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Outcome of minimally invasive plate osteosynthesis (MIPO) technique in distal tibial fracture

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Abstract
Background: Distal tibial fractures including tibial pilon present a challenge due to subcutaneous location of tibia and precarious blood supply of distal leg. MIPO (Minimal invasive plating osteosynthesis) has evolved as a newer concept to treat distal tibial fractures with minimal articular comminution and minimal soft tissue damage
Method: A prospective study for the management of distal tibial fractures by MIPO technique by using LCP (locking compression plate) was done, in 20 patients. Patients were followed and scored according to TEENY and WISS scoring criteria.
Result: Among 20 patients, there were 16 males and 4 females with a mean age of 41.4 yrs (range from 20-76yrs). High energy trauma (road traffic accident) predominated causing 11 fractures. Superficial wound infections were seen in 02 cases, surgical wound breakdown with implant exposure in 01 case. 15 patients had excellent, 3 patients had good outcome and 02 patients had fair outcome.
Conclusion: We conclude that MIPO is an effective technique for the management of distal tibial fractures.

Keywords: Distal tibia, MIPO technique, Locking Compression Plates (LCP)

Introduction
The fractures of distal tibia including tibial pilon pose great challenge to the surgeon due to subcutaneous location, scarcity of blood supply and paucity of soft tissue coverage. The involvement of the ankle joint and the vulnerability of the surrounding soft tissues further complicate these already complex injuries. Indications for minimally invasive plate osteosynthesis of distal fractures include displaced fractures involving the tibial plafond and those unstable fractures too distal for safe stabilization with intramedullary nails. Numerous classifications have been proposed for these fractures; however AO-OTA alphanumeric classification is the most comprehensive and commonly quoted classification. This led to change in the philosophy of treating such injuries. 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 envelop is minimally damaged. Minimally invasive techniques maintains alignment without compression; the operative exposure and soft tissue stripping are minimized with vascular pedicle preserved throughout. This present study describes the minimally invasive technique and its usefulness in distal tibial fractures.

Material & Methods
This study was conducted in Department of Orthopaedic, Government medical college, and associated S.S.G. Hospital, Vadodara (Gujrat). Total 20 patients of distal tibial fracture were managed and evaluated during. The objective was to evaluate functional and clinical outcome of MIPO technique in distal tibial fractures, in patients of age group 20 years and above. Fractures were classified as per AO Classification (Fig. 1) and Type A, Type B and Type C1 were included in the study.

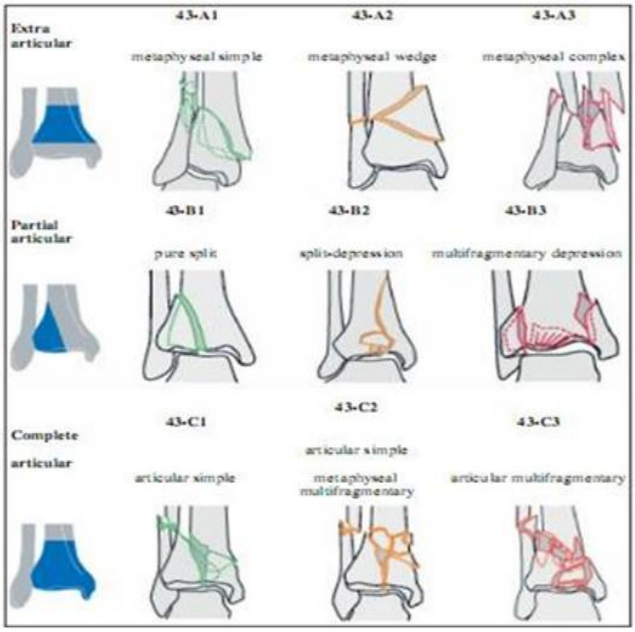
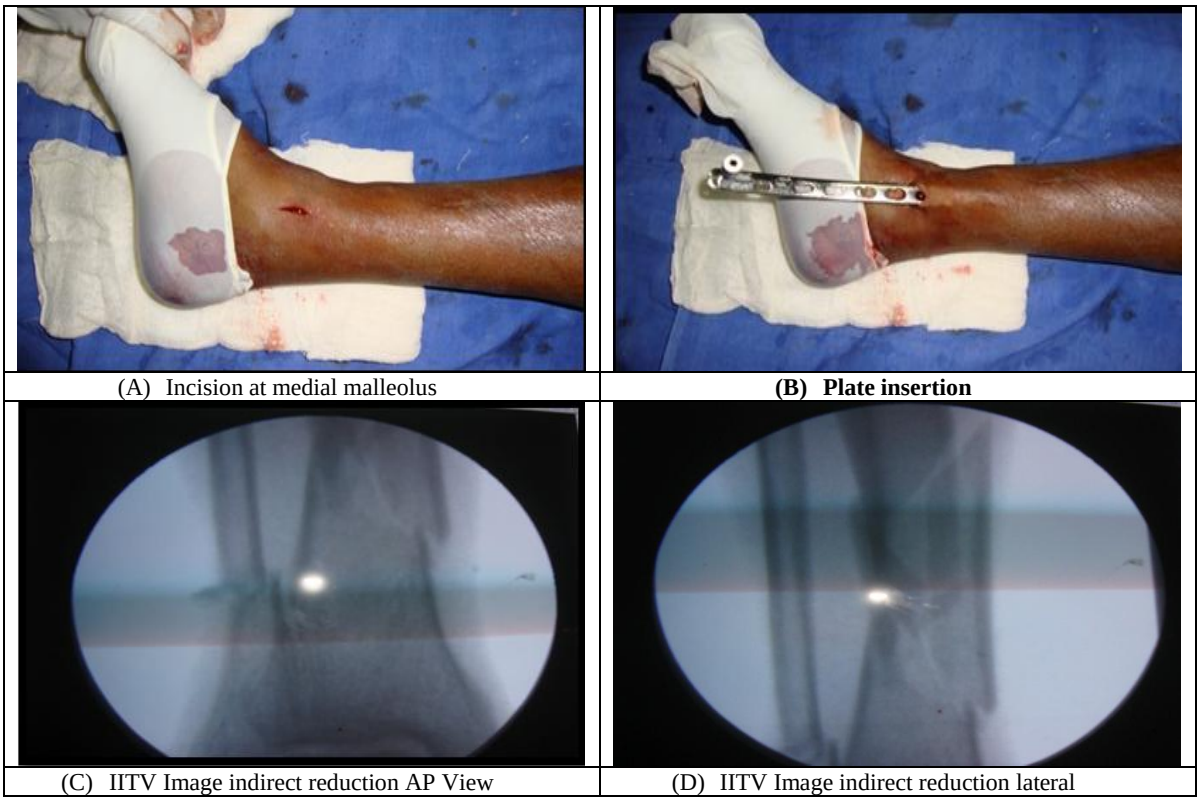


Fig 1: AO/OTA Classification of Distal Tibial fracture. Three types i.e. extra-articular, partial articular, and complete articular and nine groups based on the amount of comminution

Patients with open fractures except grade I, severely crushed and contaminated, those associated with major head injuries and injuries presented AO-OTA types C2, C3 were excluded from the study. The patients with closed fracture were treated by anti-edema drug for 5-7 days until the skin was wrinkled. Preoperative antibiotics (first- generation cephalosporin) were administered 30 minutes before the operation.

Surgical Technique

Patient was taken to the plain radiolucent table in supine position. The affected limb was scrubbed and prepared with savlon. Painting and draping was done under aseptic and antiseptic condition. After patient was prepared preliminary reduction was done with traction and manipulation under image intensifier. For minimally invasive plate insertion, small incision of 3-4 cm length either vertical or horizontal placed distal to the fracture over the medial aspect of tibia to access the medial malleolus (Fig. 2). An extra periosteal, subcutaneous tunnel is created with long scissors or a periosteal elevator using Blunt dissection. Precontoured locking compression plate for the tibia is then inserted along the tunnel. The plate can be slided under IITV image control in A-P and Lateral views. Drill guide can be used as handle for percutaneous insertion into one of the distal combi holes. The fracture fragments were reduced and reduction confirmed using image intensification. Reduction was stabilized using one of the following methods: The locking screw didn't provide interfragmentary compression; therefore, any desired compression was achieved with standard lag screws. The articular fractures was reduced and compressed prior to fixation of the 3.5 mm LCP Medial distal tibial plate with locking screws. If a combination of cortex and locking screws had Been used, the cortex screw had been first inserted to pull the plate to the bone. The screws were inserted with percutaneous method. Under IITV guidance, with knife small incision was kept over the combi hole either for simple or locking screw. The stab wounds were closed with suture. Sterile dressing with spirit applied. Below knee slab applied and patient was shifted to ward with vital signs monitoring. Post-operatively the limb was maintained in the elevated position while the patient was in bed and ambulation begun on first post-operative day in the form of toe-touch weight-bearing with crutches. On second post-operative day, gentle exercises for the ankle were begun. Radiographs, including anteroposterior and lateral views were taken at 2 weeks, 6 weeks and 3 months post-operatively to assess healing and alignment. Partial weight-bearing started depending upon their clinical and radiographic evalution, but in general most patients had advanced to partial weight-bearing by 8 weeks. Final evaluation was done for distal tibial fractures as per Teeny and Wiss clinical assessment criteria which is based on 100 points system.

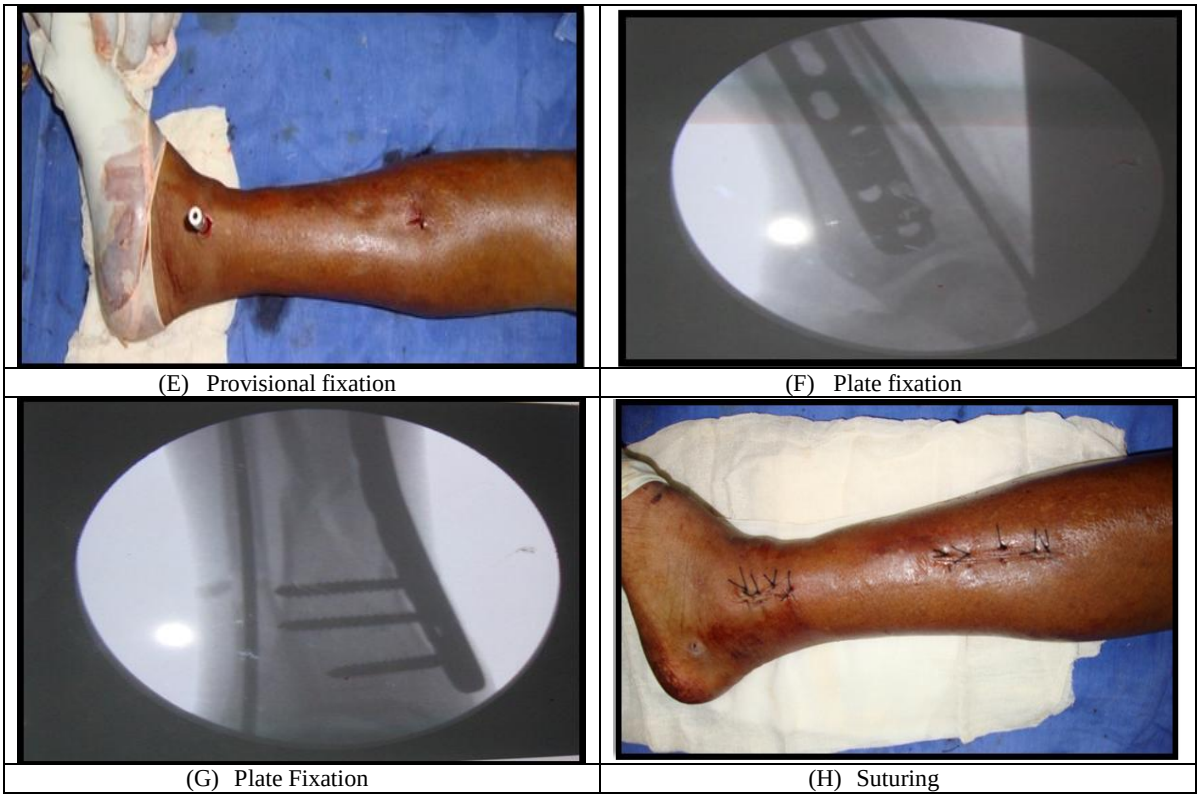


(A) Incision at medial malleolus

(B) Plate insertion

(C) IITV Image indirect reduction AP View

(D) IITV Image indirect reduction lateral



(E) Provisional fixation | (F) Plate fixation

(G) Plate Fixation | (H) Suturing

Fig 2: Surgical Technique

Table 1: Teeny and Wiss criteria (symptoms and functional evaluation of ankle)

Parameters	Points
1. Pain	
a) No pain, including long walks, running or sports.	50
b) Slight or occasional pain, pain after long walk or sports, or mild pain at end of day.	45
c) Mild pain with walking or running, but no change in activities of daily living. May have some pain going up or down stairs or walking on uneven ground. May require non-narcotic pain medicine several times a week.	40
d) Mild-moderate pain, tolerable, but re quires some concessions to pain. May required daily non- narcotic pain medicine? No night pain.	30
e) Moderate pain. Definite change in activities of daily living, pain at rest or at night, despite restriction of activities. Occasional weak narcotic needed.	20
f) Continuous pain, regardless of activities, most often not relieved with non- narcotic medication. Dependent on narcotic pain medicine for significant pain relief. Severe limitations of activities.	10
g) Disabled because of pain. Constant pain, no relief with medicines.	0
2. Distance	
a) Unlimited	8
b) Limited, but greater than 6 blocks	6
c) 4-6 blocks	4
d) 1-3 blocks	2
e) Indoors only	1
f) Bed-chair, or unable to walk	0
3. Supports or Orthosis	
a) None	8
b) Soft wrap needed for long walk	7
c) Cane or orthosis, only for long walks	6
d) Cane, single crutch or orthosis full time	4
e) Two canes or two crutches	2
f) Walker or unable to walk	0
4. Running	
a) Unlimited, as such as desired	5
b) Limited, but able to run	3
c) Unable to run	0
5. Toe raising	
a) Able to raise on toes x 10 repetitions	5
b) Able to raise on toes x 5 repetitions	3
c) Able to raise on toes x 1 repetitions	1
d) Unable to raise on toes	0
6. Hills (up or down)	
a) Up and down normally	3

b) Climbs and /or descends with foot externally rotated	2
c) Climbs and/or descends on toes or by side stepping	1
d) Unable to climb and/or descend hills	0
7. Stairs (up or down)	
a) Climbs and descends nor mally	3
b) Needs banister	2
c) Steps down and/or up with normal foot only	1
8. Limp	
a) None	8
b) Only when fatigued	6
c) Slight, constant	4
d) Moderate, constant	2
e) Marked	0
9. Swelling	
a) None	3
b) Only in the evening or after walking	2
c) Constant, mild (less than 1 cm difference around calf)	1
d) Marked	0
10. Plantar range of motion	
a) Greater than 30°	2
b)Greater than 10°	1
c) Less than 10°, or presence of equine s contracture	0
11. Dorsal range of motion	
a) Greater than or equal to 15°	5
b) Greater than or equal to 10°, less than 15°	4
c) Greater than or equal to 0°, less than 10°	3

Table 2: Clinical results graded as excellent, good, fair or poor

Rating	Results
Excellent	(>92 points)
Good	(87-92 points)
Fair	(65-86 points)
Poor	(<65 points)

Results

There were 20 patients of distal tibial fracture operated with MIPO technique among which 16 were males and 4 females with a mean age of 41.4years (range of 20-76 yrs). As per AO classification, 18 patients sustained extra-articular fractures (type A) and 00 partial intra-articular fractures (type B) and 02 patients intra-articular fractures (type C-01). High energy trauma predominated in this study, causing 13 fractures. Average trauma surgery interval in this study was 12 days (02-22days). Complications like superficial wound infection was seen in 02 cases, surgical wound breakdown with implant exposed in 01 case which healed with antibiotic and daily dressing and prominent hardware was seen in 01 case which was asymptomatic. According to the Teeny and Wiss criteria (Table 1) 15 patients (75%) had excellent outcome, 3 patients (15%) had good outcome and two cases (10%) with complications had fair outcome.

Table 3: Results in different types of Fracture

Results	Type A	Type B	Type C	Total
Excellent	14	00	01	15
Good	03	00	00	03
Fair	01	00	01	02
Poor	00	00	00	00

Discussion

Distal tibia fracture with or without intra articular extension is one of the difficult fractures to manage. None of the treatment options available perfectly fulfill requirements of fracture characteristics of distal tibia. The goals of treatment of a distal tibia fracture are anatomical articular reduction, restoration of axial alignment, maintenance of joint stability, achievement of fracture union, pain free weight baring and motion, without any wound complications.

The treatment plan in distal tibia fracture depends on fracture pattern, soft tissue injury, patient co-morbidity, fixation resources, and surgical experience. Distal tibia has got circular cross sectional area with thinner cortex as compare to triangular diaphysis with thicker cortex. So intra-medullary nail which is designed for tight interference fit at diaphysis cannot provide same stability at distal fracture. Other potential complications of IMIL nailing are malunion (0-29%) and implant failure (5-39%). ORIF with conventional plate which needs striping of periosteum is also not an ideal treatment option because tibia is subcutaneous bone and periosteum provides 2/3rd of blood supply.

The disadvantage of MIPO is more radiation exposure to the operating team compared with ORIF as it uses indirect reduction under fluoroscopy. However, the advantage of MIPO is soft tissue preservation under treatment with skillful surgeons and may lower the risk of radiation exposure and avoid unfavorable results. Similarly external fixators as a definitive method of treatment for distal tibia fracture are also reported with higher rate of infection, implant failure and malunion or non-union and hence recommended only for temporary method of stabilization in open fracture with severe soft tissue injury.

With the development of technique of MIPO with LCP which preserve extra osseous blood supply, respect osteogenic fracture haemotoma, biologically friendly and stable fixation method is available for distal tibia fracture. Indirect reduction method and sub-cutaneous tunneling of the plate and application of locking screws with small skin incisions in MIPO technique prevents iatrogenic injury to vascular supply of the bone.

The average age incidence in this study is 41.40 yrs (range 20 yrs-76 yrs) and sex distribution is of 16 males (80%) and 4 females (20%) and 11 patients right side and 9 patient left side trauma, showing similarity with other studies Ghulam Shabbir *et al*. (2011) [20], The high association of distal tibial fracture in males can be attributed to our Indian set up where female largely work indoor and do not travel much. High

energy trauma, road traffic accidents predominate causing 55% of the fractures and has been similarly reported by studies in Ghulam Shabbir *et al.* (2011) [20].

Average trauma surgery interval in this study was 11 days (range 02-18 days) which is more than other studies of Ghulam Shabbir *et al.* (2011) [20], where average range is 1-10 days.. Radiologic union and full weight bearing was achieved in average 17.8 weeks showing similarity with other studies Ghulam Shabbir *et al.* (2011) [20]. On overall assessment of results we are able to achieve 75% excellent results, 15% good results, 10% fair results.

Indirect reduction of fracture under fluoroscopy is difficult at time. Various reduction maneuvers such as calceneal pin traction, external fixators or mechanical distracters have been described to achieve reduction. Concominant fibula fracture also play the role in success of reduction especially when fracture is at same level of tibia. Some authors recommend fibula fixations before tibia fixation to achieve better tibial alignment and to prevent valgus malalignment but clear indication for fibula fixation are still lacking and controversial. In this study, 03 cases were treated with fibular plating along with tibial fixation due to syndesmosis involvement.

Complications like superficial wound infection in 02 cases and surgical wound breakdown with implant exposure in 01 case might be attributed to nosocomial infection which healed with antibiotics and daily dressing. Good preparation of soft tissue in preoperative program can reduce superficial wound infection. Prominent hardware was due to lean and thin patient but it did not require any treatment as it was of asymptomatic nature.

Conclusion

Limited number of patients in the study, short duration of follow up and evaluation of extra-articular and intra-articular fracture in same study has limited the final result. Further studies with longer follow up and large sample size will give addition aid to results. But based on favorable outcome of 90% cases from the study we conclude that MIPO is an effective technique for the management of distal tibial fractures.

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