Khan H, McElwain JP. Minimally invasive percutaneous plate fixation of distal tibia fractures. *Acta Orthop Belg.* 2007;**73**(5):635–40. [PubMed: 18019921].
9. Helfet DL, Koval K, Pappas J, Sanders RW, DiPasquale T. Intraarticular "pilon" fracture of the tibia. *Clin Orthop Relat Res.* 1994(298):221–8. [PubMed: 8118979].
10. Muller ME, Nazarian S, Koch P, Schatzker J. The comprehensive classification of fractures of long bones. Berlin: Springer-Verlag; 1990.
11. Leonard M, Magill P, Khayyat G. Minimally-invasive treatment of high velocity intra-articular fractures of the distal tibia. *Int Orthop.* 2009;**33**(4):1149–53. doi: 10.1007/s00264-008-0629-5. [PubMed: 18654775].
12. Leunig M, Hertel R, Siebenrock KA, Ballmer FT, Mast JW, Ganz R. The evolution of indirect reduction techniques for the treatment of fractures. *Clin Orthop Relat Res.* 2000(375):7–14. [PubMed: 10853149].
13. Helfet DL, Shonnard PY, Levine D, Borrelli JJ. Minimally invasive plate osteosynthesis of distal fractures of the tibia. *Injury.* 1997;**28 Suppl 1**:A42–7. [PubMed: 10897286] discussion A47-8.
14. Egol KA, Weisz R, Hiebert R, Tejwani NC, Koval KJ, Sanders RW. Does fibular plating improve alignment after intramedullary nailing of distal metaphyseal tibia fractures?. *J Orthop Trauma.* 2006;**20**(2):94–103. doi: 10.1097/01.bot.0000199118.61229.70. [PubMed: 16462561].
15. Borg T, Larsson S, Lindsjo U. Percutaneous plating of distal tibial fractures. Preliminary results in 21 patients. *Injury.* 2004;**35**(6):608–14. doi: 10.1016/j.injury.2003.08.015. [PubMed: 15135281].
16. Ozsoy MH, Tuccar E, Demiryurek D, Bayramoglu A, Hayran M, Cavusoglu AT, et al. Minimally invasive plating of the distal tibia: do we really sacrifice saphenous vein and nerve? A cadaver study. *J Orthop Trauma.* 2009;**23**(2):132–8. doi: 10.1097/BOT.0b013e3181969993. [PubMed: 19169106].
17. Oh CW, Kyung HS, Park IH, Kim PT, Ihn JC. Distal tibia metaphyseal fractures treated by percutaneous plate osteosynthesis. *Clin Orthop Relat Res.* 2003(408):286–91. [PubMed: 12616072].
18. Hazarika S, Chakravarthy J, Cooper J. Minimally invasive locking plate osteosynthesis for fractures of the distal tibia–results in 20 patients. *Injury.* 2006;**37**(9):877–87. doi: 10.1016/j.injury.2006.06.002. [PubMed: 16895727].
19. Im GI, Tae SK. 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**(5):1219–23. [PubMed: 16385303] discussion 1223.
20. Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. *Foot Ankle Int.* 1994;**15**(7):349–53. [PubMed: 7951968].
21. Bedi A, Le TT, Karunakar MA. Surgical treatment of nonarticular distal tibia fractures. *J Am Acad Orthop Surg.* 2006;**14**(7):406–16. [PubMed: 16822888].
22. Borens O, Kloen P, Richmond J, Roederer G, Levine DS, Helfet DL. Minimally invasive treatment of pilon fractures with a low profile plate: preliminary results in 17 cases. *Arch Orthop Trauma Surg.* 2009;**129**(5):649–59. doi: 10.1007/s00402-006-0219-1. [PubMed: 16951937].
23. Shanmugam C, Rahmatalla A, Maffulli N. Percutaneous fixation of distal tibial fractures using locking plates. *Tech Orthop.* 2007;**22**(3):162–6.
24. Collinge C, Protzman R. Outcomes of minimally invasive plate osteosynthesis for metaphyseal distal tibia fractures. *J Orthop Trauma.* 2010;**24**(1):24–9. doi: 10.1097/BOT.0b013e3181ac3426. [PubMed: 20035174].
25. Shon OJ, Park CH. Minimally invasive plate osteosynthesis of distal tibial fractures: a comparison of medial and lateral plating. *J Orthop Sci.* 2012;**17**(5):562–6. doi: 10.1007/s00776-012-0241-9. [PubMed: 22570013].
26. Maffulli N, Toms AD, McMurtie A, Oliva F. Percutaneous plating of distal tibial fractures. *Int Orthop.* 2004;**28**(3):159–62. doi: 10.1007/s00264-004-0541-6. [PubMed: 14968266].
27. Sitnik AA, Beletsky AV. Minimally invasive percutaneous plate fixation of tibia fractures: results in 80 patients. *Clin Orthop Relat Res.* 2013;**471**(9):2783–9. doi: 10.1007/s11999-013-2841-x. [PubMed: 23408177].
28. Li Y, Jiang X, Guo Q, Zhu L, Ye T, Chen A. Treatment of distal tibial shaft fractures by three different surgical methods: a randomized, prospective study. *Int Orthop.* 2014;**38**(6):1261–7. doi: 10.1007/s00264-014-2294-1. [PubMed: 24549966].
29. McCann PA, Jackson M, Mitchell ST, Atkins RM. Complications of definitive open reduction and internal fixation of pilon fractures of the distal tibia. *Int Orthop.* 2011;**35**(3):413–8. doi: 10.1007/s00264-010-1005-9. [PubMed: 20352430].


Archive of SID



www.SID.ir