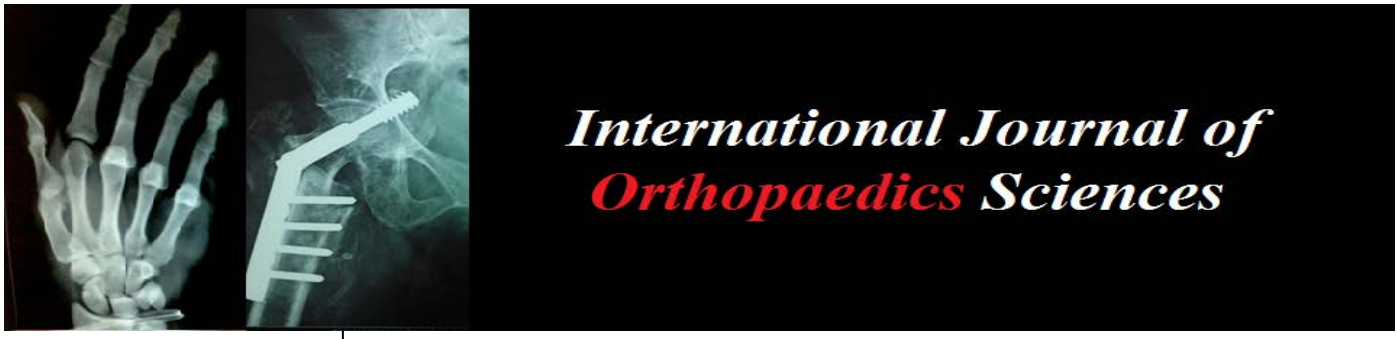

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2021; 7(3): 382-385

www.orthopaper.com
Received: 10-05-2021
Accepted: 12-06-2021

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A prospective study of distal tibial fracture fixation with anatomical osteosynthese using minimally invasive percutaneous plate osteosynthesis technique

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DOI: https://doi.org/10.22271/ortho.2021.v7.i3f.2774

Abstract
Introduction: Our objective was to evaluate clinical results and functional outcomes of extra-articular distal tibia fracture treated using anatomical osteosynthese by minimally invasive percutaneous plate osteosynthesis (MIPPO) technique.
Materials and Methods: 30 patients of closed distal tibial extraarticular fractures operated by MIPPO technique from November 2018 to October 2019 with age from 20 to 60 years with or without fibula fracture upto 5 cm proximal to distal tibiofibular syndesmotic joint were included in the study. Clinical and radiological assessment for fracture union were performed at 3 weeks,12 weeks and 24 weeks interval and results were analysed by using AOFAS Ankle-Hind foot scale.
Results: Thirty patients were followed for 6 months with mean fracture healing time was 16 weeks (12-60 weeks). 14 patients had excellent results with AOFAS score with two patients (6.7%) had delayed union and one patient (3.3%) developed superficial infection but fractures united completely.
Conclusion: Minimally invasive percutaneous plate osteosynthesis technique is an effective method of treatment for distal tibial fractures, it provides good, stable fixation with minimal complications.

Keywords: distal third tibial metaphysis, anatomical osteosynthese , minimally invasive percutaneous plate osteosynthesis (MIPPO)

Introduction
In the modern era, increased incidence of road traffic accidents forms the major epidemic of modern world. Of these injuries, fractures of distal tibia have been difficult to treat. In this era of increasing life expectancy, rise of elderly population which increases the incidence of these fractures in osteoporotic bones adding to the morbidity. Soft-tissue damage, comminution and fracture extension into the ankle joint lead to unsatisfactory results in many cases regardless of the treatment modality [1].
Main challenges encountered in the treatment of distal tibia fractures are [3-5] high energy injuries associated with extremely damaged soft tissue envelope, increased incidence of open fractures, increased skin complications following surgery, comminution of the metaphysis and articular surface makes anatomical reduction difficult. The resulting in congruency of articular surface leads to early secondary Osteoarthritis.
Initially conservative treatment with Plaster of Paris was advocated as a treatment option. But it leads to high incidence of malunion and stiffness of ankle joint. Also prolonged recumbency resulted in high incidence of thromboembolic diseases and pneumonia [6, 7].
Open reduction and internal fixation with plate osteosynthesis lead to skin necrosis and infection in > 40% of patients eventually leading to malunion and implant failure [8].
Intramedullary devices give inadequate stability due to wide medullary cavity leading to implant failure and screw breakage. For fractures, initial treatment with external fixator for wound care followed by a definitive mode of internal fixation was advocated. This involves multiple procedures which increased economical and mental stress for the patients [9].
But minimally invasive plating offers the advantage of fracture fixation without disturbing the soft tissue cover; less chances of infection, early mobilization of patient. Using a locking

compression plate reduces the tendency for varus collapse and at the same time affords better stability. The successful management of these injuries, demands a thorough knowledge of fracture personality and technical aspects of fracture fixation; and a tailored post-operative management [10].

We designed a study to determine the functional outcome of distal tibia fracture treated by MIPPO technique and to assess its complications.

Materials and Methods

After obtaining institutional ethical clearance, study was conducted at the Department of Orthopaedics, MIMS, Mandya during the period from SEPTEMBER 2018 to AUGUST 2019. The complete data was collected from the patients in a specially designed Case Record Form by taking history of illness and by doing detailed clinical examination and relevant investigations. Clinically and radiologically diagnosed patients who gave informed written consent were selected for the study based on age more than 20 years (To avoid physeal injuries), both males and females and age less than 60 years (To avoid osteoporotic fracture), had sustained Supra syndesmotic fibula fracture (5cm above the articular cartilage of tibia), Closed fracture without distal Neurovascular injury, Date of injury to Date of surgery <15 Day.

Patients who had Open fractures, Distal tibia fracture with poly trauma (Head injury, Chest injury, Abdominal injury), Associated Neuro-vascular injuries, Pathological fractures, Compartment syndrome, Intra- articular and Osteoporotic fractures were excluded from this study.

Antero-posterior and lateral radiographs of the affected leg along with ankle were taken and the fracture patterns were classified based on the AO/OTA classification of fractures of distal tibia. The limb was then immobilized in an above knee Plaster of Paris slab till definitive fixation with locking compression plate with MIPPO done.

Appropriate and valid written consent was taken. The patient was taken for surgery after routine investigation and after obtaining fitness towards surgery. A dose of tetanus toxoid and antibiotic was given pre-operatively. Preparation of the part was done before the surgery. Instruments were checked and sterilized beforehand. Pneumatic tourniquet applied and time noted

Operative Procedure

After Lumbar Sub Arachnoid Block (Spinal) or General anesthesia), patient positioned in supine position with affected leg elevated on a pillow/sand bag. Painting and draping done.

Fibular reduction and fixation was performed with limb in slight internal rotation using the lateral approach to the fibula, with 1/3rd tubular plate and 3.5 cortical screws.

In our study we used the technique of MIPPO. The patient was positioned in supine on the operating table, after closed percutaneous reduction of distal tibia, 2 cm vertical incision was made over the medial malleolus. Plate was inserted after creating a tunnel in a retrograde manner and a small counter incision made proximally to optimally align the plate on tibia and fixed with percutaneously placed screws by stab incisions under image intensifier guidance. Distal segment screws inserted with same incision.

Post-operative regimen

Intravenous antibiotic regimen was continued for 48 hours after the surgery. Another 5 days of oral antibiotics were advised. Suture or staple removal was done at 10th-12th post-operative day Non-weight bearing mobilization with walker or using standard walking frame from the second post operative day under the supervision of a physiotherapist.

The patients were followed up post-operatively at intervals of 3rd week, 12th week and 24th weeks to assess the functional outcome and radiological union according to AOFAS score. After the 1st follow up of 3 weeks patient is allowed to partially bear weight. The fracture was designated as united, when there was periosteal bridging callus at the fracture site at least in three cortices in the anteroposterior and lateral views. Trabeculations extending across the fracture site was also taken into consideration. Partial and full weight bearing were allowed based on the radiological union and consolidation of the fractures.

Results

After data collection it was analysed using appropriate statistical test. Based on the results obtained, age group varied from 20 to 60 years with the mean age of 43.5 years. Incidence of fracture was observed maximum between 40- 50 years of age accounts to 46.7%. Out of 30 patients, males were predominant with (19) 63.3% and female (11) 36.7%.

Among 30 cases 22(73.3%) patients had right sided fracture, which included 12 males and 10 females. Remaining 8(22.7%) (males-6, females-2) had left sided fracture.

The commonest mode of injury was road traffic accident 22(73.3%) and remaining had sustained injury due to self-fall. 24(80%) patients were associated with distal 1/3rd of fracture fibula, 3 cases (10%) proximal 1/3rd and 3cases were not associated with fibula fracture. Four patient had associated injuries.

Out of total 30 patients 4(13.3%) had DM, 2(6.7%) had hypertension.6 patients had addiction to smoking, 4 were associated with alcoholic and 2 had habit of tobacco chewing.

Among 30 cases, distribution of fracture in Type of AO/OTA classification were 21 (70%) had 43A1, 7(23.3%) had 43A2 and 2(6.7%) had 43A3.There was a mean delay of 1 week for surgery because of increased case load in our institution. Average duration of surgery in present study is 54.8 minutes. Among 30 patients 21 patients were operated between 41 to 60 mts. Among this 11 (36.7%) patients got operated 41 to 50mts and 10(33.3%) patients between 51 to 60mts. In our study average duration of fracture union was 16weeks. Most of the cases union was between 14-18 weeks, among these 10 cases (46.7%) united at 14 weeks, 9 cases (30%) united at 16 weeks and 7 cases (23.3%) united at18 weeks. 2 cases union was seen at 22 weeks.

Ankle movements were followed up in 3 subsequent visits in terms of mean value degree of movements. All the cases showed improvement in both dorsiflexion and plantar flexion in subsequent follow up visits.

Table 1: Ankle movements

Movements	1st follow up	2nd follow up	3rd follow up
Dorsiflexion	79.03 +/- 4.72	84.40 +/-3.77	92.73+/- 2.01
Plantar flexion	78.50 +/- 4.47	82.93 +/-3.79	92.47+/- 1.88

In our study patients were enquired about the pain during daily activities. Out of 30 patients, 16 patients had no pain at the end of final follow up.

In our study functional outcome was evaluated using AOFAS scoring among the 30 patients. 14 patients had excellent outcome and 15 patients had good outcome. Mean average AOFAS in our study was 88.27.

Table 2: AOFAS Score

Score	Outcome	No of patients
100 – 90	Excellent	14
89 – 75	Good	15
74- 50	Fair	01
< 50	Poor	00

Among 30 cases, 3 cases had complications, of which 2 had delayed union and was treated by bone grafting and 1 case had superficial wound infection which was managed by Vacuum assisted (VAC) dressing.

Discussion

Fractures of distal tibia are among the most difficult fractures to treat effectively. The status of the soft tissues, the degree of comminution sustained at the time of injury affect the long-term clinical results. The goal of operative treatment is to obtain anatomic realignment of the joint surface while providing enough stability to allow early motion. This should be accomplished using techniques that minimize osseous and soft tissue devascularization in the hopes of decreasing the complications resulting from treatment.

Minimally invasive percutaneous plate osteosynthesis (MIPPO) is the logical next step in the surgical treatment of fractures. In this way, the fracture environment is better preserved, as well as the blood supply to the bony fragments. Theoretical advantages include less infection, reduced wound dehiscence and better fracture healing.

The present study was undertaken to determine the efficacy of the locking compression plates using MIPPO technique in treatment of the fractures of the distal tibial metaphysis.

In our study, age group varied from 20 to 60 years with the mean age of 43.5 years. In study conducted by Cory collinge *et al* [11] had an average age group of 43 years, similarly study by Heather A Vallier *et al*. [12] showed mean age group of 43.5 years.

In our study, male preponderance was noted; out of 30 patients 63.3% were male. The study by Cory collinge *et al*, [11] showed male predominance of 77%. Possibly due to the fact that male dominance over the female in traveling, occupational injures etc., in India. Similarly study by Andrew Grose *et al* [13] noted that 67% males in their study and 69% males in study conducted by Heather A Vallier *et al* [12].

Our study showed 22(73.3%) fractures were due to RTA (high energy fractures). Fractures due to high energy forces are more (73.3%) in our study comparable with the study conducted by Cory Collinge *et al*, [11] Andrew Grose *et al*. [13] Cory Collinge *et al*. [11] observed 100% high energy fractures in his study. Andrew Grose *et al*. [13] and Heather A Vallier *et al*. [12] could attribute only 58% and 51% of such injuries to be of high energy respectively.

The present study could not be compared with the other studies because our primary aim was to study the distal metaphyseal fractures (without intra articular extension). We had also excluded the type B & C (AO/OTA) fractures.

However, study by Cory college *et al*. [11] showed 9% A1, 9% A2, 10% A3, 16% CI, 32% C2 and 24% C3. Andrew Grose *et al*. [13] also had fractures types 5% A1, 5% A2, 7% A3, 2% B1, 4% B2,12% B3, 6% C1, 12% C2, 64% C3. Heather A Vallier *et al*. [12] also had fractures 31% A, 21% B, 44% C.

In present study there was average delay of 1 week for surgery which accounts for 27(90%) cases, which is comparable with Shreshta *et al*. [14] and Hasenboeh *et al*[15] where there was a delay of surgery by 4.45 days and 6 days respectively. As the case load was high in our institution, average time of surgery was higher in our study.

The average surgical duration in our study was 54.8 minutes. It is comparable with the average of 97.9 minutes taken by J.J. Guo *et al* [16] in their study. Hasenboehler *et al*. [15] in his study showed an average duration of surgery was 86.6 minutes.

The average time for fracture union in various studies conducted using various methods was 16-28 weeks. Our study had an average fracture union of 16 weeks which were comparable with studies conducted using the locking compression plates by Cory Collinge *et al*. [11] were average fracture union was 21weeks and Abid Mushtaq *et al*. [2] had an average of 22 weeks, Hazarika *et al*[17]showed average time of 19.3 weeks.

In present study complications were delayed union 2 (6.7%) and superficial skin infection 1(3.3%), Two patients with delayed union were treated with bone grafting. Superficial infection was treated with I V antibiotics and VAC dressing. Study by Shrestha *et al* [14]. showed complication such as delayed union 5% and superficial infection 18.75%. Hasenboehler *et al*. [15] showed delayed union in 10% and superficial infection 21.9%.

At the end of final follow up functional outcome were calculated using AOFAS score. In our study AOFAS score was 88.2. Study done by Collinge *et al*. [11] showed a similar result with 85. Other studies by Guo *et al*. [16] and Hazarika *et al*. [17] also showed similar results with AOFAS score of 83.9 and 85 respectively.

At the end of final follow up functional outcome were calculated using AOFAS score

Study	AOFAS Score
Collinge *et al*. [11]	85
Guo *et al*. [16]	83.9
Hazarika *et al*. [17]	87
Ozkaya U *et al*. [18]	85
Present study	88.2

Conclusion

From this study it is concluded that minimally invasive percutaneous plate osteosynthesis technique MIPPO is most effective procedure with fewer complications for closed extra articular distal tibia fractures. The MIPPO technique is a reliable fixation approach to fractures of distal third tibia, preserving most of osseous vascularity and fracture hematoma and thus providing for a more biological repair. There was reduced incidence of infection due to limited exposure.

We found that MIPPO technique preserved soft tissue through indirect reduction and this technique has a steep learning curve. Although a larger sample of patients and longer follow up are required to fully evaluate this method of treatment.

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