Management of Fractures of the Distal Third of Tibia by Minimally Invasive Plate Osteosynthesis (MIPO) Technique

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Abstract:

Background: Distal tibia fractures are challenging injuries. They are primarily located within a square based on the width of the distal tibia without intra-articular extension. **Objective:** To evaluate the management of fractures of the distal third of Tibia by minimally invasive plate osteosynthesis (MIPO) technique. **Methods:** Fifty patients with distal tibia fractures treated with locked compression plating were included in the study. This was a prospective study done in a tertiary care centre from January 2017 to December 2018. All patients with age >18 years, closed fractures without intra-articular extension and Gustillo type 1 fractures were included. Intra-articular fractures, tibial shaft fractures, elderly patients with co-morbid condition, non-weight bearing limb, pathological fractures and Gustillo type II open fractures were excluded. **Results:** Two (4.0%) were delayed union, 4(8.0%) were ankle stiffness, 4(8.0%) were superficial skin infection and 1(2.0%) were deep infection. Among AOFAS scores, 34(68.0%) cases had excellent, 13(26.0%) had good and 3(6.0%) had fair. **Conclusion:** Distal Tibia fractures can be managed by distal Tibia locking plating through MIPO technique which helps in achieving less infection and also be in rapid union, because it facilitates preservation of the most of skin and soft tissues, blood supply to the bone fragment and anatomical reduction of the fracture. It is a simple, rapid (less hospital stay) and straight forward procedure which has excellent results.

Indexing words: Fracture of tibia, Minimally plate, Osteosynthesis

Introduction:

Distal tibia fractures are challenging injuries. They are primarily located within a square based on the width of the distal tibia without intra-articular extension. They are often caused by high energy axial compressive, direct bending or low energy rotation forces. These fractures constitute less than 7% of all the tibial fracture and less than 10% of all lower extremity fractures.[1] Fractures of distal tibia have been difficult to treat. In this era of increasing life expectancy, there is a rise of elderly population which increases the incidence of these fractures in osteoporotic bones, adding to the morbidity.[2,3]

Minimal invasive plating osteosynthesis (MIPO) has evolved as a newer concept to treat distal tibial fractures with minimal articular comminution and minimal soft tissue damage. Several methods of treatment are implemented including non-operative treatment, external fixation, intramedullary nailing, and internal fixation with traditional implants (standard screws and plates).[4] However, each of these treatment options is associated with certain challenges.[5] But currently, two methods are gaining popularity. One method is wire fixators, which is useful in highly comminuted fractures with significant soft tissue damage. Other is MIPO technique (Minimal invasive plating osteosynthesis) when there is minimal articular comminution and the soft tissue envelope is minimally damaged.[6]

However, compared with the traditional approach, minimally invasive techniques appear to have higher rates of the union, lower rates of postoperative complications and lower incidences of bone grafting.[7,8] In this series, the

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results of 50 cases of fracture distal tibia treated with minimal invasive plating over a period of two years were studied.

Methodology:

Fifty patients with distal tibia fractures treated with locked compression plating were included in the study. This was a prospective study done in a tertiary care centre from January 2017 to December 2018. All patients with age >18 years, closed fractures without intra-articular extension and Gustillo type 1 fractures were included. Intra-articular fractures, tibial shaft fractures, elderly patients with co-morbid condition, non-weight bearing limb, pathological fractures and Gustillo type II open fractures were excluded. AO/OTA classification system was used to classify fractures. Institutional ethics committee clearance was taken for study. Informed consent was obtained from all patients before surgical procedure and for participation in the study. Complete preoperative radiographic assessment was done and preoperative plan was prepared. Broad spectrum intravenous antibiotics were given immediate preoperatively. The patient was positioned supine on a radiolucent operating table under spinal or epidural anaesthesia. Locking Plate Osteosynthesis is done with the MIPO technique. Incision is made over the medial malleolus measuring about 3cms with a gentle curve, sparing the saphenous vein and nerve. Extraperiosteally a tunnel is made by blunt dissection in right orientation. Anatomical distal tibial locking plate is passed through this tunnel by retrograde technique. Locking sleeves can be attached to plate and used to hold the plate at distal end while insertion. Plate is passed in such a way that end of plate is visualized adequately and screws can be inserted distally. Using C arm plate is adjusted to meet the contour of the bone. Fracture reduction is achieved under image intensifier by assessing length, axial and rotational alignment. Plates can be held temporarily by K wires whenever required. Varus-valgus angulation of <50, anterior posterior angulation <100, and shortening of <15mm were considered acceptable reduction. Sagging of distal fragment at fracture site-can be prevented by elevating fracture site with a bolster and plantar flexion of foot Fig-1. A locking cortical or cancellous screw is inserted. Fracture reduction is confirmed and cortical screw is inserted into proximal diaphyseal fragment which helps plate to contact with plate surface [8]. Remaining screws are inserted by stab incisions. Associated fibula fractures when present at syndesmotic level was fixed with plates or Rush nail depending on fracture type. Wound was irrigated with saline and closure done in layers. Sterile dressing was done and well padded posterior splint was given with ankle in neutral position. Static quadriceps exercises & toe movements, as tolerated were begun from 1st postoperative day. Ankle mobilization was started from 3rd postoperative day. Intra-venous antibiotics were given for 3 days followed by a course of oral antibiotics for 5 days. Analgesics were given as per need. Suture removal was done usually on 12th to 14th postoperative day. Protected weight bearing was allowed only once signs of progress toward union were evident, usually at 6 weeks postoperatively. Full weight bearing was allowed after 10 to 12 weeks, depending on the radiographic signs of fracture healing. X-rays would be taken at regular intervals and evaluated for fracture healing, alignment at fracture site & look for any evidence of mal-alignment. Clinically union was defined as painless fracture site during full weight bearing. Radiographically fracture was considered united if 3 of 4 cortices in 2 radiographic views were continuous. Patients were followed up for a period of 1 year at 6 weeks, 12 weeks, 3 months, 6 months and 1 year Fig-2. At the final follow up patients were evaluated using American Orthopaedic Foot and Ankle Society (AOFAS) score.



Fig 1: Compression locking plate and accessories

Result:

Majority (42.0%) patients belonged to age 21-30 years. The mean age of the patients was 39.7±11.0 years with range from 18 to 56 years. Thirty six (72.0%) patients were male and 14 (28.0%) female. Twenty five (50.0%) patients had fracture of left and right tibia respectively. Majority (70.0%) patients were road traffic accident (high energy trauma) was etiological factor, 6(12.0%) were head injury and 33(66.0%) were fibular fractures. More than half (54.0%) patients were injury surgery interval 1-7 day. The mean duration of surgery was found 50.3±8.9 minutes with range from 35 to 70 minutes. The mean duration of union was found 19.1±4.9 weeks with range from 12 to 27 weeks (Table 1). Two (4.0%) were delayed union, 4(8.0%) were ankle stiffness, 4(8.0%) were superficial skin infection and 1(2.0%) were deep infection (Table 2). Among AOFAS scores, 34(68.0%) cases had excellent, 13(26.0%) had good and 3(6.0%) had fair (Table 3).

Table 1: Demographic characteristics of the study patients

	Number of patients	Percentage
Age (years)		
≤20	6	12.0
21-30	21	42.0
31-40	12	24.0
41-50	7	14.0
51-60	4	8.0
Mean±SD (Range)	39.7±11.0	(18-56)
Sex		
Male	36	72.0
Female	14	28.0
Side of fracture		
Left	25	50.0
Right	25	50.0
Road traffic accident		
High trauma	35	70.0
Low trauma	15	30.0
Injury		
Head	6	12.0
Chest	2	4.0
Patellar fracture	3	6.0
Radius fracture	1	2.0
Fibular fractures		
Yes	33	66.0
No	17	34.0
Injury surgery interval		
<12 hour	19	38.0
1-7 day	27	54.0
>7 day	4	8.0
Duration of surgery (min)		
<60	44	88.0
61-120	6	12.0
Mean±SD (Range)	50.3±8.9	(35-70)
Duration of union (weeks)		
≤15	39	78.0
16-30	11	22.0
Mean±SD (Range)	19.1±4.9	(12-27)

Table 2: Complications of the study patients

	Number of patients	Percentage
Delayed union	2	4.0
Ankle stiffness	4	8.0
Superficial skin infection	4	8.0
Deep infection	1	2.0

Table 3: AOFAS scores of the study patients

AOFAS scores	Number of patients	Percentage
Excellent	34	68.0
Good	13	26.0
Fair	3	6.0

Discussion:

In this study showed that the majority (42.0%) patients belonged to age 21-30 years. The mean age of the patients was 39.7±11.0 years with range from 18 to 56 years. Thirty six (72.0%) patients were male and 14 (28.0%) female. Twenty five (50.0%) patients had fracture of left and right tibia respectively. Majority (70.0%) patients were road traffic accident (high energy trauma) was etiological factor, 6(12.0%) were head injury and 33(66.0%) were fibular fractures. More than half (54.0%) patients were injury surgery interval 1-7 day. The mean duration of surgery was found 50.3±8.9 minutes with range from 35 to 70 minutes. The mean duration of union was found 19.1±4.9 weeks with range from 12 to 27 weeks. Jaswani et al.[9] study reported the age of the patients ranged from 20-60 years with the majority (19; 42.22%) of them being in the age of 40-50 years. 26 had a fracture on right and 19 on the left side. The most common mode of injury was road traffic accident in 33 (73.33%) cases. Dhakar et al[1] reported The age of the patients in this study, ranged from 22 years to 62 years average being 41 years. There were 34 male and 16 female patients, 26 patients had fracture of left and 24 patients had fracture of right tibia. Forty three fractures were closed and 7 were open fractures. Road traffic accident (high energy trauma) was etiological factor in 33,

17 cases sustained fractures following fall (low energy trauma). Head injury was present in 5 cases, chest injury in 2 and radius fracture in 1 case. There were 33 cases of associated fibular fractures. Injury surgery interval was less than 8 hours in 14 cases, <3 days for 20 cases, 3-7 days for 14 cases and more than 7 days in 2 cases. Average surgery time was 49mins, 13 cases took 31-40 minutes, 17 (35%) took 41-50 minutes, 12 (24%) took 51-60 minutes, 8 cases took 61-70 minutes. Average union time was 20.96 weeks. Guo et al[10] in their study concluded nailing to be better option for treating distal tibial fractures with atleast 3 cm distal fragment and no articular incongruity. They found no difference in union rate but mean radiation time and operating time were significantly longer in LCP group and no statistical difference was noted in alignment.[10,11] Open reduction and internal fixation leads to increased risk of infection and nonunion.[12,13] Minimally invasive plating techniques reduce iatrogenic soft tissue trauma and damage to vascularity of bone fragments, as well as preserve the fracture haematoma resulting in uncomplicated union. Anatomical reduction of fractures should be done under image intensifier before fixation. Different methods for fracture reduction include calcaneal traction, external fixators or distractors, reduction clamps and interfragmentary screws through stab incision.[14,15] Senthilkumar et al[16] study reported the age groups of patient chosen for the study varied from 21 years to 51 years with the mean age of 36.5 years. Eight among the eighteen cases had associated injuries which include four cases of patellar fracture, two cases of head injury, a case of supracondylar femur fracture and a distal radius fracture. Eleven cases (66%) had signs of union within 16 weeks, four cases (23%) had signs of union within 16-24 weeks, and two cases (11%) had union of more than 2 months. Ashwani et al[17] also reported the mean age of the patients was 39.09±10.13 years with 15 males and 6 females with 52.38% having left tibia involvement. The operating duration mean was 66.67±5.55 min with ranged from 60-80 minutes. The average time for union in our study was 21.70±2.67 weeks.

In this study observed that 2 (4.0%) were delayed union, 4(8.0%) were ankle stiffness, 4(8.0%) were superficial skin infection and 1(2.0%) were deep infection. Dhakar et al.[1] reported Two (4.0%) were superficial skin infection, 2(4.0%) were deep infection, 3(6.0%) were ankle movement restriction, 2(4.0%) were valgus angulation and 4 (8.0%) were implant failure. Intramedullary nailing has advantages of closed stabilization with preservation of fracture haematoma and no damage to overlying soft tissues.[18] However, due to the widening of medullary canal at metaphysis, angular and rotational stability is not achieved. Inadequate reduction, intraoperative loss of reduction after nail insertion, implant failure and malunion are reported complications.[19,20] Ashwani et al.[17] observed implant irritation (23.80%), ankle stiffness (23.80%) and infection (19.04%) were the main complications noted amongst patients. Jaswani[9] reported postoperative complications observed were a superficial infection (1 case), deep infection (1 case) and non-union was seen in one patient. The period of hospitalization ranged from 5 to 21 days.

Dorsiflexion of the ankle is done while observing the anterior aspect of the ankle for skin creases; the absence of a skin crease or wrinkle suggests severe swelling.[20,21] Lau et al. reported late infection rate of 15% in fixation with locking plates.[22] Average rate of infection in various literature available was 5-15%. Delaying surgery if limb is swollen and bruised, gentle soft tissue handling and reducing operative time helps in reducing infection rates.[22,23] Collinge et al. reported a reoperation rate of 5% which included secondary procedure like bone grafting for delayed union.[24] Rate of secondary procedures for delayed union or non union or change of hardware has been reported 3.8% to as high as up to 35%. Implant failure has been reported to be 2-6%. Plate bending or breakage is often associated with malalignment, delayed or nonunion.[22,23,25]

In this study showed that among AOFAS scores, 34(68.0%) cases had excellent, 13(26.0%) had good and 3(6.0%) had fair. Dhakar et al.[1] reported based on AOFAS scores excellent results were obtained in 33, good in 14 and fair in 3 cases. Senthilkumar et al.[16] showed that they achieved 54% excellent, 29% good, and 17% fair results that results is similar to our observation. Functional outcome according to AOFAS score was measured in Ashwani et al.[17] study which came out to mean score was 96.52±4.16, which was similar to studies by Guo et al.[10] and Collinge et al.[24] Jaswani[9] study showed On analyzing the results of MIPO, excellent results were seen in 66.66% cases and 33.34% had satisfactory results. In Ravindra

study of 20 cases, 10(50%) patients had excellent outcome, 4 (20%) had good outcome, 4(20%) had fair outcome and 2 (10%) had poor outcome.[26]

Conclusion:

Distal Tibia fractures can be managed by distal Tibia locking plating through MIPO technique which helps in achieving less infection and also be in rapid union, because it facilitates preservation of the most of skin and soft tissues, blood supply to the bone fragment and anatomical reduction of the fracture. It is a simple, rapid (less hospital stay) and straight forward procedure which has excellent results.

Reference:

1. Dhakar A, Annappa R, Gupta M, Harshwardhan H, Kotian P, Suresh P. Minimally Invasive Plate Osteosynthesis with Locking Plates for Distal Tibia Fractures. Journal of Clinical and Diagnostic Research. 2016; 10(3): RC01-04.
2. 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.
3. Ronga M, Longo UG, Maffulli N. Minimally invasive locked plating of distal tibia fractures is safe and effective. Clin Orthop Relat Res 2010;468:975-82.
4. Salton HL, Rush S, Schuberth J. Tibial plafondfractures: Limited incision reduction with percutaneous fixation. J Foot Ankle Surg. 2007; 46(4):261–9.
5. Zelle BA, Bhandari M, Espiritu M, Koval KJ, Zlowodzki M. Evidence-based Orthopaedic Trauma working group. Treatment of distal tibia fractures without articular involvement: a systemic review of 1125 fractures. *J Orthop Trauma* 2006; (1):76–9.
6. Patel YC, JangidAK and Patel CB. The outcome of minimally invasive plate osteosynthesis (MIPO) technique in distal tibial fracture.International Journal of Orthopaedics Sciences 2017; 3(3): 10-14.
7. Oh C-W *et al*. Percutaneous plating for unstable tibial fractures. *J Orthop Sci* 2003; 8(2):166-169.
8. Leunig M *et al*. The evolution of indirect reduction techniques for the treatment of fractures. *Clin Orthop* 2000; 375:7-14.
9. Jaswani K. Result of minimally invasive plate osteosynthesis (MIPO) with use of locking plate in fracture tibia distal end. International Journal of Biomedical and Advance Research 2019; 10(5): e5183.
10. Guo JJ, Tang N, Yang HL, Tang TS. A prospective, randomized trial comparing closed inramedullary nailing with percutaneous plating in the treatment of distal metaphyseal fractures of the tibia. J Bone Joint Surg Br. 2010;92(7):984-88.
11. Ronga M, Longo UG, Maffulli N. Minimally invasive locked plating of distal tibia fractures is safe and effective. Clin Orthop Relat Res. 2010; 468:975–82.
12. Maffuli N, Toms A, McMurtie A, Oliva F. Percutaneous plating of distal tibia fractures. Int Orthop. 2004; 28:159–62.
13. Redfern DJ, Syed SU, Davies SJM. Fractures of the distal tibia: minimal invasive plate osteosynthesis. Injury. 2004; 35:615–20.
14. Court-Brown CM, Walker C, Garg A, McQueen MM. Half-ring external fixation in the management of tibial plafond fractures. J Orthop Trauma. 1999; 13:200–06.
15. Bedi A, Le TT, Karunakar MA. Surgical treatment of nonarticular distal tibia fractures. J Am Acad Orthop Surg. 2006; 14:406-16.
16. Senthilkumar M, Vanaj P, Sujith H, Anandan H. Distal Tibial Fractures Managed with Locking Compression Plate using Minimally Invasive Plate Osteosynthesis Technique: A Case Study. Int J Sci Stud 2016;4(8):43-47.
17. Ashwani M, Daolagupu AK, Vikash A, Sinha AK. Management of fractures of the extra articular distal tibia by minimally invasive plate Osteosynthesis—A prospective series of 21 patients. International Journal of Medical Research & Health Sciences, 2016; 5(6): 276-282.
18. Vallier HA, Le TT, Bedi A. Radiographic and clinical comparisons of distal tibia shaft fractures (4 to 11 cm proximal to the plafond): plating versus intramedullary nailing. J Orthop Trauma. 2008; 22(5):307–11.
19. Shrestha D, Acharya BM, Shrestha PM. Minimally invasive plate osteosynthesis with locking compression plate for distal diametaphyseal tibia fracture. Kathmandu Univ Med J. 2011;34(2)62-68.
20. Fan CY, Chiang CC, Chuang TY, Chiu FY, Chen TH. Interlocking nails for displaced metaphyseal fractures of the distal tibia. Injury. 2005; 36:669–74.
21. Tull F, Borrelli J. Soft-tissue injury associated with closed fractures: evaluation and management. J Am Acad Orthop Surg. 2003; 11:431–38.
22. 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.
23. Guo JJ, Tang N, Yang HL, Tang TS. A prospective, randomized trial comparing closed inramedullary nailing with percutaneous plating in the treatment of distal metaphyseal fractures of

the tibia. J Bone Joint Surg Br. 2010; 92(7):984-88.

24. Collinge C, Kuper M, Larson K, Protzman R. Minimally Invasive Plating of High- Energy Metaphyseal Distal Tibial Fractures. J Orthop Trauma. 2007; 21:355-61.
25. Ronga M, Longo UG, Maffulli N. Minimally invasive locked plating of distal tibia fractures is safe and effective. Clin Orthop Relat Res. 2010; 468:975–82.
26. Ravindra, Paramesh K. Mipo technique for management of distal third tibia fractures using LCP-precontoured (3.5mm & 4.5mm). International Journal of Orthopaedics Sciences 2016; 2(4): 81-85.