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**Dr. Rajani Kumar Giddi**  
Associate Professor, Department  
of Orthopedics, Andhra Medical  
College, Visakhapatnam, Andhra  
Pradesh, India

**Dr. D Santhosh Karunakar**  
Assistant Professor, Department  
of Orthopaedics, Andhra Medical  
College, Visakhapatnam, Andhra  
Pradesh, India

**Dr. Vamsi Krishna Pudi**  
Assistant Professor, Department  
of Orthopaedics, Andhra Medical  
College, Visakhapatnam  
Andhra Pradesh, India

**Corresponding Author:**  
**Dr. Rajani Kumar Giddi**  
Associate Professor, Department  
of Orthopedics, Andhra Medical  
College, Visakhapatnam, Andhra  
Pradesh, India

## A prospective observational study of functional outcome of fracture distal end of Tibia, treated with minimally invasive plating osteosynthesis (Mippo) technic

**Dr. Rajani Kumar Giddi, Dr. D Santhosh Karunakar and Dr. Vamsi Krishna Pudi**

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### Abstract

**Background:** Distal tibia fractures including Tibia pilon fractures present a challenge as to their best method of management due to subcutaneous location of larger portion of tibia, paucity of soft tissue coverage and precarious blood supply to the distal leg. The involvement of the ankle joint and the vulnerability of the surrounding soft tissues further complicate these already complex injuries. Numerous classifications have been proposed for these fractures, however AO-OTA alphanumeric classifications the most comprehensive as well as the most commonly quoted classification. The lower end of the tibia including its medial and the lateral malleoli of the fibula form a socket (mortise) into which the body of the talus articulates, and along with capsule and ligament thus form the ankle joint. Any disruption of length, axis or rotation of the fibula or the tibia can result in an incongruent ankle joint. The lateral aspect of the distal tibia forms a triangular notch where the fibula articulates. The interosseous membrane and the anterior and posterior tibiofibular ligaments bind these bones together.

**Aim:** To evaluate the efficiency of internal fixation for the fractures of distal tibia by using minimally invasive plating osteosynthesis [Mippo] technique. To assess the functional outcome of Mippo technique with locking compression plate and dynamic compression plate.

**Methods:** A prospective observational study of patients above the age of 20 years with distal tibia fracture admitted in King George hospital, Visakhapatnam. Study duration 9 months.

**Results:** There were 72 patients in the study including 50 males (69.4%) and 22 females (30.6%) of mean age 46 years. The commonest cause of injury was RTA with High energy trauma with total of 31 patients (43.06%) followed by Low energy RTA with total of 28 patients (38.89%) and the rest 28 of the patients with Low energy fall (18.06%) respectively. All fractures united at an average of 15 weeks (range 12 to 20 weeks). As regards pain, 48 patients (66.66%) were pain-free, 18 patients (25%) had only occasional pain.

**Conclusion:** It is well accepted that the final outcome of distal tibial fractures including pilon fractures with this MIPPO technique, a single stage operative procedure. It is obvious that these are not directly influenced by this technique MIPPO, single-stage operative procedure, contributing to a favorable outcome.

**Keywords:** Mortis, AO-OTA, Mippo, tscherne and gotzen

### Introduction

Distal tibial fractures including tibial pilon fractures present a challenge as to their best method of management due to subcutaneous location of larger portion of tibia, paucity of soft tissue coverage and precarious blood supply to the distal leg<sup>[1]</sup>. The involvement of the ankle joint and the vulnerability of the surrounding soft tissues further complicate these already complex injuries. Numerous classifications have been proposed for these fractures, however-OTA alphanumeric classification is the most comprehensive as well as the most commonly quoted classification. Ruedi and Allgower popularized open reduction and internal fixation (ORIF) for these fractures and established treatment guidelines<sup>[5]</sup>. However, their impressive results were not paralleled by other authors and subsequent reports showed a significant number of major complications. This was mainly attributed to lack of appreciation of the damage to the soft tissues, and on the other hand attempting to apply the principles of ORIF to all types of pilon fractures injuries without discrimination.

This led to a change of the philosophy of treating such injuries, with more respect to the soft tissues and a tailored management of different fracture types. The classic ORIF with buttress plating now being replaced with other methods of fixation. Currently two methods are gaining popularity. One method is wire fixators, which is useful in highly comminuted fractures with significant soft tissue damage. The other method is minimally invasive plate osteosynthesis (MIPPO), when there is minimal articular comminution and the soft tissue envelope is minimally damaged.

**Modalities of treatment for distal tibial fractures**

1. Conservative- By traction and plasters, but its disadvantages are prolonged immobilization, joint stiffness, malunion, delayed union, and nonunion.
2. External Fixation-Its Disadvantages-Pintrack infection and loosening, malunion, stiffness of ankle joint, and nonunion [2].
3. ORIF –Its disadvantages-High rates of infections, delayed union and nonunion [3].
4. MIPPO -It is a new concept. It works on Biological Fixation Principles, in which blood supply to the fractured fragments is maximally preserved, and Percutaneously inserted [4] plate is placed epiperiostally and fixed at a distance proximal and distal to the fracture site through minimal exposure [5]. Its Objective is to assist physiological process of bone healing wisely and optimally with minimal amount of operative intervention.

**Biological Fixation In MIPPO**

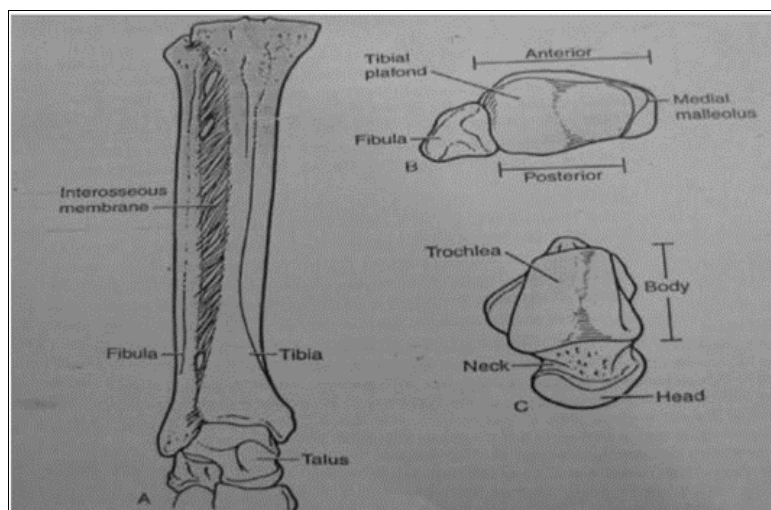
1. Repositioning and Realigning by manipulation at a distance to the fracture site, preserving soft tissues [i.e, Indirect Reduction Technique.]
2. Leaving comminuted fragments out of the mechanical construct, while preserving their blood supply.
3. Limited operative exposure.

**Advantages of MIPPO**

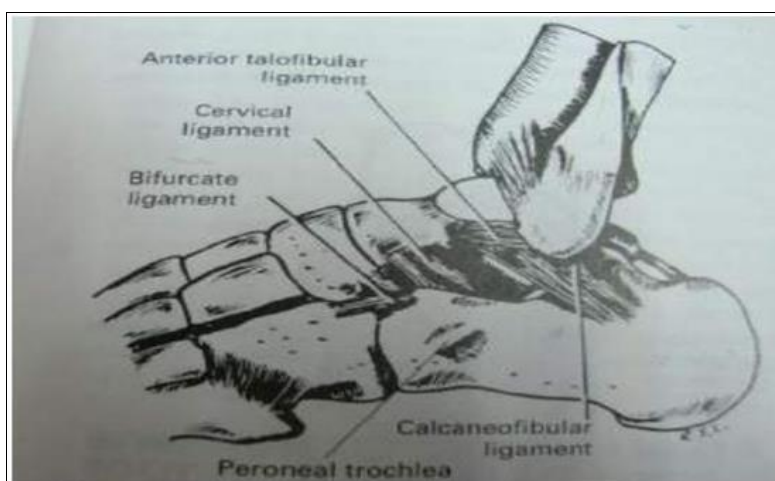
1. Improve rates of fracture union
2. Decrease rate of infection
3. Decrease need for bone graft
4. Early mobilization of the extremity.
5. Ideal technique for dealing with multiply injured patients.
6. No need of additional expensive instrumentations.
7. Learning curve short, and
8. Decreased incidence of refracture after plate removal.

**Biomechanics**

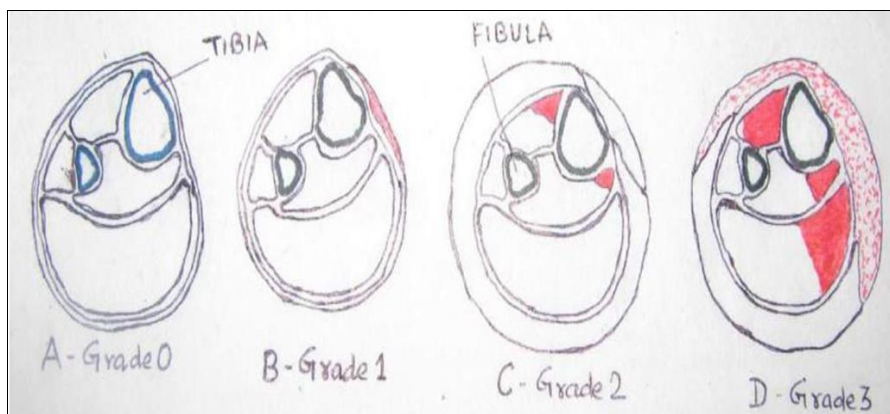
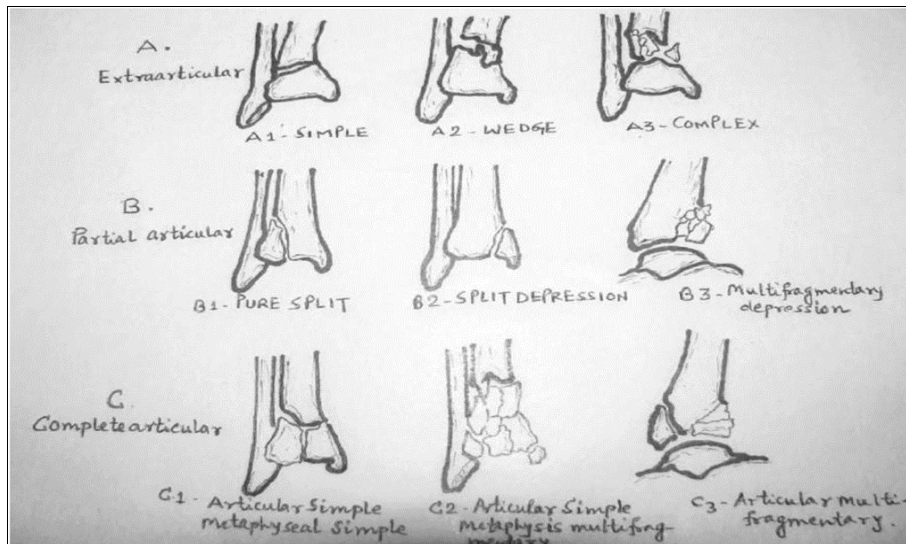
MIPPO works on Biological Fixation Principles, in which blood supply to the fractured fragments is maximally preserved, and Percutaneously inserted plate is fixed at a distance Proximal and distal to the fracture site through minimal exposure. Its Objective is to assist Physiological process of bone healing wisely and optimally with minimal amount of operative intervention. Stress is laid on maintaining a precarious balance between Devascularisation and mechanical perfection.



**Fig 1:** Bony Anatomy of the ankle joint A. Mortis view; B. Infero-superior of tibiofibular side of the Joint. C. Supero-inferior view of talus



**Fig 2:** Lateral side of the ankle



**Fig**

**T scherne and Gotzen Grading system of soft-tissue injury in closed fractures.**

1. **Grade 0:** Little or no soft-tissue injury.
2. **Grade 1:** Superficial abrasion with local contusional damage to skin or muscle.
3. **Grade 2:** Deep contaminated abrasion with local contusional damage to skin and muscle.
4. **Grade 3:** Extensive contusion or crushing of skin or destruction of muscle.

**AIM:** To evaluate the efficiency of internal fixation for the fractures of distal tibia by using minimally invasive plating osteosynthesis [Mippo] technique. To assess the functional outcome of Mippo technique with locking compression plate and dynamic compression plate.

**Materials and Methods**

**Study area**

Andhra Medical College, affiliated to NTRUHS, King George hospital, Visakhapatnam, Andhra Pradesh, India.

**Study population**

All patients above the age of 20 years with distal tibia fracture admitted in Department of Orthopaedics.

**Type of study**

Prospective observational study.

**Study Period**

(March 2021 to-December 2022)

**Sample size:** A total of patients admitted in the department of orthopedics having distal tibia fracture falling under the inclusion criteria.

**Sample size is calculated using the formula:** We will use following formula to calculate sample size

$$N = (Z_{1-\alpha/2}^2 \times p(1-p)) / e^2$$

Where  $\alpha$  is the level of significance and  $Z_{1-\alpha/2}$  is standard value of Normal deviate (=1.96)

$p$  is the proportion of excellent score [15] and  $e$ = precision (error).

In a previous study<sup>15</sup> it was seen that 75% of patients got excellent functional score ( $p=0.75$ ).

Precision of error taken as 10%

$$\begin{aligned} \text{Therefore calculated sample size is} &= 1.96 \times 1.96 \times 0.75 \times (1 - 0.75) / 0.01 \\ &= 72.03 \approx 72 \end{aligned}$$

We studied in 72 cases.

**Inclusion criteria**

1. 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.
2. Patients with open fractures around ankle including Gustilo –Anderson type I upto type IIIA, presented within six hours from time of injury.
3. Fractures with minimal articular comminutions and minimal soft –tissue lacerations.

4. Polytrauma patients with minor head injuries not requiring neurosurgical intervention.

**Exclusion criteria**

1. Patients with proximal two –third tibial fractures.
2. Patients with severely comminuted articular fractures (AO-OTA type-C 2, C3).
3. Patients with severely crushed soft –tissues.
4. Skeletally immature patients.

**Study design:** Prospective observational study.

**Study intervention:** No Intervention during study period.

**Study methodology**

The study conducted in patients with distal tibia fracture falling under inclusion criteria. After taking informed and written consent of all patients, detailed history was taken and examined clinically and radiologically. All preoperative routine investigation done. After pre-anaesthetic checkup. The surgery was performed under spinal or general anesthesia. All patients will be positioned accordingly using operating table. We included in our study both types of distal tibial fractures, Closed and Open. For closed fractures, we put the cases

directly for definitive procedure, i.e, MIPO, as early as the soft tissue swelling subsided and skin wrinkles appeared, usually within seven days. All the open fractures treated in two stages; First stage comprises wound debridement, wait for 1 -2 weeks to allow the soft tissue to heal and putting calcaneal traction for fractures with articular comminutions. After complete healing soft tissue injury, we put the case for second stage i.e, MIPO, as the definitive procedure.

Day 2 dressing was done under aseptic condition. All the patients were assessed both clinically and radiological 6 weeks, 3 months, 6 months and 1 year based on subjective parameters (like pain and walking), objective parameters (like deformity, range of movement) and radiological findings (like fracture union, consolidation, maintenance or loss of reduction, position of implant and radiographic evidence) and postoperative complications.

**Method of measurement of outcome of interest**

Functional outcome of patients is evaluated by Clinical and radiological follow up using. Teeny and Wiss criteria at 6 weeks, 3 months, 6 months.

**Table 1:** Teeny and wiss criteria

Rating	Result
Excellent (>92 Points)	No pain, normal gait, normal range of motion, no swelling
Good (87-92)	Minimal pain, 3/4 normal motion, normal gait, trivial swelling.
Fair (65-86)	Aching with use, 1/2 noelmal motion, normal gait, mild swelling, NSAIDS.
Poor (<65)	Pain with walking or at rest, 1/2 normal motion, limp, swelling

Under GA fracture reduced by manual traction and pointed reduction clamp if necessary and the reduction checked by the C-Arm. Then the fibula fixed through the posterolateral approach by a DCP /One third tubular plate / rush nail in some cases. Provisional fixation of the articular fragments done percutaneously with pointed reduction clamp and k-wires which were removed later. In 2 cases fixation of articular fragments with lag screws outside the plate done through separate stab. A 3 c.m. long incision made over medial malleolus and a subcutaneous extraperiosteal/epiperiosteal tunnel created through that with a blunt periosteal surf for the introduction of LCP.

**After treatment**

Post-operatively, AP and lateral radiographs were used to check the fracture reduction and the congruency of articular surface of the ankle. Postoperatively, the leg was elevated and anti-oedema drugs were given to guard against postoperative oedema

**Results and statistical analysis**

There were 72 patients in the study including 50 males (69.4%) and 22 females (30.6%) of mean age 46 years. The commonest cause of injury was RTA with High energy trauma with total of 31 patients (43.06%) followed by Low energy RTA with total of 28 patients (38.89%) and the rest 28 of the patients with Low energy fall (18.06%) respectively. Among the age group maximum patients were at the age interval between 50-60 years. There were equal distribution of the side of injury with 50% each of right and left side. The interval between injury and treatment for most of the patients

were 1 day (38 patients out of 72) and only 3 patients were treated at the interval of beyond 4 days. Follow-up period of our patients were for 6 months. The mean time to union was 15 weeks,

(Range-12 weeks to 20 weeks). There was six delayed-union patients who sustained OA-OTA type - A 2 fracture and Gustilo –Anderson type I fracture and was treated with the standard MIPPO technique after closed reduction of the fracture. There was wound breakdown at 12 days, managed with soft-tissue covering. At 3 months postoperatively, there was little evidence of clinical or radiological union and the patient underwent autologous bone grafting from the iliac crest. At 4.5 months postoperatively, evidence of radiological union appeared and the patient improved clinically and 20 weeks complete radiological union occurred and full weight bearing (FWB) allowed.

There were five superficial wound infections which were treated with oral Levofloxacin and oral cefuroxime and progressed to union. There were no failures of fixation or implants and two angulatory malalignment in patients with AO-OTA type –C 1 with overall

Poor functional outcome.

All fractures united at an average of 15 weeks (range 12 to 20 weeks). About 48 Patients (66.66%) were pain-free, 18 patients (25%) had only occasional pain after stressful activities and not requiring medication, 6 patients (8.33%) had mild to moderate pain requiring analgesics.

**Statistical analysis method**

All continuous variables will be presented as mean ± sd or median (1<sup>st</sup> quartile, 3<sup>rd</sup> quartile) as appropriate. All qualitative data will be presented as numbers and percentages.

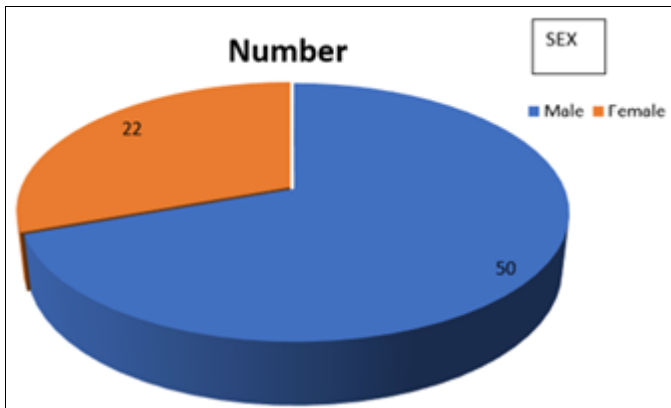


Fig 1: Number

Male	50
Female	22
Total	72

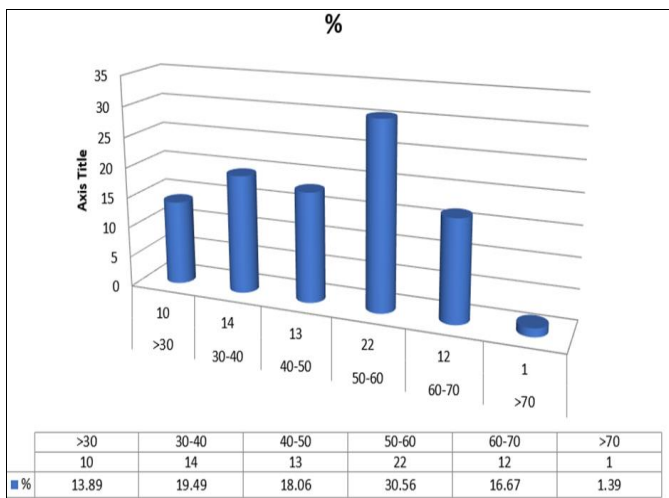


Fig 1: Age Distribution

Table 2: Post-Operative Data

Time of radiological union(weeks)	<b>15.65±1.35</b>
Time of full weight bearing(weeks)	<b>15.65±1.35</b>

Table 3: Interval between injury and treatment Interval (days)  
Average 1.69±0.93 median

Days	Number of patients	Percentages
1 day	38	52.7%
2 days	23	31.94%
3 days	8	11.11%
≥4 days	3	4.16%

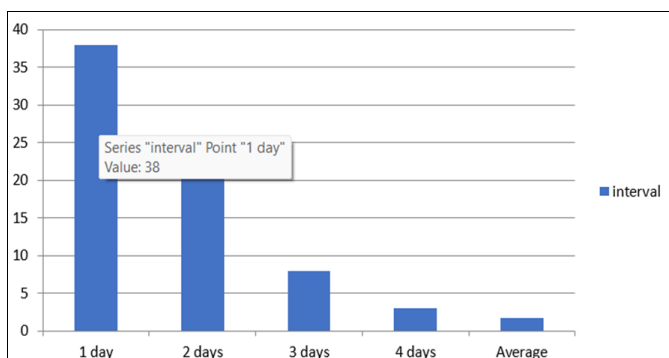


Fig 2: Interval

Table 4: Interval between injury and treatment

Score	No. of patients	Percentage
Excellent	61	84.7%
Good	04	5.6%
Fair	5	6.9%
Poor	2	2.8%
Total	72	

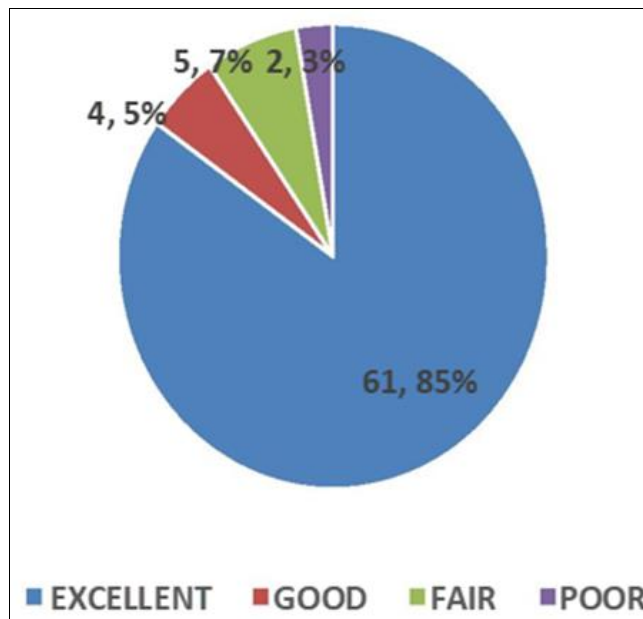


Fig 4: Interval between injury and treatment

### Discussion

The landmark paper by Ruedi<sup>6</sup> and Allgower with 74% of their patients free from pain and with good functional results at four years follow-up revolutionized the management of pilon fractures which were treated predominantly conservatively before that. According to 1970-80 studies the authors concluded that in the management of distal tibial fractures including Pilon fractures, soft tissue management is as important as the bony reconstruction. Comparison<sup>6,7,8,9</sup> of minimally invasive percutaneous plate Osteosynthesis<sup>11</sup> with open reduction and internal fixation for treatment of extra-articular distal tibia fractures witnessed widespread application of the principles of ORIF in the management of pilon fractures [12, 13, 14] however, this was accompanied by a shockingly high rate of major complications including nonunion up to 18%, superficial infections up to 20%, osteomyelitis up to 17%, arthrodesis rates of 27%, below knee amputation rates of 6%, post-traumatic osteoarthritis rates of 54% and mal-unions in 42% of patients. This has led many authors to conclude that the avoidance of soft tissue complications has to be a primary focus and factored into any surgical plan and that treatment based on the degree of soft tissue compromise yielded better results. Finally, the ideal method of treatment is one that would achieve excellent articular reduction and stability while minimizing soft tissue compromise and devascularization of the fracture fragments. Consequently, new tactics were utilized for the management of distal tibial fractures, including pilon fractures including: delayed ORIF, limited ORIF, hybrid fixators, and MIPO. The MIPPO 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.

The plate we used was an anatomical prebent plate rather than

a manually contoured semitubular plate that Helfet *et al.* used thus providing strong fixation as it allowed for insertion of 2 or 3 cancellous 5.5 mm screws in the small distal. Segment while conforming to the anatomical features of the distal tibia. As regards functional outcome, we adopted an easy, simple and well-accepted. Teeny and Wiss clinical rating scoring system, based on clinical parameters and our results are comparable to those of Helfet *et al.* [15, 16]

### Summary

After taking proper history and consent local and systemic examination and after radiological evaluation patient was planned for surgery. Adequate analgesia was started as soon as patient was admitted. Routine preoperative investigation was done, After taking pre anaesthetic clearance from anaesthetist patient was posted for surgery. In fracture of distal tibia surgery will performed after reducing the fracture under fluoroscopy control in fracture table. Antibiotic was started 1 hour prior to surgery and Continued till stitch off. On postoperative day 2 dressing was done. Physiotherapy was started from 1<sup>st</sup> postoperative day for all patients. Stitch off was done at 2weeks of Postoperative period. Duration of surgery was 60 minutes. In our study all patients were evaluated clinically, radiologically and using Teeny and Wiss clinical score. At the final follow up with Teeny and wiss<sup>10</sup> clinical score for distal tibia fracture using MIPPO technique 61 cases (84.7%) were excellent, 4 cases(5.6%) were good, 5 cases (6.9%) were fair and 2 cases(2.8%) were poor outcome. Hence MIPPO is a reliable, relatively a traumatic procedure which offers combined advantages of minimal soft tissue damage with stable, rigid and bridge-fixation of fractures.

### Limitations of the study

The notable short comings of this study are:

1. The sample size was small. Only 72 cases are not sufficient for this kind of study.
2. The study was carried out in a tertiary care hospital, so hospital bias cannot be ruled out.

### Conclusion

With the aim to evaluate the efficiency of internal fixation for the fractures of distal tibia by using Minimally Invasive Plating Osteosynthesis (MIPPO) technique. The purpose of our study was to evaluate the functional and radiological results of 72 consecutive patients in age-group 20 years and above, and to follow them in prospective way. We followed our patients up both clinically and radiologically at 1 week, 4 weeks, 8 weeks, 4 months, 6 months and thereafter. Our overall follow-up period was for 6 months. After proper pre-operative care of the injured limb and after appearance of skin wrinkles, we put the cases with close fractures directly for single- stage definitive procedure i.e, MIPPO.

We used in all but one cases distal tibial anatomical LCP on anteromedial surface of tibia inserted through subcutaneous epiperiosteal tunnel created by small linear incisions which was fixed provisionally by 2 k-wires, one proximal and one distal after manual traction and indirect reduction, then finally 3-4 distal and 3 proximal screws applied sparing the fractured segment, thus creating a bridging rigid construct. All these steps were done under c-arm guidance. In first case of our series we used non-anatomical LCP which was contoured intra-operatively. For open fractures, we routinely followed two-stage protocol. In first stage, necessary debridement, thorough saline wash, splintage in plaster of paris (POP) back

slab, limb elevation, anti-inflammatory drugs and prophylactic oral antibiotics (cefuroxime/Levofloxacin) given. We applied calcaneal traction variably, particularly in patients with fractures involving articular surface, in more comminuted and impacted metaphyseal fractures and in moderate soft tissue lacerations in which definitive MIPPO procedures were anticipated to be delayed.

**To conclude**, it is well accepted that the final outcome of distal tibial fractures including Pilon fractures is largely dependent upon the residual articular displacement and articular Chondral damage. It is obvious that these are not directly influenced by this technique of MIPPO, but we believed that the real advantages lie in the prevention of soft tissue problems and the possibilities for earlier and even single-stage operative procedures, contributing to a favourable outcomes. MIPPO is a reliable, relatively a traumatic procedure which offers combined advantages of minimal soft tissue damage with stable, rigid and bridge-fixation of fractures. It allows restoration of limb alignment and yields successful clinic-radiological outcomes for moderate to high-energy distal tibial fractures.

### Conflict of Interest

Not available

### Financial Support

Not available

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