



Original Research Article

Study of distal tibial extra-articular fractures fixed with locking compression plate using MIPO technique

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ABSTRACT

Background: Fractures of distal tibial metaphysis present a management challenge because of their inherent instability, scarcity of soft tissue, subcutaneous nature and poor vascularity of bone. MIPO techniques are advantageous because of limited soft tissue strapping, maintenance of the osteogenic fracture haematoma without interrupting vascular supply to the individual fracture fragments.

Materials and Methods: This is a study of 20 patients of closed extra articular distal tibial fractures treated with anatomical LCP applied on antero-medial surface of lower end tibia with MIPO technique. Age was ranging from 20 to 60 yrs. 14 male and 6 female patients were there. 7 patients were having fibula fracture at same level of tibia fracture, they were fixed with DCP/ 1/3rd tubular plate before fixing tibia.

Results: AO/OTA type 43 A1 fractures were there in 15 patients. 4 pts. were having 43 A2 and one pt. was having 43 A3 type fracture. Average operation time was 80 mins. Average union time was 18.5 weeks. One pt. was having delayed union, one having superficial skin infection, one having 6° varus angulation and one having malleolar skin irritation. No pts. required second surgery of bone grafting. No implant failure.

Conclusion: MIPO with LCP is a reliable and effective method of treatment for the distal tibial extra-articular fractures, preserving most of the osseous vascularity and fracture haematoma and thus providing a more biological repair. Using indirect reduction technique and small incision is technically demanding.

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1. Introduction

Distal tibial fractures are one of the most complex injuries around the ankle joint, accounting for approximately 7% of all tibial fractures.¹ Fractures of the distal tibial metaphysis are challenging as there is inherent instability, soft tissues are scarce and vascularity of bone is poor. Treatment method is determined by the fracture displacement, comminution, intra-articular extension and injury to the soft-tissue envelope.² Soft-tissue treatment is very much important in the management beside the bony reconstruction.³ 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 But, each of these modality is having certain challenges.⁵

We can treat stable fractures with minimal shortening conservatively, but it has to be immobilized for long time. It has also been associated with malunion, shortening of affected limb, restriction of range of motion and early osteoarthritis.^{6,7} External fixation is useful in open fractures, but it can lead to mal-alignment, delayed union, pin-track infections & septic arthritis.⁸

Large exposure is required for the dynamic compressive plating technique to perform reduction and plate fixation. Associated with the large exposure is an increase in the risk of non-union and infection.^{9,10} The intramedullary nail spares the extraosseous blood supply, allows load sharing,

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and avoids extensive soft tissue dissection.^{11,12} However, proximal and distal shaft fractures can be difficult to control with an intramedullary device, increasing the frequency of malalignment.¹³ Concerns regarding difficulties with reduction/ loss of reduction, inappropriate fixation in fractures with articular extension, anterior knee pain¹⁴ and hardware failure have slowed the acceptance of intramedullary nailing as a treatment of fractures of the distal tibia. The need to innovate nails with tip locking proves that earlier nails were having insufficient fixation for distal tibia; however tip locking is technically difficult and fractures that require it are essentially difficult to fix with nails.^{11,13,15}

Minimally invasive plate osteosynthesis (MIPO) techniques are advantageous because soft tissue stripping is limited and osteogenic fracture haematoma is maintained without interrupting vascular supply to the individual fracture fragments. MIPO works on biological fixation principles in which percutaneously inserted plate is placed epiperiosteally and fixed away from the fracture site to preserve blood supply of the fracture fragments maximally. It assists physiological process of bone healing wisely and optimally with minimal amount of operative intervention. 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.¹⁶ Callus formation is stimulated as it is flexible elastic fixation. Malalignment is prevented by anatomical shape of plate.

The distal tibial fracture should be treated like 'open fracture' due to its poor soft tissue cover, which will be contused from the injury, even there is no open wound. So to minimize secondary damage to the soft tissues by the surgical approach and implants is very much important. Therefore we evaluated MIPO technique in distal tibial extra articular fractures.

2. Materials and Methods

This is a study of 20 patients of closed extra articular distal tibial fractures treated with anatomical LCP applied on antero-medial surface of lower end tibia with MIPO technique. Open fractures, pathological fractures, old neglected fractures, old fractures with implant failure and fractures associated with neurovascular injuries or compartment syndrome were excluded from the study.

After stabilising the patient, routine investigations were carried out. Standard A-P and lateral radiographs of the involved leg with knee and ankle were taken. The limb immobilised in a plaster slab till definitive surgery. Patients with bad skin condition were managed with elevation of leg, regular dressing care and prophylactic antibiotics; surgery delayed until the 'wrinkle sign' was appeared, but performed within 2 weeks from injury. X-rays were evaluated for fracture morphology, site and amount of comminution. The fibular fracture was looked for and

surgical plan decided accordingly. The probable length of the plate was calculated.

Surgery was performed under spinal anaesthesia with a tourniquet in the supine position on a radiolucent table. In the distal tibia the anatomical locking compression plate was applied on the antero-medial surface. A locking compression plate of adequate length in order that 6-8 cortices are obtained on either side of the fracture was kept on the leg and visualised under C-arm. The fracture reduced by indirect means.

After provisional reduction, about 3 to 4 cm long vertical incision was given at the middle of the medial malleolus and a subcutaneous tunnel made with an artery forceps. Then the chosen locking compression plate with a locking sleeve attached into its distal hole was held with a pen-like grip. The plate was tunnelled proximally subcutaneously across the fracture, with use of the locking sleeve as handle. Smooth and gentle supination-pronation movements were used while advancing the plate. The thumb was kept anteriorly on the tibial crest to guide the plate onto the antero-medial surface of the tibia. The plate was centered on the proximal fracture fragment in both antero-posterior and lateral views with the assistance of a locking sleeve inserted into the foremost proximal hole.

Following confirmation, a K-wire was used to fix the plate onto the tibia. Non locking screws were applied first in either the proximal or distal fragment as needed for helping the reduction of the fracture so as to pull the bone to the plate. The locking screws were inserted only when the fracture reduction was satisfactory. The proximal holes are often located in thin patient by palpation through the skin. A plate of similar size was placed over the skin to localise the hole in the inserted plate (Mirror plate technique).¹⁷ Only in obese patient, C-arm help was needed to localise the locking hole. All the distal screws were inserted under direct vision through the incision put over the medial malleolus. Minimum 6-8 cortices were fixed proximal and distal to fracture site. Fracture fibula was fixed first by open reduction using DCP or 1/3rd tubular plate when fracture of lower fibula was present.

Intravenous antibiotic was continued for 5 days after the surgery. After that 5 days of oral antibiotics were given. Suture or staple removal was done at 12th post-operative day. Active quadriceps exercises were started on the 1st post-operative day with active ankle and toe movements with knee mobilization as far as the patient is comfortable and free of pain. The patients were made to mobilize from the 3rd post-operative day without weight bearing on the operated limb with walker. The patients were followed up at regular intervals of 6 weeks to assess clinically, functionally and with radiological evaluation. Partial and full weight-bearing were allowed based on radiological consolidation of the fractures. The fracture was believed as united, when there was periosteal bridging callus at the fracture site at

minimum three cortices in the antero-posterior and lateral views. Trabeculations extending across the fracture was also taken into account.

3. Results

All 20 patients were having closed, extra-articular distal tibia fractures. Age was ranging from 20 to 60 yrs., average age was 41 yrs. 14 male and 6 female patients were there.

Cause of fracture was road traffic accidents in 12 pts., domestic fall in 5 pts. and fall from height in 3 pts. 12 were right sided and 8 were left sided fractures.

Table 1: Fracture distribution according to AO/OTA classi system

AO fracture type	No. of patients
43 A1	15
43 A2	4
43 A3	1
Total	20

Fibula was intact in 5 patients, it was fractured in middle or upper region in 8 patients and was fractured at lower region (at level of tibia fracture) in 7 patients. We fixed all that 7 lower fibula fractures with DCP/1/3rd tubular plate.

Table 2: Duration of surgery in minutes

Duration of surgery in minutes	No of patients
0-60	0
60-90	12
90-120	8

Average operative time was 80 minutes.

Table 3: Duration of fracture union

Duration in weeks	No of patients
12-16	3
16-20	13
20-24	3
>24	1

Average union time was 18.5 weeks.

Table 4: Complications

Type of complication	No of patients
Superficial skin infection	1
Deep infection	0
Ankle movement restriction	
>50%, 25-50%, <25%	0, 1, 1
Varus angulation	1
Malleolar skin irritation	1
Implant failure	0



Fig. 1: Case 1: Pre-operative x-ray



Fig. 2: Case 1: Post-operative x-ray



Fig. 3: Case 1: 20 weeks follow-up x-ray



Fig. 4: Case 1: Range of movements at 20 weeks



Fig. 7: Case 2: 20 weeks follow-up x-ray



Fig. 5: Case 2: Pre-operative x-ray



Fig. 8: Case 2: Range of movements at 20 weeks



Fig. 6: Case 2: Post-operative x-ray

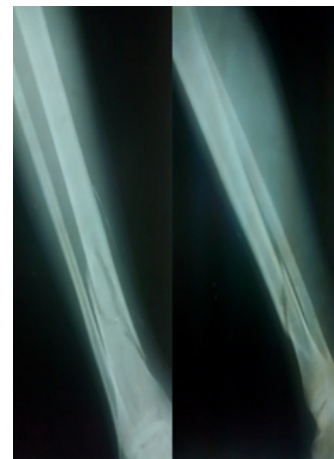


Fig. 9: Case 3: Pre-operative x-ray

4. Discussion

Fracture of distal tibia with or without intra-articular extension is a challenge despite 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 or 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



Fig. 10: Case 3: Post-operative x-ray



Fig. 13: Position of the limb showing incision with plate insertion technique



Fig. 11: Case 3: 20 weeks follow-up x-ray

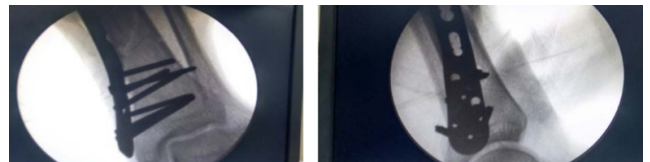


Fig. 14: Intra operative C-arm images



Fig. 12: Case 3: Range of movements at 20 weeks

management is as important as the bony reconstruction. The ideal method of treatment is one that would achieve reduction and stability while minimising soft tissue compromise and devascularisation of the fracture fragments. With the advent of MIPO technique with LCP which preserve extra-osseous blood supply and respect osteogenic fracture haematoma; now biologically friendly and stable fixation method is available for distal tibial fractures. 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 self stable and fracture independent implant, which provides both angular and axial stability and minimises risk of secondary reduction loss through a threaded interface between the plate body and screw head.

Stable internal fixation and early mobilization of joints is one of the current concepts in the treatment of fractures. But it is difficult to get 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.¹⁸ With LCP inserted by MIPO, we encountered no implant failure in patients with osteoporosis.

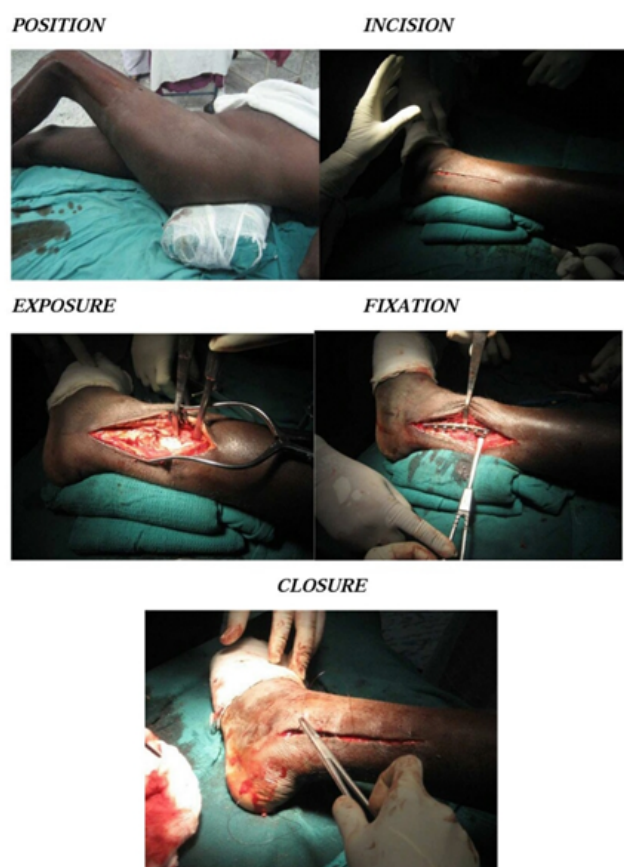


Fig. 15: Fibula fixation

Anatomical fracture reduction should be done under IITV before fixation. Different methods for fracture reduction include calcaneal traction, external fixators or distractors, reduction clamps and interfragmentary screws through stab incision.^{2,14,19} Fibula fractures when present, also affect fracture reduction. For better alignment fibular fractures were fixed before tibia. No clear guidelines exist in literature for fibular fixation but when syndesmosis is involved it should be fixed.^{20–23} Malreduction can result in delayed or non-union and malleolar skin irritation and pain due to prominent hardware.²⁴ In our study one patient was having malleolar skin irritation, in which we removed implant after fracture united. One patient was having 6 degree varus angulation, but clinically not having any complain.

Malunion is an uncommon complication after LCP. Percentage of malunion in literature varies from 0-5%. Delayed union and non-union has been reported to be 5-16% in various studies. Collinge et al. reported a reoperation rate of 5% which included secondary procedure like bone grafting for delayed union.²⁵ Rate of secondary procedures for delayed or non-union or change of implant 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 non-union.^{12,21,23}

As MIPO works on biological fixation principle, we believed in indirect reduction technique, not to disturb the natural biological environment of the fractures. We had seen obvious benefits of the procedure as we had not needed bone-grafts, also union rates improved, infection rates decreased and early mobilization could become possible. In our study one patient of type A3 comminuted fracture was having delayed union but fracture was united without bone-grafting.

Like any procedure, MIPO is also not without disadvantages like - perfect anatomical reduction of all of the fragments should not be expected, congruity should be tried to be maintained as much as possible through separate stab incisions if needed. 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 entrapment in our study.

Local wound complications like infections and wound breakdown can also occur. Due to subcutaneous location these fractures are associated with gross swelling, skin damage and blisters. Skin condition determines the timing of surgery. Wound dehiscence and infection can occur if surgery is done with poor soft tissue conditions. Stabilization by splinting, icepacks and delaying surgery helps in avoiding further soft tissue damage and better preoperative soft tissue condition. Surgery done when the swelling subsided and the wrinkle sign appeared. 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.^{22,26} In our study 4 cases were operated after 3 days due to poor skin condition. No difference was there regarding union rates and complications in those who were operated before 3 days or after.

Guo JJ et al. reported more wound complications in LCP group (14.6%) compared to nailing group (6.8%).¹² Lau et al. reported late infection rate of 15% in fixation with locking plates. Average rate of infection in various literature was 5-15%. In our study one patient got superficial infection which was cured by injectable antibiotics. No deep infection or wound breakdown was seen in our study. Delaying surgery if limb is swollen and bruised, gentle soft tissue handling and reducing operative time helps in reducing infection rates.^{12,20,21,23}

5. Conclusion

MIPO with LCP is a reliable and effective method of treatment for the distal tibial extra-articular fractures, preserving most of the osseous vascularity (which is particularly critical in distal tibial injuries) and fracture haematoma and thus providing a more biological repair. The use of indirect fracture reduction technique and limited incision is technically demanding. It is minimally invasive

& safe, reduces the incidence of infection, allow restoration of limb alignment and provides good clinical & radiological results with low complications and high union rates. It helps in early mobilization of ankle, reducing ankle stiffness, thus improving functional outcome.

6. Source of Funding

None.


7. Conflict of Interest

The author declares no conflict of interest.

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