

Minimally Invasive Percutaneous Plate Osteosynthesis (Mippo) In The Treatment Of Pilon Fractures: A Prospective Study

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Abstract

Background: The management of Pilon fractures is challenging because of its poor vascularity, scarcity of soft tissues and its subcutaneous nature. A mechanically stable fracture-bridging osteo-synthesis can be obtained without significant dissection and surgical trauma to the bone and surrounding soft tissues by minimally invasive percutaneous plate osteosynthesis (MIPPO).

Aim: The following study is to evaluate the functional outcome of Tibial Pilon fractures treated with minimally invasive per cutaneous plate osteo synthesis(MIPPO) using locking compression plate

Methodology: the study was conducted in patients with Pilon fractures treated with MIPPO with LCP Who are admitted in department of orthopaedics in Maharaja's institute of medical sciences, Vizayanagaram from January 2016 to June 2017. 30 patients were prospectively underwent mippo for Pilon fractures. patients were ranged from 24-67 years with average age of 42 years. out of these 21 (70%) patients are males and 9(30%) are females. postoperative regimen includes Non-weight bearing of the patient using standard walking from the first postoperative day under the supervision of a physiotherapist. patient was allowed to weight bearing on 4th week post operatively, the patients were followed up at intervals of four weeks for up to 6-10 months to assess the radiological union and functional outcome. Functional evaluation of results was done by OLEURD and MOLANDER scoring system Radiological evaluation is done by serial x-rays at each follow up.

Observation and Results: 21 (70%) of patients sustained injury following road traffic Accidents (high velocity) and 9 (30%) patients sustained injury following fall (low velocity). 18 (60%) patients with right pilon fractures and 12(40%) patients with leftfractures. 30 cases treated with MIPPO with locking compression plates 1 (3.33%) case took 31-40 minutes, 8 (30%) took 41-50 minutes, 15(50%) took 51-60 minutes, 4(13.33%) took 61-70 minutes, 1(3.33%) took 71-80 minutes. The surgical time averaged 55.83 minutes. All the fractures united with an average of 20 weeks. There was 10 cases united by 16 weeks, 17 cases united by 20 weeks and 3 cases united by 24 weeks.

Conclusion: The greatest advantage of MIPPO technique with locking compression plate is to preserve the blood supply and fracture haematoma is not disturbed much, which helps in fracture healing. By the analysis of the data collected in the present study, closed reduction and internal fixation with locking compression plate using MIPPO technique for pilon fractures is the choice of treatment where intramedullary nails are not preferred and complication rates as compared to open reduction and plating and intra medullary nailing is significantly lower. 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 pilon fractures in an endeavour to reduce morbidity and associated complications, especially of the soft tissue.

Key words: Pilon fractures, MIPPO, locking compression plate.

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I. Introduction

Pilon fracture comprises important group of fractures around ankle, it is a fracture of lower end of tibia which articulates with talus to form the ankle joint. This fracture involves plafond of the distal tibia and extend into the adjacent metaphysis. The fibula may or may not intact. The talus is driven vertically into the tibial plafond. Surgical treatment is indicated for fractures caused by high energy trauma. It allows early mobilization, and avoids shortening and other complications associated with prolonged immobilization. The fundamental goal of treatment of pilon fractures is restoration of normal or near normal alignment and articular congruity

and finally to obtain a well healed fracture; pain free weight bearing; and functional ROM of ankle joint. For the past decade, plating has been successful in treating pilon fractures. Conventional ORIF have been associated with complications like infection and delayed or non-union due to devitalization of bony fragments and additional damage to the soft tissues. To improve fracture healing, more “biological” methods have been developed in the last decade to lessen the surgical dissection, preserving blood supply to bony fragments and containing at least partially the fracture hematoma. MIPPO promoted by AO group emphasis on indirect reduction, axial alignment and stable fixation without disturbing the fracture environment and thus preserving most of the vascularisation and fracture haematoma, containing all necessary growth factors for bony healing.

II. Aim and Objective

To evaluate the functional outcome of Pilon fractures treated with minimally invasive percutaneous plate osteosynthesis (MIPPO) technique by using locking compression plate.

III. Materials and Methods

This is a prospective study from January 2016 to June 2017. Patients with pilon fractures were admitted in the Department of Orthopaedics, were taken for this study after obtaining their informed, valid written consent.

Inclusion criteria :

1. Age group: 19 to 60 years
2. All Pilon fractures with or without fibula fracture
3. Grade 1 compound fracture

Exclusion criteria :

1. Pathological fractures
2. Compound fractures - grade 2, grade 3
3. Associated neurovascular injury.
4. Patients with co-morbid conditions and not fit for surgery

Pre-operative Planning:

All the patients were taken for surgery after pre anaesthetic checkup and routine haematological investigations. Appropriate informed and written consent was taken. A dose of tetanus toxoid and antibiotic (inj ceftriaxone 1gram intravenously 30 min before surgery) was given pre-operatively. Preparation of the part was done before a day of the surgery .

Surgical technique:

After spinal anaesthesia , draping should be done.

Estimate the length of the plate based on pre operative films, place the plate on the skin while checking the position under fluoroscopy.

Make one anteromedial incision at the proximal end of the anticipated plate position and one at the distal end. Make a tunnel connecting these two incisions in an extra periosteal fashion by advancing an elevator from distal to proximal or from proximal to distal.

Reduce the fracture fragments if necessarily by indirect or direct method as mini open technique. insert the plate from distal to proximal on anteromedial aspect of tibial plafond, using the threaded drill guide as a handle and check the position under fluoroscopy and secured the plate with 2 mm k wires distally and proximally. Distal locking done with 3.2 mm cancellous locking screws after drilled with 2.7mm drill bit and proximal locking done with 3.5mm cortical screws, locking screws after drilled with 3mm drill bit with help of guide sleeve.

Finally check the adequate reduction and proper plate fixation using the fluoroscope antero-posteriorly and laterally.

Deflate the tourniquet and obtain haemostasis, close the wound in standard layered fashion after wound wash given. Place a bulky cotton dressing with a posterior plaster sling to maintain ankle in neutral position

Postoperative regimen:

Immobilization with above knee casting and non-weight bearing of the patient using standard walking frame from the first postoperative day under the supervision of a physiotherapist. patient was allowed to weight bearing on 4th week post operatively, first touchdown weight bearing was ensured, progressing gradually to incremental weight bearing from 10% to 50% as evidenced by pain free mobility. Intravenous antibiotic regimen was continued for 5-7 days (12-14 days in compound fractures) after the surgery. Another 5 days of oral antibiotics were advised. Suture or staple removal was done at 10th-12th post operative day.

Follow up:

The patients were followed up at intervals of four weeks for up to 6-10 months to assess the radiological union. After the 1st follow up of 4 weeks patient is allowed to bear weight with patellar tendon bearing cast. This patellar tendon bearing cast is allowed for 4 more weeks and later removed. Partial and full weight bearing were allowed based on the radiological union and consolidation of the fractures. Patellar tendon bearing cast was applied which were removed after radiological union of the fracture. Functional evaluation of results was done by OLEURD andMOLANDER scoring system¹ Radiological evaluation is done by serial x-rays at each follow up.

IV. Observation and Results

During the study period ,48 patients admitted in the hospital with pilon fractures ,out of the total patients 30 patients were included in the study,remaining patients treated with other modes. The age of the patients ranged from 24-67 years with the fracture being most common in the 4th and 5th decade and an average age of 42 years.Out of 30 patients, 21(70%) patients were males and 9 (30%) patients were females showing male predominance because of traveling and working in fields and factories.

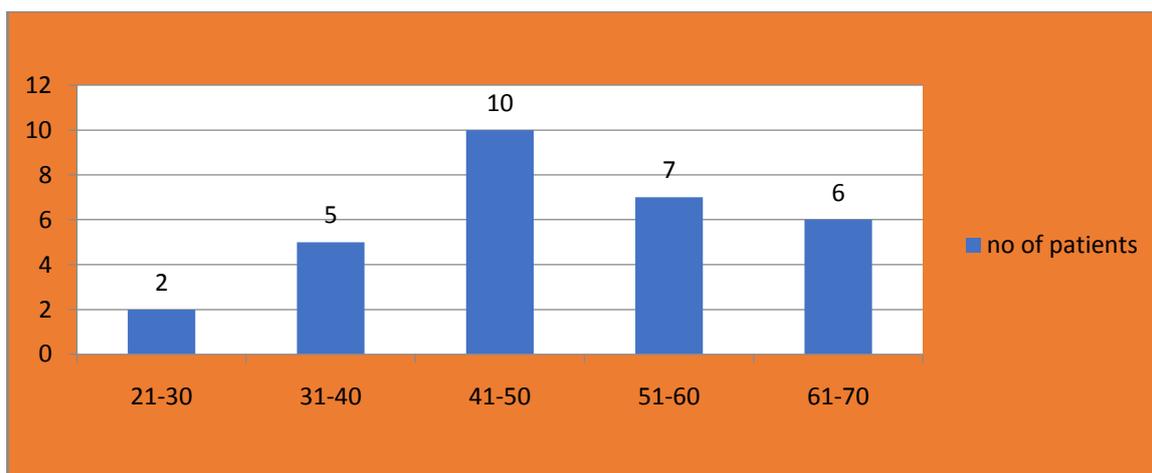


Figure 1: Age distribution of patients

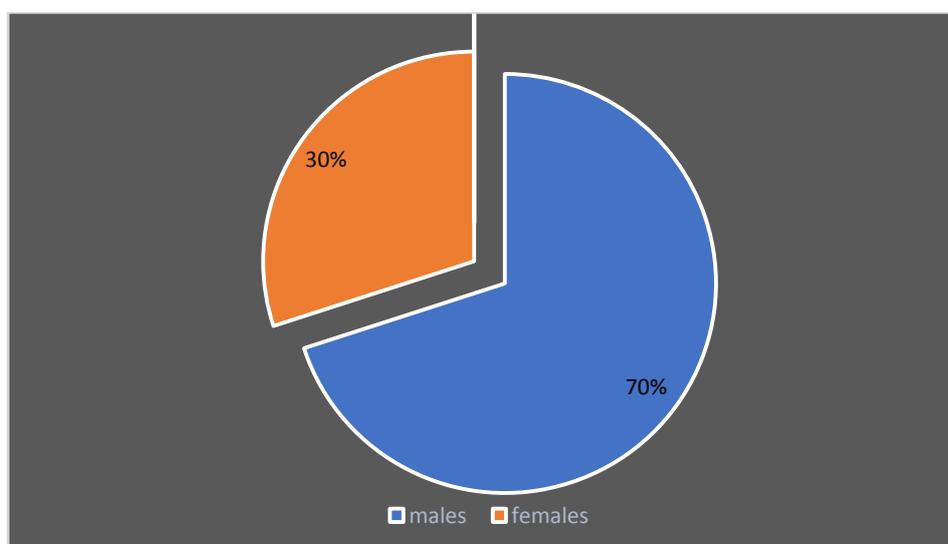


Figure 2: Sex distribution of patients

There were 18 (60%) patients with right pilon fractures and 12(40%) patients with left pilon fractures. In this study, 21 (70%) of patients sustained injury following road traffic Accidents (high velocity)and 9 (30%) patients sustained injury following fall(low velocity).

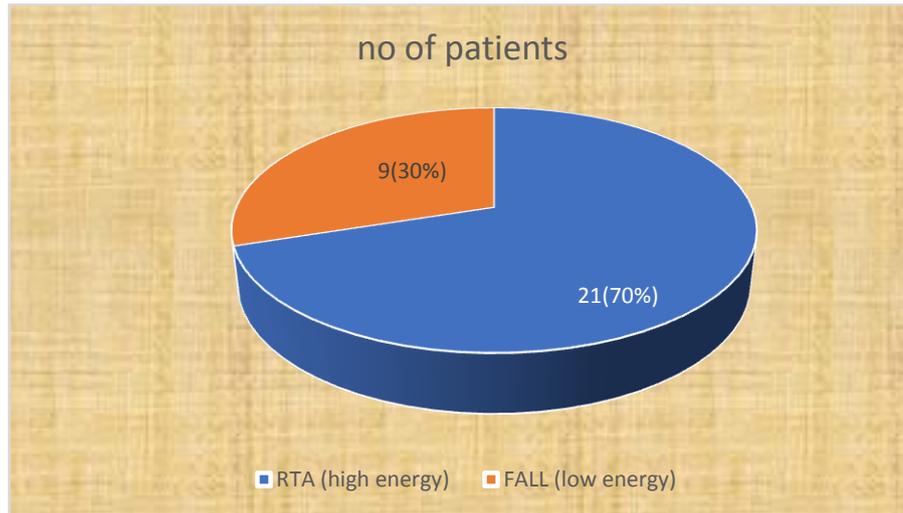


Figure 3: Mechanisam of injury

These fractures classified based on Ruedi and allgower classification. out of 30 cases studied,10 (33.33%) were type I and 15 (50%) were of type II and 5(16.66%) were typeIII fractures.

Type of fracture	No of patients	Percentage of patients
Type1	10	33.33%
Type 2	15	50%
Type 3	5	16.66%

Table 1 : Showing Type of fractures

Of the 30 cases treated with MIPPO with locking compression plates 1 (3.33%) case took 31-40 minutes, 8 (30%) took 41-50 minutes,15(50%) took 51-60 minutes,4(13.33%) took 61-70 minutes, 1(3.33%) took 71-80 minutes. The surgical time averaged 55.83 minutes.All the fractures united with an average of 20 weeks. There was 10 cases united by 16 weeks, 17 cases united by 20 weeks ,and 3 cases united by 24 weeks.

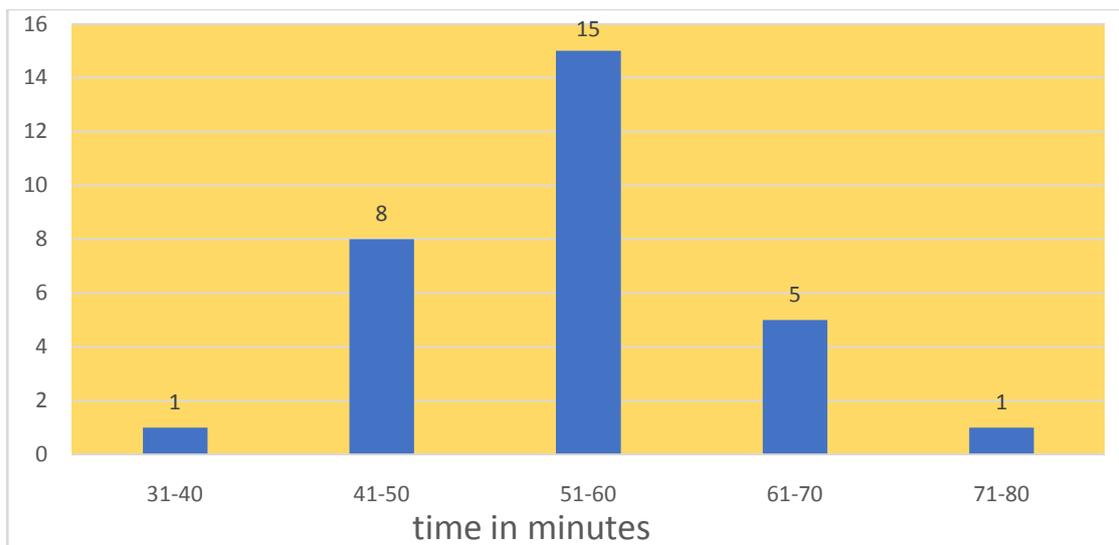


Figure 4:Duration of surgery in minute

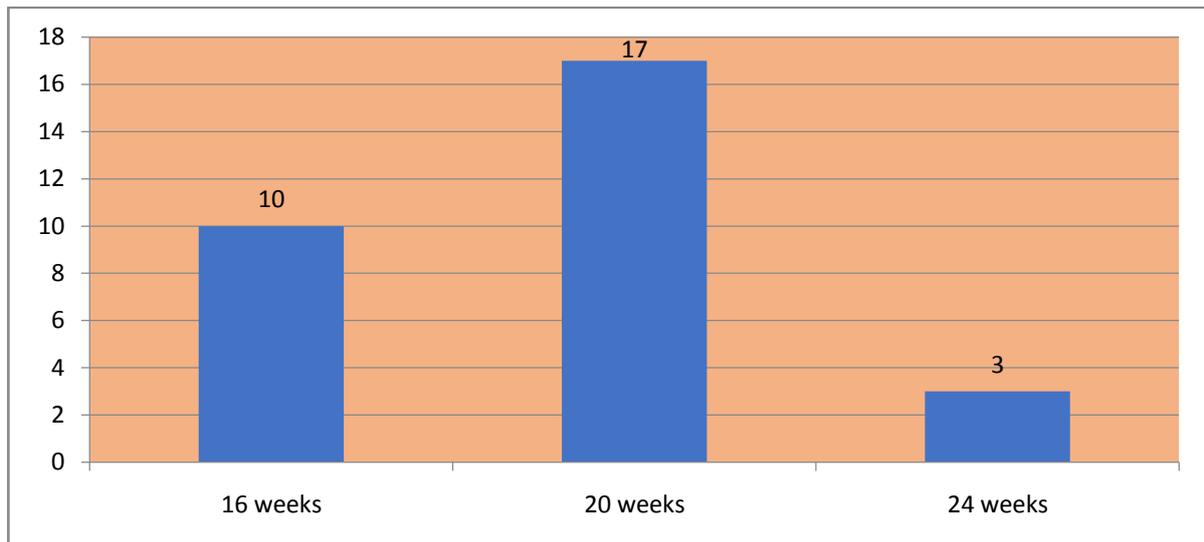


Figure 5: Duration of fracture union

At the end of 6 months of the 30 patients treated, 15 (50%) patients had excellent outcome, 9(30%) had good results, 4 (13.33%) had fair outcome and 2 (6.66%) patient had a poor result.

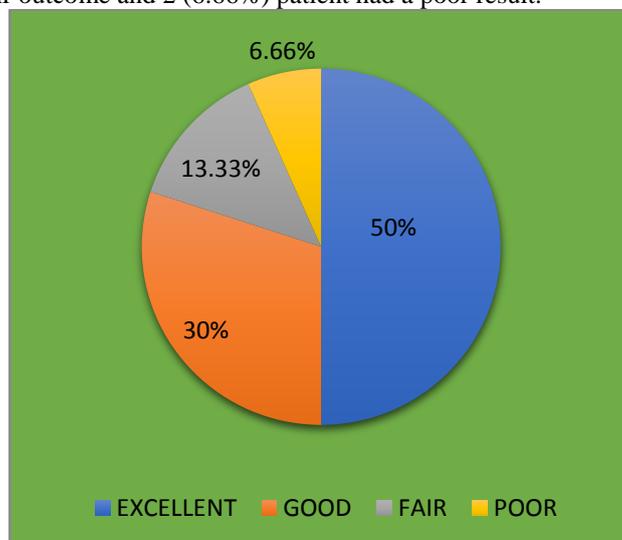


Figure 6: Objective results

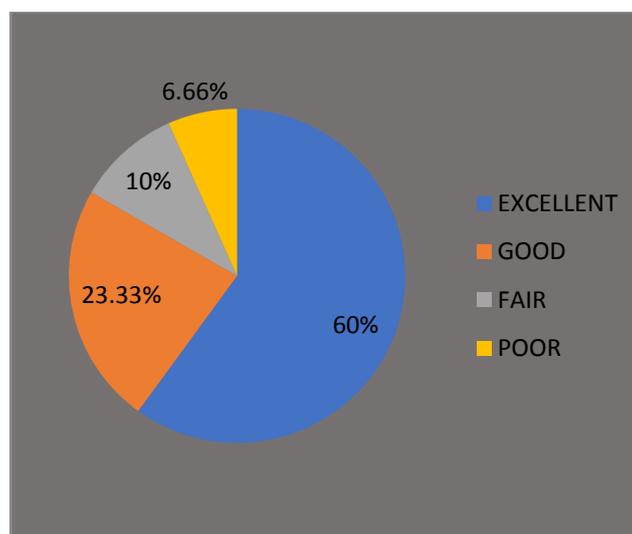


Figure 7: Subjective results

V. Discussion

Pilon fractures are one of the most difficult fractures to manage. None of the treatment options available perfectly to treat the tibial pilon fractures. Distal tibia has circular cross-sectional area with thinner cortex as compare to the triangular diaphysis with thicker cortex. so, intra medullary nail which is designed for tight interference fit at diaphysis, cannot provide the same stability at distal tibia site. ORIF with conventional plating which needs stripping of periosteum, is also not an ideal treatment for pilon fractures, because tibia is subcutaneous bone and periosteum provides 2/3 of blood supply, stripping of periosteum causes derangement of blood supply. Non union and infections are reported with the range of 8.3-35% and 8.3-25% respectively. Understanding the mechanism of injury is major importance in order to choose the optimal treatment option. The differences regarding the treatment options between fractures caused by torsional forces and axial compressions. These two type of fractures totally different to each other ,despite of the fact that they are site that the same anatomical region. Open reduction and internal fixation is indicated in type II and type III pilon fractures. Good reduction is generally rewarded by good functional outcome. Non operative treatment achieves good results in typeI pilon fractures, however the good position may lost in plaster. hind foot function is negligibly affected in type I fractures. Internal fixation is followed by recovery of hind foot function in type II and type III pilon fractures. Post traumatic ankle arthritis is most common complication.

Ruediet al² reported 74-90% cases had good or excellent results in their series after open reduction and internal fixation. In Ruedi and Allgower series, 74% patients were pain free and had good functional resultsfor 9 years follow up. Most of the fractures in their series were of a low energy pattern. The high complication rate with open reduction and internal fixation especially in high energy fractures can be diminished with careful selection of patients and respect to soft tissues and with the use of less invasive techniques such as limited open reduction and internal fixation and hybrid fixators. Similarly, external fixators as a definitive method of treatment for pilon fractures are also reported that high rate of pin tract infection, implant failure, malunion or nonunion and hence it is recommended only for temporary method of stabilization in open fractures with severe soft tissue injuries. With the development of MIPPO with LCP, which preserve extra osseous blood supply, respect osteogenic fracture haematoma, biologically friendly and stable fixation method is available for distal tibial pilon fractures. In direct reduction method and sub-cutaneous tunneling of the plate and application of locking screws with small skin incisions in MIPPO technique prevents iatrogenic injury to vascular injury to the bone. unlike conventional plating, LCP is a friction independent self stable construct, which provides both angular and axial stability and minimizes risk if secondary loss of reduction through a threaded interface between the screw heads and the plate body. MIPPO with LCP for pilon fractures has been found an effective treatment option. But unlike the present study, most of the previous studies have done most of the closed fractures and are retrospective study. Cheng et al.³ in a small sampled paired comparison (15 in each group) of MIPPO and open reduction and internal fixation with LCP found former is not statistically better in terms of time of union (16.8 vs 19.2 weeks $p=0.737$), recovery time to return to normal work (21.1 vs 27.7 weeks, $p=0.35$) and functional results. Kao et al found no statistically significant advantages of LCP over conventional plate group. Mal reduction and sub optimal precontouring of the plate can result delayed union, nonunion, prominent hardware, malleolar skin irritation and pain. Low profile metaphyseal LCP has been designed to reduce hardware prominence related complications but plates specifically designed according to measurement of adult distal tibia of western population may not perfectly match to Indian subpopulation and often need change in precontouring to avoid mismatch. Indirect method of reduction of the fracture under C arm can be difficult on few occasions. 2 mm K wires and reduction forceps were used to facilitate proper reduction in difficult cases. Concomitant fibula fractures at the same level plays an important role in reduction. Though a few authors advocate fixation of fibula before fixation of the tibia to achieve a better alignment and to prevent valgus or varus malalignment, no clearcut indication or protocol exists as far as fibular fracture fixation is considered Some authors said that the stability of the ankle joint is not enhanced by fibula fixation because axial compression fractures are not accompanied by ligamentous damage⁴. If we consider that the major stabilizing element of the ankle joint is the deltoid ligament at the medial side, we can conclude that reduction and fixation of the fibula in such fractures has no significant effect on the stability of the ankle joint.

In the present study out of 30 patients, 24 patients were associated with lower one third fibular fractures have been managed with CRIF/ORIF with rush nail and tubular plate. No secondary procedures like percutaneous bone marrow injection/bone grafting were done delayed union. Immobilization was continued for these cases till fracture union was seen. The protocol of fixation was as early as possible considering the gross swelling and fracture blisters. However, this delay didn't have bearing on the duration of fracture union, which was at an average of 20 weeks as compared to other studies. No cases of injury to the saphenous nerve or long saphenous vein or the posterior tibial tendon. Atraumatic placement of the drill sleeve and careful attention towards skin incision, tunneling prevents these complications. No plates and screws were removed in this series, hence the difficulty encountered in the removal was not studied.

The present study was undertaken to manage the pilon fractures with minimally invasive percutaneous late osteosynthesis. (MIPPO) with locking compression plate for fracture fixation. We evaluated the presented study results and compared them with those obtained by various other studies, utilizing different modalities of treatment.

Present study revealed the average age of patients with such injuries to be 42 years and youngest being 24 and oldest being 67 years. The results matching with the other studies done by Cory Collinge et al⁵ and Heather A Vallier et al⁶ where average age incidence was 43 and 39.1 years respectively. In this study, the male preponderance for such kind of injuries were high 70% compared to the study by Cory Collinge et al which was 67% possibly due to the fact of male dominance over the female in traveling, occupational injuries etc., in India. However, The study by Heather A Vallier et al comparable in the fact that they had 69% male patients. Cory Collinge et al observed 100% high energy fractures in his study. Andrew Grose et al⁷ could attribute only 58% of such injuries to be of high energy and remaining 42% are due to low energy (self fall) . However, our present study correlates with the study conducted by Cory Collinge et al, Andrew Grose et al⁷, and along with that Heather A. Vallier et al⁸, who contributed only 51% of high energy fractures.

The average surgical time was 55.83 minutes. It is not comparable with the average of 97.9 minutes taken by J.J. Guo et al⁹ in their study because of difference in fracture pattern and treatment protocol. The length of the operative time reflects a significant learning curve. The first few locking compression plates took 70-80 minutes in this study, whereas the most recent ones took 40-50 minutes.

The average time for fracture union in various studies conducted using various methods was 16-28 weeks. Present study had an average fracture union of 20 weeks which were comparable with studies conducted using the locking compression plates. Cory Collinge et al had an average fracture union of 21 weeks and Abid Mushtaq et al¹⁰ had an average of 22 weeks.

Clinical outcome of patients and Functional evaluation of results was done by OLEURD and MOLANDER scoring system¹¹. The scoring system includes subjective and objective factors into numerical scales to describe pain ,swelling, stiffness, functions, daily life activities. At the end of 6 months of the 30 patients treated, 15 (50%) patients had excellent outcome, 9(30%) had good results, 4 (13.33%) had fair outcome and 2 (6.66%) patient had a poor result. Hazarika et al¹¹, a series of 20 patients of distal tibial fracture treated using locking compression plates through MIPPO technique. This approach aims to preserve bone biology and minimise surgical soft tissue trauma. This provided 87.5% of good to excellent results. Fractures were classified according to the AO system and performed as scored stage surgery after sterilization with external fixators primarily. Ozkaya U, et al,¹² a retrospective review of 22 patients with distal third tibial fractures were treated with titanium locking compression plates using minimally invasive technique good biological fixation of distal tibial. A total of 81% of good to excellent outcome was assessed using American Orthopaedic Foot and Ankle Society.

VI. Conclusion

According to the study, 30 patients with fractures of the distal tibial pilon had undergone closed reduction through MIPPO techniques of application of the locking compression plates. This technique has resulted in the effective stabilization of these fractures. It does provide adequate stability and allows early motion. The greatest advantage of MIPPO technique with locking compression plate is to preserve the blood supply and fracture hematoma is not disturbed much, which helps in fracture healing. By the analysis of the data collected in the present study, closed reduction and internal fixation with locking compression plate using MIPPO technique for pilon fractures is the choice of treatment where intramedullary nails are not preferred and complication rates as compared to open reduction and plating and intramedullary nailing is significantly lower. 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 pilon fractures.

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Figure 8 : Plate inserted through minimal skin incision fixation



Figure 9:Minimal skin incisions for screw



Figure 10: Pre operative x-ray

figure 11:6 months follow up post operative x ray



Figure 12: Dorsiflexion after 6 weeks



Figure 13: Plantar flexion after 6 weeks

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