



EVALUATION OF RESULTS OF MINIMALLY INVASIVE PLATING OSTEOSYNTHESIS (MIPO) TECHNIQUE IN THE TREATMENT OF FRACTURES OF DISTAL TIBIA AT SKMCH, MUZAFFARPUR, BIHAR

Orthopaedics

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ABSTRACT

Background: The limited soft tissue, subcutaneous location of large portion of tibia and precarious blood supply renders the treatment of distal tibial fracture very challenging. The main treatment of this type of fracture is reinstatement of the normal alignment and articular congruity. Conventional osteosynthesis is not suitable because distal tibia is subcutaneous bone with poor vascularity. Closed Reduction and MIPO with locking compression plate (LCP) has emerged as an alternative treatment option because it respects biology of distal tibia, maintains fracture haematoma and provides biomechanically stable construct, early mobilization, less complications and relatively higher rates of union. The aim of this study was to evaluate the functional and clinical outcomes of distal tibia fracture of patients, treated by internal fixation by minimally invasive plating osteosynthesis (MIPO) technique with locking compression plate (LCP).

Methods: Sixty patients with distal tibia fracture with or without intra articular extension were treated in Orthopaedics department of Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar with MIPO with LCP and were prospectively followed for average duration of 16 months (6-24 months).

Results: There were 60 patients in the study including 48 males and 12 female of mean age 43 years. The mean follow up period of our patients varied ranging from 6 months to 24 months (average- 16 months). All fractures united at an average of 16 weeks (range- 12 to 20 weeks) except two cases of delayed union(>20 weeks) in patients with Gustilo – Anderson type III A fracture. There were five superficial wound infections which were treated with oral antibiotics and progressed to union and there were no failures of implants. There were two cases of delayed union and malalignment.

Conclusion: Minimally invasive plating osteosynthesis (MIPO) is an effective method of treatment for distal tibial fractures. The use of indirect reduction techniques and small incision is technically demanding as it is effective, minimally invasive, optimises the operation time, promotes early healing and reduces the incidence of infections.

KEYWORDS

Distal tibia fracture, LCP, MIPO, Osteosynthesis, Plating

INTRODUCTION

Distal tibial fracture has always been challenging despite of their best method of management due to subcutaneous location of larger portion of the tibia, paucity of soft tissue coverage and precarious blood supply to the distal tibia. These fracture are associated with severe soft tissue compromise and the involvement of the ankle joint further complicates these complex injuries. According to the reports, 63% of all open type fractures occur in tibia.

Although several classification have been recommended for the distal tibial fractures but the most useful and worldwide accepted is Arbeitsgemeinschaft für Osteosynthesefragen/Orthopedic Trauma Association (AO-OTA) alphanumeric classification. Several methods of treatment are implemented including non-operative treatment, external fixation, intramedullary nailing, and internal fixation with traditional implants (standard screws and plates). However, each of these treatment options is associated with certain challenges. Stable fractures with minimal shortening can be treated conservatively, but requires prolonged immobilisation. It has also been associated with malunion, shortening of affected limb, restriction of range of motion and early osteoarthritis. Non-surgical approach with calcaneal traction remained the treatment of choice prior to case series reported by Reudi and Allgower in 1969 with 84 fractures treated with standard open protocol with 74% of patients reported good to excellent function. External fixation can be a useful option in open fractures with soft tissue injury, but can lead to pin-track infections, septic arthritis, malalignment and delayed union. Soft-tissue management has been seen to play a vital role in the management alongside the bony reconstruction. There are several surgical techniques adapted for the treatment of distal tibia fractures. Each of these techniques has their own merits and demerits. IMIL nailing has been reported with higher rate of malunion.¹⁰ Wound infection, skin breakdown and delayed union or non-union requiring secondary procedures like bone grafting are some of the complications associated with conventional osteosynthesis with plates. Currently two methods are gaining popularity. One method is wire fixators, which is useful in highly comminuted fractures with significant soft tissue damage, whereas MIPO (Minimally Invasive Plate Osteosynthesis) is used when there is minimal articular comminution and minimal damage of the soft tissue envelope. The two techniques are advantageous because of limited soft

tissue stripping, maintenance of the osteogenic fracture haematoma without interrupting vascular supply to the individual fracture fragments.

MIPO works on biological fixation principles in which blood supply to the fracture fragment is maximally preserved and percutaneously inserted plate is placed epiperiostally and fixed at a distance proximal and distal to the fracture site through minimal exposure. Its objective is to assist physiological process of bone healing wisely and optimally with minimal amount of operative intervention. Stress is laid on maintaining a precarious balance between devascularisation and mechanical perfection. Anatomical LCP are commonly used for fracture fixation as it provides an angular stability to the fixation. Locked screws prevent the plate from pressing the bone, preserving periosteal blood supply. This system stimulates callus formation due to flexible elastic fixation. Anatomical shape of the plate prevents malalignment of the fracture and provides a better axial and angular weight distribution.

MATERIAL AND METHODS

Sixty patients of distal tibia fracture with or without intra articular extension were treated in the Department of Orthopaedics, Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, among the patients attending OPD and casualty during the period of March 2019 to August 2020 and prospectively followed. There were 48 males and 12 females. The age ranged from 21 to 70 years (mean 43 years). Radiographs were assessed for classification of fractures and evidence of union. Fractures were classified according to AO-OTA classification system. Open fractures were graded using Gustilo and Anderson classification.¹⁷ Surgery was performed under spinal or General Anaesthesia in the supine position. Tourniquet was applied routinely. A vertical or curvilinear incision was made at the level of medial malleolus with utmost care not to injure great saphenous vein and saphenous nerve. Subcutaneous plane was made without stripping periosteum and disturbance to fracture haematoma.

Fracture was reduced under C-arm guidance. Precontoured anatomical LCP was tunnelled into subcutaneous plane and its position was reconfirmed with C-Arm and was fixed with screws. In some polytrauma patient's fibula was fixed first by open reduction using

DCP/1/3 semitubular plate when fracture of fibula was present. Patients were evaluated in delais preoperatively, perioperatively and post operatively both clinically and radiologically at 1 week, 4 week, 2 months, 4 months, 6 months, 1 year and thereafter.

Inclusion criteria included patients with closed distal tibial fractures with or without articular involvement ranging from AO-OTA Type-A 1 to C 1, presented within seven days from the date of injury, patients with open fractures around ankle including Gustilo –Anderson type I up to type IIIA, presented within six hours from time of injury, fractures with minimal articular comminutions and minimal soft tissue lacerations and polytrauma patients with minor head injuries not requiring neurosurgical intervention.

Exclusion criteria were patients with proximal two-third tibial fractures, patients with severely comminuted articular fractures (AO-OTA type-C 2, C3), patients with severely crushed soft –tissues, skeletally immature patients and patients with major head injuries.

RESULTS

There were 60 patients in the study including 48 males and 12 females of mean age 43 years as shown in Table 1. The fractures were classified according to AO–OTA classification in to various types shown in Table 2. There were 15 patients with A1 type fractures, 18 patients with A2 type, 10 patients with A3 type, 6 patients with B1 type, 6 patients with B2 type, 2 patients with B3 type and 3 patients with C1 type fracture. The commonest cause of injury was RTA. 24 patients had closed fractures and 36 patients had open fractures. Among open fractures, 24 patients had Gustilo – Anderson type –I, 8 patients had type –II and 4 patients had type –IIIA fractures.

Follow-up period of our patients varied ranging from 6 months to 24 months (average-16 months). The mean time to union was 16 weeks, (range– 12 weeks to 20 weeks). In our study 58 fractures united well in time.

There was 2 delayed union in patients who sustained OAOTA type - C1 and Gustilo–Anderson type IIIA fracture, both the patients were treated with the standard MIPO technique after closed reduction of the fracture. There was wound breakdown at 12 days, managed with soft tissue covering. At 4 months postoperatively, there was no evidence of clinical or radiological union and the patient underwent autologous bone grafting from the iliac crest. At 6 months postoperatively, evidence of radiological union appeared and the patient improved clinically and radiologically and full weight bearing (FWB) was allowed.

There were five superficial wound infections which were treated with oral antibiotics and progressed to union.

There were no failures of fixation or implants and there was angulatory malalignment (5o varus) in two patients with AO-OTA type –C1 fracture.

All fractures united at an average of 16 weeks (range 12 to 20 weeks). As regards pain, 36 patients (60%) were pain-free, 16 patients (26.66%) had only occasional pain after stressful activities and not requiring medication, 8 patients (13.33%) had mild to moderate pain requiring analgesics.

Except two all patients had full ROM. Two patient had restricted ROM, dorsiflexion <10o and eversion <5°.

According to the clinical rating system by Teeny and Wiss, 46 patients (76.66%) had excellent results, 8 patients (13.33%) had good result, 4 patients (6.66%) had fair results and 2 patients (3.33%) had poor result as in Table 3.

Table 1 : Distribution of cases between both sexes in specified age groups

Age (Year)	No. of cases (Males)	Age (Years)	No. of cases (Females)
21-30	10	21-30	06
31-40	11	31-40	03
41-50	05	41-50	01
51-60	18	51-60	02
61-70	04	61-70	0

Table 2 : AO-OTA classification

Type	Subtypes
Type A 43 (71.66%)	A1 15(25%)
	A2 18(30%)
	A3 10(16.66%)
Type B 14 (23.33%)	B1 6(10%)
	B2 6(10%)
	B3 2(3.33%)
Type C 3 (5%)	C1 3(5%)
	C2 0(0%)
	C3 0(0%)

Table 3 : Results as per clinical scoring system by Teeny and Wiss

AO-OTA Type	Excellent (%)	Good (%)	Fair (%)	Poor (%)	Total
A1	15(100)	-	-	-	15
A2	16(88.88)	1(5.55)	1(5.55)	-	18
A3	8(80)	2(20)	-	-	10
B1	4(66.66)	2(33.33)	-	-	6
B2	2(33.33)	3(50)	1(16.66)	-	6
B3	1(50)	-	1(50)	-	2
C1	-	-	1(33.33)	2(66.66)	3
Total	46(76.66)	8(13.33)	4(6.66)	2(3.33)	60



Fig. 1: intra-operative photograph of MIPO technique



Fig. 2: A male patient aged 24 years old had a fracture in distal tibia after RTA that was classified as 43-A3 according to AO classification. Operated using the MIPO technique with post-operative radiographs and follow-up after one year X-ray showing complete union of the fracture.

DISCUSSION

Fracture of distal tibia with or without intra articular extension is a challenge despite of the best method of treatment because majority of these fractures are unstable, comminuted with extensive soft tissue damage.

Treatment of these fractures with ORIF with conventional plate, IMIL nailing resulted in high rates of complication. This led surgeons to the conclusion that in the treatment of distal tibial fractures including pilon fractures, soft tissue management is as important as the bony reconstruction. The ideal method of treatment is that would achieve excellent articular reduction and stability while minimising soft tissue compromise and devascularisation of the fracture fragments. With the development of technique of MIPO with LCP which preserve extraosseous blood supply, respect osteogenic fracture haematoma, biologically friendly and stable fixation method is available for distal tibial fracture.

Indirect reduction method and subcutaneous tunnelling of the plate and application of locking screws with small skin incision in MIPO technique prevents Iatrogenic injury to vascular supply of the bone. Unlike conventional plates, LCP is a fracture independent self stable construct which provides both Angular and axial stability and minimises risk of secondary loss of reduction through a threaded interface between the screw heads and the plate body. Helfet et al treated distal tibial fractures by MIPO in 2 stages. In the first stage they fixed the fibular fracture, if present, and applied an external fixator to the tibia. In the second stage they did a limited ORIF of the pilon fracture, and introduced subcutaneously a semitubular plate that they

contoured manually to the shape of the distal tibia. They applied this protocol to 20 patients with 8 intraarticular and 12 open extraarticular distal tibial fractures. All their fractures united. Two fractures healed with $>5^\circ$ varus alignment and 2 fractures healed with $>10^\circ$ recurvatum. No patient had a deep infection. The average range of motion in the ankle for dorsiflexion was 14° and plantar flexion averaged 42° .

Hazarika et al treated 20 patients who had open and closed distal tibia fractures with minimally invasive locking plate osteosynthesis (MILPO). Thirteen of their patients had preliminary external fixation. Average time to full weight bearing was 18.1 weeks (closed fractures), and 19.3 weeks (open fractures). Two fractures (one open – one closed) who had temporary external fixation were bone grafted from the iliac crest during the definitive MILPO procedure. They had two cases of wound breakdown and one case of wound infection, one case of implant failure, and one case of reflex sympathetic dystrophy. However, in their report, they did not comment on the functional results of the patients. Stable internal fixation and early mobilization is one of the current concepts in fracture treatment. However, it is difficult to obtain a stable internal fixation in an osteopenic bone. The screw is weakly held to the bone and pull-out is probable which may cause implant failure. We encountered no implant failure in patient with osteoporosis. Anatomical reduction of the fracture before applying the plate is very important surgical step.

Malreduction and suboptimal pre contouring of the plate can result in delayed union, nonunion, prominent hardware, malleolar skin irritation and pain. MIPO technique can restore alignment in high velocity distal diaphyseal tibia fracture and patients can expect predictable return of function. However, Collinge et al reported increased secondary procedure rate like bone grafting for delayed union.

We in our study included selected patients with minimal intra-articular comminutions and minimal soft-tissue injuries and as we know that MIPO works on biological fixation principle, we believed in indirect reduction technique and did not disturb the natural biological environment of the fractures. We had seen obvious benefits of the procedure as we rarely needed bone-grafts, also union rates improved, infection rates decreased and early mobilization could become possible. Our method of treatment did not involve preliminary external fixation as in the Helfet et al's and Hazarika et al's series, rather used only calcaneal traction in few selected cases with intra-articular comminutions till soft-tissue healed, because we avoided to increase the morbidity of already compromised distal tibia. Utilizing the MIPO technique as a second stage procedure, further protecting the soft tissue envelope by minimizing the surgical insult (large wound size, periosteal stripping) which might in itself lead to major complications (wound breakdown, infection, delayed or non-union). The MIPO technique was very useful in fractures with metaphyseal comminution as it avoided attempts at fixation of small comminuted fragment and a bridging fixation was done between the proximal and distal segments.

Like any procedure, MIPO is also not without demerits such as perfect anatomical reduction of all fragments should not be expected, congruity must be tried to be maintained as far as possible through separate stab incisions if required. Another possible demerit is plate impingement to the skin and entrapment of neurovascular structures (long saphenous vein, saphenous nerve, artery or tendons), but we never faced. Local wound complications like infections and wound breakdown can also occur, which were managed with oral antibiotics and by soft-tissue covering in two cases of wound breakdown in our series. The same case shown the tendency toward delayed union, so we grafted that case with iliac bonegraft and union finally achieved. As regards clinicoradiological outcomes of our results were very good and comparable to other studies on MIPO for distal tibial fractures.

CONCLUSION

MIPO with LCP is a reliable and effective method of treatment for the distal tibial fractures with or without intra articular extension, preserving most of the osseous vascularity and fracture hematoma and thus providing for a more biological repair. The use of indirect reduction technique and small incision is technically demanding as it is effective, minimally invasive, safe, optimises the operation time, reduces the incidence of infection, allows restoration of limb alignment and provides good clinical and radiological results with low complications and high union rates.

REFERENCES

- Konrat G, Moed BR, Watson JT, Kaneshiro S, Karges DE, Cramer KE. Intramedullary nailing of unstable diaphyseal fractures of the tibia with distal intraarticular involvement. *J Orthop Trauma*. 1997;1:200-5.
- Salton HL, Rush S, Schubert J. Tibial plafond fractures: Limited incision reduction with percutaneous fixation. *J Foot Ankle Surg*. 2007;46(4):261-9.
- 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(1):76-9.
- Othman M, Strzelczyk P. Results of conservative treatment of "pilon" fractures. *Ortop Traumatol Rehabil*. 2003;5:787-94.
- Digby JM, Holloway GM, Webb JK. A study of function after tibial cast bracing. *Injury*. 1983;14:432-9.
- Metcalfe BP. Pilon fractures of the tibia. *Curr Orthop*. 2003;17(3):190-9.
- Ruđi T, Allgöwer M. Fractures of the lower end of the tibia into the ankle joint. *Injury*. 1969;1:92-99.
- Anglen JO. Early outcome of hybrid external fixation for fracture of the distal tibia. *J Orthop Trauma*. 1999;13:92-7.
- McFerran MA, Smith SW, Boulas HJ, Schwartz HS. Complications encountered in the treatment of pilon fractures. *J Orthop Trauma*. 1992;6:195-200.
- 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.
- Redfern DJ, Syed SU, Davies SJM. Fractures of the distal tibia: minimally invasive plate osteosynthesis. *Injury*. 2004;35:615-20.
- Apivatthakakul T, Phomphutkul C, Patumasutra S. Idea and innovation: Simple minimally invasive plate osteosynthesis (MIPO) instruments. *Injury Extra*. 2009;40:39-44.
- 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.
- 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.
- De Boer P, Metcalfe R. Mini-symposium: Tibial fractures, (iv) Pilon fractures of the tibia. *Curr Orthop*. 2003;17:190-9.
- Field JR, Hearn TC, Caldwell CB. Bone plate fixation: an evaluation of interface contact area and force of the dynamic compression plate (DCP) and the limited contact-dynamic compression plate (LCDCP) applied to cadaveric bone. *J Orthop Trauma*. 1997;11:368-73.
- Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. *J Bone Joint Surg [Am]*. 1976;58(4):453-8.
- Teeny SM, Wiss DA. Open reduction and internal fixation of tibial plafond fractures. *Clin Orthop Relat Res*. 1993;292:108-17.
- Helfet DL, Shonnard PY, Levine D, Borrelli BJr. Minimally invasive plate osteosynthesis of distal fractures of the tibia. *Injury*. 1997;28(1):42-8.
- Hazarika S, Chakravarthy J, Cooper J. Minimally invasive locking plate osteosynthesis for fractures of the distal tibia – Results in 20 patients. *Injury*. 2006;37:877-87.
- Koval KJ, Meek R, Schemitsch E, Liporace F, Strauss E, Zuckerman JD. An AOA critical issue. Geriatric trauma: young ideas. *J Bone Joint Surg Am*. 2003;85:1380-8.
- Kim WY, Han CH, Park JJ, Kim JY. Failure of intertrochanteric fracture fixation with a dynamic hip screw in relation to pre-operative fracture stability and osteoporosis. *Int Orthop*. 2001;25:360-2.
- Gupta RK, Rohilla RK, Sangwan K, Singh V, Walia S. Locking plate fixation in distal metaphyseal tibial fractures: series of 79 patients. *Inter Orthop*. 2010;34:1285-90.
- Collinge C, Kuper M, Larson K, Protzman R. Minimally invasive plating of high energy metaphyseal distal tibia fractures. *J Orthop Trauma*. 2007;21:355-61.