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Dr. Ramavtar Saini
Professor & Unit Head,
Department of Orthopaedics,
Geetanjali Medical College and
Hospital, Udaipur, Rajasthan,
India

Dr. Nihar Shah
Assistant Professor, Department
of Orthopaedics, Geetanjali
Medical College and Hospital,
Udaipur, Rajasthan, India

Dr. Abhishek Dholakia
3rd year Resident, Department of
Orthopaedics, Geetanjali Medical
College and Hospital,
Udaipur, Rajasthan, India

Dr. Dharan Shah
3rd year Resident, Department of
Orthopaedics, Geetanjali Medical
College and Hospital,
Udaipur, Rajasthan, India

Dr. Kshitij Agrawal
3rd year Resident, Department of
Orthopaedics, Geetanjali Medical
College and Hospital,
Udaipur, Rajasthan, India

Dr. Utkarsh Patel
3rd year Resident, Department of
Orthopaedics, Geetanjali Medical
College and Hospital,
Udaipur, Rajasthan, India

Corresponding Author:
Dr. Abhishek Dholakia
3rd year Resident, Department of
Orthopaedics, Geetanjali Medical
College and Hospital, Udaipur,
Rajasthan, India

A prospective study on functional outcome of distal tibial fracture fixation with locking compression plate using minimally invasive percutaneous osteosynthesis technique

Dr. Ramavtar Saini, Dr. Nihar Shah, Dr. Abhishek Dholakia, Dr. Dharan Shah, Dr. Kshitij Agrawal and Dr. Utkarsh Patel

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Abstract

Introduction: Treatment of distal tibia fractures is challenging because of its subcutaneous location, poor vascularity and limited soft tissue envelope. Various modalities of surgical treatment such as Intramedullary nailing, Open reduction and internal fixation with conventional plate osteosynthesis and external fixation have reported good functional outcomes but had a high complication rate. The newer technique of distal tibia fracture fixation with Minimally invasive plate osteosynthesis (MIPO) using Locking compressing Plates (LCP) has emerged as an alternative treatment option because it involves less soft-tissue handling, minimal periosteal stripping resulting in low infection rate, faster healing and it respects biology of distal tibia and also provides biomechanically stable construct.

Aim: To assess the functional role of locking compression plates in treatment of distal tibial fractures using minimally invasive percutaneous osteosynthesis technique.

Materials and Methods: In this study, 30 patients with distal 1/3rd tibia extra-articular fractures (AO type 43A1, 43A2, 43A3) with or without associated fibula fractures were treated with LCPs using MIPO technique. The present prospective study was conducted in Department of Orthopaedics, Geetanjali medical college and hospital, Udaipur between January 2019- May 2020.

Results: All fractures had excellent clinical and functional outcome, the fractures were stabilized by LCP using MIPO technique with an average operative time of 48.16 minutes. The age of the patients ranged from 20 to 76 years with the fracture being most common in the 3rd and 4th decade. Out of 30 patients, 21 (70%) patients were males and 9 (30%) patients were females showing a male preponderance. Functional outcome evaluation was done using American Orthopaedic Foot and Ankle Society (AOFAS) score. At the end of this study, 21 (70%) patients had excellent outcome, 08 (26.66%) had good results, 01 (3.33%) had fair outcome and no patient had a poor functional outcome. None of the cases had implant failure or any significant deformity.

Conclusion: The present study shows that the MIPO technique using LCP proves to be a most effective and safer technique in the management of distal tibial fractures with or without intra-articular comminution by providing good fracture healing, enabling rapid functional recovery and avoiding major complications.

Keywords: Distal tibia fracture, MIPO, LCP, American orthopaedic foot and ankle society score

Introduction

The tibia is the major weight-bearing bone of the leg. It is the one of the commonest bone to be fractured [1]. Distal tibia fractures are more complicated due to its proximity to the ankle, and with a close relationship with thin soft tissue envelope and severe comminution [2-4] High energy motor vehicle trauma constitutes the commonest cause, followed by falls, direct blow, and sports injury [5]. The degree of associated soft tissue injury is higher in distal metaphyseal fractures than with shaft fractures [6]. Due to its subcutaneous location, poor blood supply and decreased muscular cover anteriorly, complications such as delayed union, non-union, wound infection and wound dehiscence are often a challenge in these fractures [7]. The fundamental goal of the treatment of distal tibial fractures is 1) Restoration of normal or near normal alignment 2) Ensure joint stability and 3) articular congruity [8].

Conservative treatment in this group of fractures can result in shortening, translation and rotational malunion in more than 30% of cases and joint stiffness in 40% of cases [9]. Operative treatment allows early motion, provides soft tissue access and avoids complications associated with prolonged immobilization [8]. Malalignment or loss of reduction after nailing, occurs mostly due to improper reduction, poor nail position (e.g., not centering the nail in the distal fragment) and loose fixation [10]. External fixation is indicated in severe soft tissue injury or as a temporary stabilizing device. Pin tract infection, mal-reduction and joint stiffness are the drawbacks of external fixation [11]. Locking plates (LPs) have the biomechanical properties of internal and external fixators, with superior holding power because of fixed angular stability through the head of locking screws, independent of friction fit [8]. Open anatomical reduction and stable internal fixation allows axial alignment of the limb, permits early mobilisation, and results in the bony union from endosteal bone healing [12] but it evacuates the osteogenic fracture haematoma and causes soft tissue stripping that can result in infection, wound necrosis and delayed or non-union [13]. Minimally invasive plate osteosynthesis (MIPO) is a technique which aims to reduce iatrogenic soft tissue injury and damage to bone vascularity, as well as preserving the osteogenic fracture hematoma [14, 15]. This present study describes the minimally invasive technique using locking compression plates and its effectiveness in distal tibia fractures.

Aim

To assess the functional role of locking compression plates in the treatment of distal tibial fractures using the minimally invasive percutaneous osteosynthesis technique.

Material and Methods

This study was conducted in GMCH Udaipur, Rajasthan. Department of Orthopaedics, from January 2019 to June 2020.

Inclusion criteria

1. Patients with Extra-articular Distal tibia fractures (closed or open up to grade IIIA).
2. Patients above age of 18 years.
3. Patients fit for surgery.
4. Patients who give informed consent.

Exclusion criteria

1. Patients with local soft tissue conditions making surgery inadvisable.
2. Patients with Gustillo-Anderson Type-III B and Type-III C open fractures.
3. Patients with compartment syndrome.
4. Patients are coming with a history of more than 6 weeks of fracture tibia.

In this study, we included 30 patients of extra-articular distal tibia fractures who presented to orthopaedic emergencies and The outdoor department. On admission, all patients were evaluated clinically and were stabilized hemodynamically. Radiograph of ankle with leg AP & Lateral views were taken & above knee slab was applied.

Routine investigations were carried out and Anaesthetic fitness for surgery was obtained. Patients were operated on as early as possible using MIPO technique.

Surgical technique

Patients were operated under SA or GA after obtaining written informed consent. Above knee, tourniquet was applied in all cases. In patients where fibula was fractured at the level of tibial fractures, they were fixed with ORIF with semi-tubular or 1/3rd tubular plates or CRIF with long k- wire. Fibula fractures associated with distal tibia fractures aid in the reduction of tibia fracture, especially when the fracture is at the same level of tibia. We recommend to fix the fibula before tibial fixation to achieve better alignment and to prevent valgus malalignment. For Distal tibia fracture, an anteromedial approach was used, an incision of 3-4 cm was given over medial aspect of distal tibia, starting 1cm below and over the centre of medial malleolus and extended proximally over the tibia, Subcutaneous tunnel was opened with the help of a tunnelling device, fracture reduction was achieved under fluoroscopic guidance and temporary placement of plate was done and held over the bone by k-wire. After confirming the reduction, cortical screw was placed, followed by locking screw placement in subchondral bone and in shaft. Before placing all the distal screws syndesmotic stability status was checked in each patient by externally rotating the ankle and by pulling the fibula with a hook. If syndesmotic instability was found, syndesmotic screws were applied. Then wash was given, closure was done in layers and aseptic dressing was done with short leg plaster cast.

Post-operative protocol and follow-up

Antibiotic medication was given as per requirement. Sutures were removed on 15th post-operative day. Follow-up was done at 2nd, 6th, 12th week and finally at 6th month postoperatively. On each follow-up visit X- rays were carried out and a functional assessment was done by AOFAS score. Non-weight bearing ambulation was allowed as soon as possible and ankle ROM exercises were started after 3rd postoperative week. Partial weight-bearing was allowed once the radiological union was noted on plain radiographs. After fracture consolidation, full weight-bearing was allowed.

Results

In this study, 30 cases of distal 1/3rd tibia fractures (closed or open upto grade IIIA) were treated with MIPPO. The age of the patients ranged from 20-76 years with an average age of 47.9 years. Most of the patients are found to be between the age group of 31-40 and 41-50 years (Table 1).

Table 1: Age Distribution

Age in years	No. of patients	Percentage
20-30	2	6.66 %
31-40	8	26.66 %
41-50	8	26.66 %
51-60	6	20 %
61-70	5	16.66 %
71-80	1	3.33 %

Among 30 cases a total number of male cases were 21 (70%) and female cases were 9 (30%) (Table 2).

Table 2: Sex Distribution

Sex	No. of patients	Percentage
Male	21	70%
Female	9	30%
Sex ratio	70:30	

In this series, road traffic accidents are the major cause for injury 19 (63.33%), followed by Fall from bike 6 (20%)

patients and Fall from height 5 (16.66%) patients (Table 3).

Table 3: Mode of Injury Distribution

Mode of Injury	No. of Patients	Percentage
RTA	19	63.33 %
Fall from bike	6	20 %
Fall from height	5	16.66 %

Out of 30 patients, 15 (50%) patients were with Left distal tibia fractures and 15 (50%) patients with Right distal tibia fractures.

Among all the fractures, there are 11 (36.66%) patients with 43A1 type, 12 (40%) patients with 43A2 type and 7 cases (23.33%) with 43A3 type (Table 4).

Table 4: AO Type

AO Type	No. of Patients	Percentage
43A1	11	36.66 %
43A2	12	40 %
43A3	7	23.33 %

Out of 30, 14 patients (46.66%) had concurrent fibula fracture.

Above knee, a tourniquet was applied in all cases. Overall operative time was within the range of 35-60 minutes with an average of 48.16 minutes. Among 30 cases, complications are seen in 6 cases (20%) in which 3 patients (10%) had a superficial infection which got treated by dressing &

antibiotic support, 1 patient (3.33%) presented with wound dehiscence/plate exposed for which re- suturing was done and antibiotics were given, 1 patient (3.33%) showed Delayed union and 1 patient (3.33%) had Non- union for which Bone grafting was done (Table 5)

Table 5: Complications & Interventions

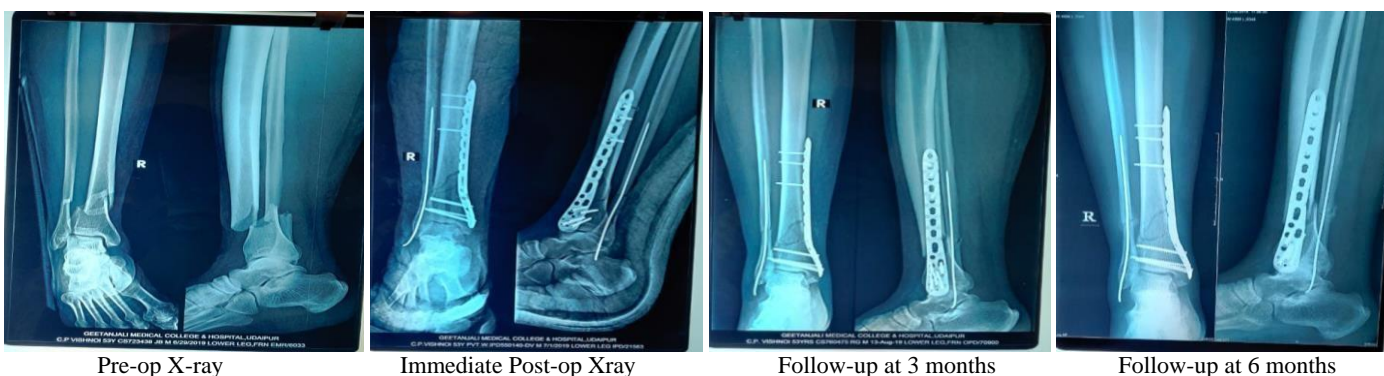
Complications	Intervention	No. of Patients	Percentage
Nil	Nil	24	80 %
Superficial Infection	Dressing & Antibiotic	3	10 %
Wound dehiscence	Re-suturing & Antibiotic	1	3.33 %
Delayed Union	Late full Weight-bearing	1	3.33 %
Non-Union	Bone Grafting	1	3.33 %

Functional evaluation was done using American Orthopaedic Foot and Ankle Society (AOFAS) Score.

Out of 30 patients, 21 cases (70%) had excellent results and good results were observed in 8 cases (26.66 %) and 1 patient (3.33%) had a fair result and no patient had poor results (Table 6). In all, 96.66% of patients had good to excellent results.

Table 6: Functional Result

End Results	No. of patients	Percentage
Excellent	21	70 %
Good	8	26.66 %
Fair	1	3.33 %
Poor	0	0 %



Assessment of ROM



Discussion

Distal tibia fractures result from low-energy torsional to high-energy axial-loading mechanisms. High energy fractures are commonly associated with severe soft tissue injury, and comminuted distal fibula fractures. Distal 1/3rd Tibia fractures account for <10% of lower extremity fractures and occur in adults owing to falls from height or from road traffic accidents. Treatment of distal tibia fractures can be challenging because of its subcutaneous location, poor vascularity and limited soft tissue envelope. The goals in the

management of treatment of distal tibia fractures are anatomical reduction, maintenance of joint stability, restoration of axial alignment, achievement of fracture union, pain-free weight-bearing and motion, without any wound complication [16]. Definitive fixation is advisable and proceeded only when the soft tissue injury was managed properly. This is indicated by the skin wrinkle sign once limb oedema, blisters, swelling subsides. In our study, internal fixation was carried out according to the severity of soft tissue injury.

Ruedi and Allgower achieved 74% good functional results following ORIF for distal tibia fractures of low-velocity injuries^[17, 18]. They could not reproduce similar results following the principles of open reduction internal fixation in high-velocity injuries^[19]. This led to the development of procedures that respects the soft tissue envelope. These biological methods of fixation are currently the procedures of choice in the challenging distal tibia fractures.

Two methods are currently popular in distal tibia fracture management.

1. Hybrid external fixators are used in severely comminuted distal tibia fractures with significant soft tissue damage.
2. Minimally invasive plate osteosynthesis (MIPO), is used in fractures without articular comminution and with minimal soft tissue damage^[19, 20].

Helfet *et al.*^[21] introduced a 2 stage MIPO for distal tibia fractures.

Stage 1—fibular internal fixation and spanning external fixation of tibia

Stage 2 – limited ORIF for distal tibia.

Minimally invasive plating techniques (MIPO) reduces the iatrogenic soft tissue injury and damage to bone vascularity, and also preserve the osteogenic fracture hematoma. The MIPO technique enables a bridging fixation without disturbing the comminuted segments and the surrounding soft tissue.

The present study was undertaken to determine the efficacy of Locking compression plates in the treatment of distal 1/3rd tibia fractures using MIPO technique. In our study, for all the patients soft tissue assessment was done prior to definitive fixation. None of the patient presented or developed compartment syndrome in affected extremity post-hospitalization out of all 30 patients included in study. In our study we used a single-stage fixation of all distal tibial fractures by using a medial distal tibia locking compression plate.

Present study revealed the average age of patients with distal 1/3rd fractures of the tibia to be 47.9 years (range from 20 to 76 years). The fracture is more common in the age group of 31-40 years and 41-50 years. It is comparable with a study on similar fractures conducted by Cory Collinge *et al.*^[22] in 2010, whose mean age was 43 years (range from 17 to 62), Shrestha D *et al.*^[11] in 2011 their study of patients mean age was 34 years (range from 17 to 65 yrs), Abdulla S *et al.*^[23] in 2013 whose mean age was 32 years.

In our study of 30 patients the male preponderance for distal 1/3rd tibia fractures was high, 70% (21 males and 9 females). It is comparable with a study by Andrew Grose *et al.*^[24] in 2007 showed that they had 67% male patients. However study by Shrestha D *et al.*^[11] in 2011 showed not much significant difference in sex incidence (57% males and 43% females), a study by Ch. Banikanta Sharma *et al.*^[25] in 2015 reported that the incidence of these fractures was significantly high in males, which was 85.7% comparing to present study.

Present study showed that 19 cases (63.33%) of total injuries were due to RTA. Cory collinge *et al.*^[22] in 2010 observed 100% high energy fractures in their study. Shrestha D *et al.*^[11] (2011) reported that half of the patients (50%) in their study were injured due to RTA, and 40% of patients were injured due to fall. A study on similar fractures conducted by Ch. Banikanta Sharma *et al.*^[25] in 2015 reported 81% of injuries were due to RTA.

In our study of 30 patients, according to AO classification 11 (36.66%) of the fractures were 43A1 type, 12 (40%) patients

were 43A2 type and 7 patients (23.33%) were 43A3 type. In the present study 14 (46.66%) patients among 30 patients had ipsilateral concurrent fibula fracture at different levels, of which 10 (33.33%) fractured at the level of tibial fracture, were fixed with ORIF with semi-tubular or 1/3rd tubular plate or CRIF with long k-wire.

Average operative time in present study was 48.16 minutes (range from 35 to 60 min). It is significantly less average duration compared to 97.9 min reported by Guo *et al.*^[26] in their study in 2010. VK Kumar *et al.*^[27] in their study in 2014 reported average operative time in their study was 60 minutes. Our study of 30 patients with plate modality showed complication rate of 20%, there were 3 (10%) cases of superficial infection improved with antibiotics and daily dressings, Wound Dehiscence leading to plate exposed in 1 case for which re- suturing and antibiotic coverage was given. Shrestha D *et al.*^[11] in their study in 2011 reported superficial infection in 4 (10%) cases, ankle stiffness in 2 case (5%) among 20 patients. Shikhar D Singh *et al.*^[28] in their study in 2015 reported that rate of superficial wound infection was 10%.

One patient had delayed union which eventually got united. 1 (3.33%) case had non-union for which bone grafting was done, followed by which fracture site healed. Varus or valgus angulation of greater than 5 degrees and anteroposterior angulation of 10 degrees and shortening of 15mm or more are considered to be malunited.^[11] In our series there was no valgus or varus mal-union. Shikhar D Singh *et al.*^[28] in their study of 30 patients in 2015 reported 3 cases (10%) of mal-union, 1 (3.3%) case of delayed union. Abdulla S *et al.*^[23] in their study in 2013 reported 1 (5%) case of delayed union among 20 patients. Our study of 30 patients showed, Excellent functional outcome in 21 patients (70%), Good results in 8 patients (26.66%) and Fair result in 1 patient (3.33%) with American Orthopaedic Foot and Ankle Society (AOFAS) Score. Abdulla S *et al.*^[23] (2013) reported 80% excellent results with this operative method. Shikhar D Singh *et al.*^[28] in 2015 reported 46% excellent, 30% good, 13.3% fair and 10% poor results (Olerud- Molander Ankle Score). Study by Ozkaya U *et al.*^[29] of 22 patients with distal third tibial fractures treated with titanium locking compression plates using MIPO technique, reported a total of 81% of good to excellent outcome assessed using AOFAS Score.

On the basis of the finding of this present study it is found that MIPPO technique is a biological repair technique that preserves most of the osseous vascularity and fracture hematoma, reduces surgical time, tourniquet time, along with smaller incisions. There are fewer incidences of superficial infection, wound dehiscence, delayed union and non-union, thus providing for a better outcome in terms of functional outcome and clinical improvement with speedy recovery and excellent to good functional outcome in majority of patients (99.66%). The technique of MIPPO is safer and efficacious modality of the treatment for distal 1/3rd tibia fractures.

Conclusion

This technique has resulted in the effective stabilization of these fractures. It provides adequate stability and allows early range of motion. MIPO technique facilitates preservation of blood supply to the fragment and anatomical reduction of the fracture. The greatest advantages of using locking compression plates by MIPO technique are: 1) Acceptable reduction is achieved, which helps in Biological fixation and aids in fixation of osteoporotic bone. 2) Fracture hematoma is not disturbed much.

Thus minimally invasive plate osteosynthesis using LCP proves to be a most effective and safer technique in the management of distal tibial fractures with or without intra-articular comminution by providing good fracture healing, enabling rapid functional recovery and avoiding major complications.

Limitations

Less sample size & Short follow-up period.
No conflicts of interest.

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