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Minimally Invasive Percutaneous Plate Osteosynthesis (Mippo) A Technique for Treatment of Distal Tibia Fractures

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Abstract: *Distal tibia fractures are challenging injuries with multiple fixation options. Minimal invasive plating for distal tibia fracture is becoming more popular with documented good outcomes. Aim of study was to evaluate the functional and radiological results of fixation of distal tibia fractures with locking plates using Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) technique. Total of 56 patients with extra articular distal tibia fractures, were included in the study . Distal tibia locking compression plate were used with MIPO technique. Functional and radiological results were evaluated at the end on one year. Fractures united in all the patients with few complications i.e: superficial skin infection, deep infection, hardware problem (plate prominence, plate bending) , osteomyelitis at the fibular site . Overall complication rate was 16 % . Clinically , patients were analysed using 100-point scoring system of American Orthopaedic Foot And Ankle Society Ankle – Hind Foot Scale . Mean AOFAS score was 94.4 with minimum 74 and maximum 99. Excellent score were noted in 51 (91%), good in 3 (5.4 %) , fair in 2 (3.6%). To conclude , MIPO with locking plates for distal tibia fractures is associated with good functional outcomes and is an effective treatment for distal tibia extra articular fractures. Although, a larger sample of patients and longer follow up are required to fully evaluate this method of treatment, we strongly encourage its consideration in the treatment of such complex fractures.*

Keywords: *Distal tibia fractures , Distal tibia locking plates, MIPPO , AOFAS*

I. Introduction

Distal tibia fractures remain one of the most substantial therapeutic challenges that confront the orthopaedic traumatologist , because bone is located subcutaneously with decreased muscular cover. They are often caused by high energy axial compressive, direct bending or low energy rotation forces. The aim of treating the fracture is to preserve normal mechanical axis, ensure joint stability and restore a near full range of motion. This is a difficult task to accomplish in each and every case as we face compromised soft tissue condition, variable bone quality and associated medical conditions [1, 2]. Treatment of distal tibial fractures ranges from conservative to surgical procedures using external fixators, intra medullary nailing and locking plates . All methods of fixation have merits and demerits and hence there is no consensus for superiority of one method over the other for these type of fractures. For successful outcome, soft tissue healing is of paramount importance alongwith bone healing. The intramedullary nail spares the extraosseous blood supply, allows load sharing, and avoids extensive soft tissue dissection [3, 4] . However, proximal and distal shaft fractures can be difficult to control with an intramedullary device, increasing the frequency of malalignment.5 Concerns regarding difficulties with reduction/loss of reduction, inappropriate fixation in fractures with articular extension, anterior knee pain [6] and hardware failure have slowed the acceptance of intramedullary nailing as a treatment of fractures of the distal tibia. Locking compression plating has gained popularity and is being used frequently for fixation of distal tibia fractures. With the use of minimal invasive techniques excellent results are obtained in complex fractures. Locking compression plating is technically feasible and creates a stable, fixed angle device when locking screw heads lock itself with the plate better protection against loss of reduction and minimization of bone contact. Preservation of vascularity of fracture fragments, fracture haematoma and minimal soft tissue damage favour minimally invasive percutaneous plating for distal tibia fractures [7] .

II. Aim And Objective

To evaluate the functional and radiological results of fixation of distal tibia fractures with locking plates with Minimally Invasive Plate Osteosynthesis (MIPO) technique.

III. Material and methods.

The present study was undertaken in the patients admitted , in department of orthopaedics , between August 2013 to June 2016 . A total of 56 patients of distal tibia fractures , with age ranging from 16-72 yrs , were treated with minimally invasive percutaneous plate osteosynthesis (MIPPO) technique were included in the study.

Inclusion Criteria

1. Patients with age >18 years
2. Distal tibial fractures without intra-articular extension
3. Gustillo type 1 distal tibia fracture
4. Unstable distal metaphyseal fractures**.**

Exclusion Criteria

1. Intra-articular distal tibia fractures,
2. Gustillo type II and III open distal tibia fractures
3. Deformities around ankle
4. History of surgical intervension around ankle
5. Ankle arthritis with limitation of movements
6. Elderly patients with co-morbid condition.
7. Fractures leading to Compartment or impending compartment syndrome
8. Tibial shaft fractures
9. Patients not willing to give written conscent for the study.

Clinical Evaluation

After taking detailed history , local and general examination was done. Distal neurovascular and neighbouring joint survey was done and recorded. During the evaluation period , calcaneal skeletal traction or posterior plaster slab was applied and limb was elevated on the Bohler Braun splint . After taking appropriate x - ray, the fractures were classified according to AO classification . We have 17 patients of 43 A 1 , 23 patients of 43 A 2 , and 16 patients of 43 A 3. Depending upon the skin and soft tissue condition , surgery was delayed for 5-7 days , until soft tissue oedema had subsided and skin began to wrinkle.

Surgical Technique

Patients were operated under spinal or epidural anaesthesia . The patient was positioned supine on a radiolucent table , torniquetes were applied in all cases. Anatomical landmarks i.e : medial and lateral malleolus were marked. Anteromedial approach were used to operated these tibia fractures. Angular deformity in coronal or sagittal plane was assessed and corrected by using k-wire or schanz pin as a joystick under image intensifier. After correction of deformity , 2-3 cm incision was made starting at level of tibial plafond and extending proximally along medial surface of tibia. A subcutaneous tunnel was created along medial aspect of tibia by blunt dissection. A small incision was given at proximal end of plate. The plate was placed on anteromedial aspect of distal tibia . Plate position was checked using image intensifier in anteroposterior and lateral views. The distal end of plate was at the level of tibial plafond and proximal end extended at least four screw holes beyond extend of fracture. The plate was fixed temporarily with k wires . Locking and cortical screws were inserted in the shaft and metaphyseal fragment of distal tibia as per the requirement of fracture geometry. For fracture to be stable, minimum of six cortical purchase were essential on either side of fracture .

Fixation Of Fibula

Fracture was stabilized with either plate ($1/3^{rd}$ semi tubular or recon plate) or intramedullary device (rush nail or tens) .

Postoperative Mobilization & Rehabilitation

Postoperatively limb was elevated on Bohler Braun splint to avoid swelling. Intravenous antibiotics for 5 days, followed by oral antibiotics for next 5 days . Analgesics were given as per need after 2 nd day. Check dressing was done on day 3 and patient was discharged on day 6 .

- Day 1 : Static quadriceps exercises and toe movements
- Day 3 : Active ankle mobilization .
- Day 5- 7 : Walking with the aid of a walker without weight bearing .
- Day 13 : Sutures removed and radiographs were taken The patients were instructed to continue walking (non weigtht bearing) with a walker , sit on chair or high stool .

follow up protocol

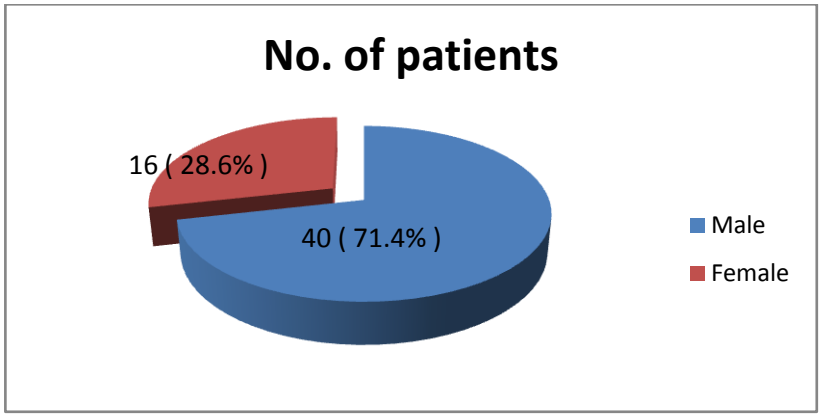
- At 6 to 8 weeks – if signs of union were evident , partial weight bearing with walker support was allowed.
- At 10 to 12 weeks -- Depending on the radiographic signs of fracture healing, full weight bearing was allowed .

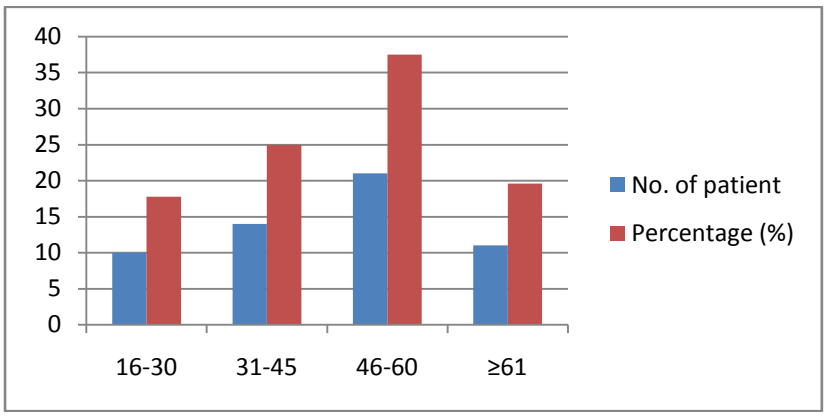
The patients were followed up for an average of 12 months . The follow up visits were done at : 1,2, 3,6,12,18 months . X-rays of distal tibia in antero-posterior and lateral view were taken at regular intervals and

evaluated for fracture healing , alignment at fracture site & look for any evidence of malalignment. At final follow up patients were evaluated using American Ortopaedic Foot And Ankle Society Score (AOFAS)[8] Clinically union was defined as painless fracture site during full weight bearing. Radiographically fracture was considered united if 3 of 4 cortices in 2 radiographic views were continuous.

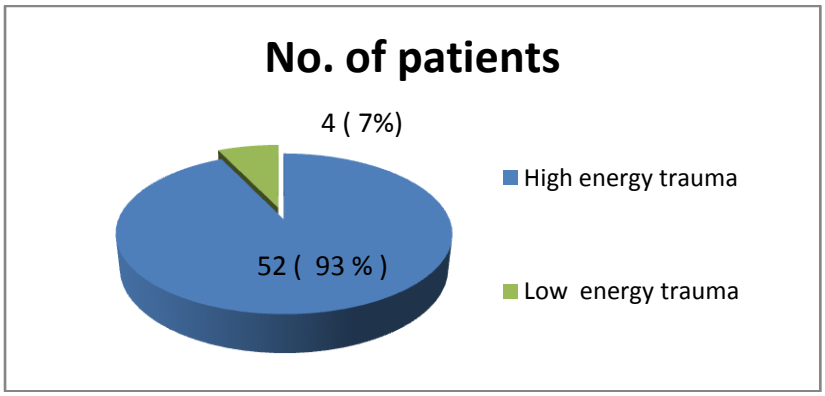
IV. Observation And Results

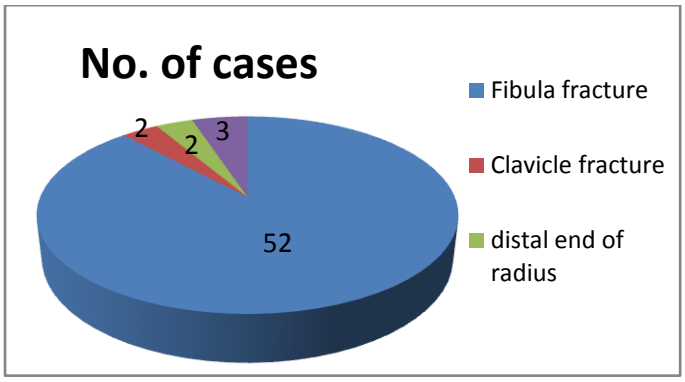
During the study period , total 80 patients were admitted to the hospital with fracture of distal tibia with or without associated injuries . Out of the total admitted patients , 56 patients were included in the study , and rest were treated with other modes. The study involves 40 (71.4 %) males and 16 (28.6 %) females , ranging in age from 16 to72 years old with an average age of 48.03 years. 60 % patients were in age group of 30 to 60 years





In our study there were 34 right sided and 22 left sided distal third tibial fractures. High energy trauma i.e : Road traffic accidents , fall from heights, direct blows etc . was etiological factor in 52 (93 %), rest 4 (7%) cases sustained fractures following low energy trauma i.e : twisting injuries, sports injury etc. There were 52 cases of associated ipsilateral fibula fracture , 2 cases of clavicle fracture , 2 cases of distal end of radius, 3 cases of chest injury. Overlap of associated injuries are seen in the group.





Our study involve , close as well as grade I open injuries. Most of the patients ,around 51 (90%) were having close and rest 5 (10%) were having grade I open injuries . All the fibula fractures are not fixed , they are fixed in 33 cases. The fibula fracture were fixed either with plate or inramedullary device. Plate were used in 17 and intramedullary device in 16 patients. All the patients were temporarily stabilised before the operative procedure . Calcaneal skeletal traction were applied in 40 patients (71.4%) and in rest 16 (28.6%) patients posterior plaster slab was applied for stabilisation. The hospital stay of patient ranges from minimum of 5 days to maximum of 43 days with an average hospital stay was 13 days . Majority of patients were operated within first 3 weeks. Delay in surgery may bwe due to soft tissue swelling, comorbid condition unable to manage implant , limited availability of operation theatre in govt. settings.The duration of follow up ranges from 6-24 months ,with average follow up time was 12 months.

Length of plate was determined according to extent of communition of fracture. Aim was to put at least 3 locking or 4 simple cortical screws in proximal part of fracture . 5 hole plate was used in 5 (8.9 %) , 6 hole in 9 (16 %) , 7 hole in 14 (25 %) ., 8 hole in 17 (30.3 %) , 9 hole in 5 (8.9 %) , 10 hole in 4 (7. 1%) , 11 hole in 2 (3.6 %) patients. Screw sizes used were between 32 to 36 mm , both normal cortical and locking screws were used. Type of plate used , depends upon the patients affordability, which can be either Stainless steel or titanium. Most of our cases were uneventful but few complications were seen during the post operative and follow up period. Superficial infection were seen in 2 (3.6%) and deep wound infection in 2 (3.6%) patients in post op period and rest of the complications are seen during the follow up period i.e . hardware problem (plate prominence, plate bending) in 4 (7.2 %.), osteomelitis at the fibular site in 1 (1.7%) case. Overall complication rate was 16 % . Union occurs in all the cases. The Time to union was between 16 to 24 weeks with an average of 20 weeks . Most patient started partial weight bearing around 12 -14 weeks post surgical fixation. The time of full weight bearing was between 17 – 22 weeks with an average time for full weight bearing was 20 weeks. Clinically , patients were analysed using 100-point scoring system of American Orthopaedic Foot And Ankle Society Ankle – Hind Foot Scale Mean AOFAS score was 94.4 with minimum 74 and maximum 99. . Excellent score were noted in 51 (91%), good in 3 (5.4 %) , fair in 2 (3.6%).

V. Discussion

Distal diametaphyseal tibia fractures are one of the most problematic injuries to manage. Results of operative treatment are dependent on the severity of the initial injury, the quality and stability of the reduction. The mechanism of injury, status of soft tissues, the degree of comminution and articular damage affect the long term clinical outcome. A variety of treatment options i.e external fixation, intramedullary nailing and plate fixation are available ,but there is no consensus on the best treatment modality [1, 2, 9]. Plate fixation can be done by open and minimally invasive technique. Open reduction and internal fixation leads to increased risk of infection and nonunion [7]. Minimally invasive plating techniques reduce iatrogenic soft tissue trauma and damage to vascularity of bone fragments, as well as preserve the fracture haematoma resulting in uncomplicated union. In this study an attempt was made to evaluate the results of minimally invasive percutaneous plate osteosynthesis (MIPPO) in distal tibial fractures.

The study group include 40 (71.4 %) male and 16 (28.6 %) female , indicating males are more involved than female, similar to Leonard [10] et. al study . The average age of patient was 48.03 years , youngest being 16 yrs and oldest being 72 yrs. Most of the patients were in age group of 30 to 60 years . The results were matching with the other studies done by Toplis's [11] et. al , Pai's [12] et. al, Aksekili [13] et. al, where average age incidence was 45.3, 43, 41.9 years respectively but slightly differs from Court-Brown et al [14] study where average age of patient was 37.2 years and the range being 12-98 years . In Mahajan [15] et. al study , High energy trauma (especially road traffic accident) was commonest mode of injury and in Varsalona [16] et. al study high-energy distal tibial injuries involve concomitant fibular fractures in more than 80% of cases . Similarly in our study , we had 52 (92.8 %) cases of associated ipsilateral fibula fracture due to High energy trauma.

Similar to our study, other investigators i.e: Bahari et al [17] , Francois [18] et al, Pai [12] et al and Leonard [10] et al used AO classification in their study. Patients were temporarily stabilised with calcaneal tractions (40/56 - 71.4%) and posterior plaster slab (16/56 - 28.6%) before the definitive procedure , similar to Bahari [17] et al who performed immediate reduction with temporary plaster application. Francois [19] et al believes that it is very important to restore the original length and rotation of the lateral column of the ankle joint. The need for fibular fixation in such fractures is controversial. Many agree that fibular fractures associated with syndesmotic or ankle mortise instability should be stabilised as malreduction of the ankle mortise has been shown to be a factor in poor functional outcomes, but there is no consensus over the role of fibular fixation in extra-articular fractures of the distal tibial metaphysic [16] , Shrestha [19] and Cheng [20] et al , in their study did not fix fibula routinely unless it involve syndesmosis, leading to instability of ankle joint. But Bahari [17] and Joveniaux [21] et al, in their study fix the fibula in most of the cases by open reduction and stabilising it with the plates . We have 52 cases of ipsilateral of fibula fractures , 33 were fixed by different methods (17 by Plate and 16 by intramedullary device) as the fractures were leading to instability of ankle joint. 17 patients with minimally displaced , and well aligned fibular fractures at higher level were not fixed. Union was defined as the presence of bridging callus on two radiographic views and the ability of the patient to bear full weight on the injured extremity. No secondary procedures were required , as we were lucky to get union of fractures in all the cases . The Time to union was between 16 to 24 weeks with an average of 20 weeks .

The results were matching with the other studies done by , Bahari [17] et al and Aksekili's et al [13] where mean fracture healing time is 22.4 and 20.7 weeks postoperative respectively. The average follow up time was 12 months (range from 6-24 months) , similar to Guven et al study [22] , where average duration was 15.3 months (range from 6-36 month) . Guo JJ et al., reported more wound complications in LCP group (14.6%) compared to nailing group (6.8%) [23]. Lau et al., reported late infection rate of 15% in fixation with locking plates [24]. Average rate of infection in various literature available was 5-15%. In our study infection was seen in 4 cases (7.2 %.). Delaying surgery if limb is swollen and bruised, gentle soft tissue handling and reducing operative time helps in reducing infection rates [25, 26, 23, 27, 24] . Hard ware prominence is seen in 4 cases , Pain over medial malleolus, hardware prominence and pain due to impingement of the implant on the skin was commonly seen because of lack of proper contour of plates. No patient complained of plate bending or brekage because we were strict enough while giving instructions for mobilisation and weight bearing. Gao et al., suggested polyaxial locking plates to gain adequate fixation and to achieve a perfect match between the plate and the distal part of the tibia [28], which in turn may further reduce tension in the soft tissue [25, 24] .

Time of partial weight bearing was decided on the type of fracture , adequacy of fixation and radiological picture at the time of follow up. Partial and full weight bearing was allowed around 12 -14 weeks and 17 – 22 weeks post surgery respectively . The average time for full weight bearing was 20 weeks. Mahajan noted time for complete weight bearing as 11.75 weeks in his study [15] . In Hazarika et al average time to full weight bearing was 18.1 weeks (closed fractures), and 19.3 weeks (open fractures) [29] and in Aksekili's [13] study it was 14.43 (range: 12 to 20) weeks . Clinical outcome of all the patients were evaluated using american orthopaedic foot and ankle society ankle – hind foot scale [8] . The system incorporates both subjective and objective factors into numerical scales to describe function, alignment, and pain. [8] Its a 100-point scoring system , 50 points have been assigned to function , 40 points to pain and 10 points to alignment. Score of 90-100 is considered Excellent , 75-89 is Good, 50-74 is Fair, < less than 50 is Poor [21] . Mean AOFAS score was 94.4 with minimum 74 and maximum 99. Excellent score were noted in s 51 (91%), good in 3 (5.4 %) , fair in 2 (3.6%). Various studies i.e - Borens et al [30] , Joveniaux et al [21] , Leonard et al [10] ,Bahari et al [17] had used AOFAS score for analysis with mean scoring of 86.1 (range 61-100), 76 (range 30-100), 84.6 and 90 respectively. The results were matching with the Bahari et al [17] study, but slightly differs from the others because of proper selection of patients as per inclusion and exclusion criteria (all fractures were extraarticular and most of the cases were closed , only few were grade 1 open fractures).

VI. Conclusion

Effective stabilization of distal tibia fractures can be achieved by distal tibia locking plating through MIPO technique which not only helps in achieving reduction in difficult situations, but also in rapid union, because it facilitates preservation of the blood supply to the fragment and anatomical reduction of the fracture. It is a simple, rapid and straight forward procedure which has good results.

Bibilography

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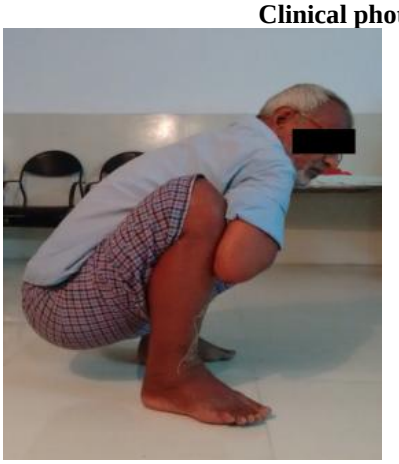
Figures :- X – Rays Follow Up

Pre –operative **immediate post op** **1 months post op** **3 month post op**

6 month post op **12 month post op** **after plate removal**

Clinical photographs



Squatting

full weight bearing

Dorsiflexion at ankle joint

Plantarflexion at ankle joint

Complications

Superficial Skin Infection

Deep Skin Infection Leading

To Skin Loss And Plate Exposure

osteomelitis at fibular site (x-ray & clinical snap)