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## Functional outcome of tibial pilon fractures treated with minimally invasive plate osteosynthesis in adults

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### Abstract

**Aim:** The aim of the study is to assess the functional outcome of tibial pilon fractures treated with a minimally invasive plate osteosynthesis technique among adults.

**Materials & Methods:** Patients who arrived at the orthopaedics department from 1st September 2018 to 30th September 2020 were considered for our study. Minimal Invasive Plate Osteosynthesis is the method adopted to treat pilon fractures. The mean follow-up time after surgery was six months to two years. Union time, complications, and AOFAS scores were evaluated.

**Results:** According to AO/OTA classification, 7 patients were type A1 fractures, 4 were type A3, 2 were type A3, 3 were type B1, 1 was type B2, 1 was type C1 and 2 were type C3 fractures. The mean AOFAS score was 86.6. Minimal complications were noticed in patients.

**Conclusion:** Minimal invasive plate osteosynthesis is a steadfast method of management for pilon fractures that delivers great fracture healing and a significant functional outcome with fewer complications.

**Keywords:** Fractures of pilon, outcomes, AOFAS score, MIPO

### Introduction

A Pilon fracture is a type of fracture of the distal tibia describing the anatomical region extending 5 cm from the joint line. At the end of a tibial fracture, a large part of the weight-bearing articular surface is very hard to treat [1]. The involvement of the articular surface with extension into the distal tibial metaphysis is a characteristic feature of a Pilon fracture. Pilon fractures account for only 5 % to 10% of all fractures of the tibia, and they may involve less than 1% of fractures of the lower extremity that are most common in the fourth decade of life, and they are more common in men [2]. Pilon fractures are related to the high-energy mechanism that occurs with articular and metaphyseal comminution, chondral injuries, open wounds, deep abrasion, fracture blisters; and compartment syndrome. Open fractures account for 10% to 30% of all fractures. The treatment of these complex fractures remains challenging for orthopaedic surgeons.

The ideal treatment method for pilon fractures is a controversial subject. Open reduction and internal fixation is the most common method for the treatment of tibial pilon fracture, which is applied for joint surface anatomical structure restoration. However, soft tissue complications and a higher rate of infections are due to widespread dissection of soft tissue. In addition, open reduction and plate fixation have been proven to alter the blood supply of the tibia, which leads to delayed union or non-union [3,4].

The minimal invasive plate osteosynthesis a powerful technique that enables indirect reduction and stable fixation with minimal soft tissue dissection by maintaining the fracture hematoma. Fracture is primarily reduced by ligamentotaxis in percutaneous plating via a minimally invasive technique [5].

The aim of the study was to assess the functional outcome of tibial pilon fracture treated with minimally invasive plate osteosynthesis technique among the adults.

### Materials & Methods

The study was performed in the Department of Orthopaedics at GSL medical college and

general hospital from 1st September 2018 to 30<sup>th</sup> September 2020. The study was approved by the Institutional Ethical Committee and a total of 20 patients with distal tibial pilon fractures were treated with plates and screws using the MIPO technique who could be followed for 6 months to 2 years. Informed consent is obtained from all the patients.

The inclusion criteria of the study involve participants of age above 18 years; closed fractures with intra-articular extension; extra-articular metaphyseal fractures (AO 43-A); simple/minimally comminute fracture of the distal tibia with associated ipsilateral fibula fracture; and open Gustilo type I fractures. Fractures were classified by the AO/OAT classification system.

The study won't include people who can't have surgery because of their health, who don't give their consent, who don't have a grade 1 compound fracture (according to the Gustilo Anderson classification), who have pathological fractures, or who are over the age of 70.

### Treatment

In all cases, surgery was performed in a supine position under spinal or general anaesthesia and with the use of an image intensifier. Fracture reduction was achieved manually in all except in two cases where k-wires and lag screws were used for reduction. A curvilinear incision of 3 to 4 cm was made at the medial end of the distal tibial metaphysis, protecting the saphenous vein. A subcutaneous or extra periosteal tunnel was prepared with the use of a periosteal elevator for subsequent plate insertion. After insertion of the implant, the position of the bone fragments and the plate were secured in place with the help of k-wires and checked with an image intensifier. One screw was inserted in each of the main fragments, and the position of the fracture and plate were checked again. Fixation was then completed with the insertion of a planned number of screws (a minimum of 3 to 4, 4mm locked head screws and 5mm cortex locking screws were considered sufficient.) After fracture fixation was complete and a final radiological evaluation of all components of fixation was performed, the wounds were closed in layers. If an associated fibular fracture was found in the lower third region at syndesmotic level or below syndesmotic level, it was fixed with a 1/3 tubular plate or rush nail. After wound closure, the limb is immobilised with a below-knee slab.

**Post-operative management:** Static quadriceps exercises and toe movements, as tolerated, began from the 1st post-operative day. Intra-venous antibiotics are given for 5 days, followed by a course of oral antibiotics for 7 days. Analgesics are to be given as per need. Suture removal is done on the 10th post-op day. Ankle mobilisation started on the 10th post-op day. Non-weight-bearing started with a walker after the 4th week. Partial protected weight bearing started as the first sign of callus seen in follow-up x-rays. Usually after 8 to 10 weeks. X-rays were taken at regular intervals and evaluated for fracture healing, alignment at the fracture site, and for any evidence of mal-alignment. Full weight bearing started as the union was achieved in 3 out of 4 cortices, usually around 18 to 20 weeks. (Clinically, union is defined as a painless fracture site during full weight bearing. Radiographically, a fracture will be considered united if 3 of 4 cortices in 2 radiographic views are continuous. If fracture union was not achieved by the sixth month of surgery, the situation was classified as delayed union, and non-union by the ninth month.)

**Follow-up:** Patients were followed up for a period of 6 months; the first follow-up at 4 weeks; the second follow-up at 8 weeks; the third follow-up at the 12th week; and the fourth follow-up at 6 months. At the final follow-up, patients were evaluated using the American Orthopaedic Foot and Ankle Society (AOFAS) score.

The American Orthopaedic Foot and Ankle Society Score (AOFAS), introduced in 1994 by Kitaoka, has nine questions related to three components: Pain (one question with 40 points), Function (7 questions with 50 points) and Alignment (one question with 10 points), making a total score of 100 points. The questions related to alignment and range of motion (measured by a goniometer) was done by the examiner based on radiographs and clinical assessment; the other questions were completed by the individual patients. The individual scores were then added to obtain an overall functional score, which was then expressed in the form of a percentage of the normal (100 points).

### Statistical Analysis

Statistical analysis was performed for all the samples, and the data was analysed using SPSS Software 2.0.  $p \leq 0.05$  is considered statistically significant.

### Results

The demographic features of the patients are tabulated below. There were 15 (75%) males and 5(25%) females. The average age of the patients during the time of surgery was 43.7 (range of 20-66 years). The fractures were at the right side in 13 (65%) and at left side in 7 (35%) patients. The mean follow-up after surgery was 3.6 months (range, 6 to 24 months) Fig 1. The mean operative time was 65 min (45-125 min). The mean time until surgery was 2 days (1-7 days)

**Table 1:** Distribution of subjects based on age, sex, and fracture patterns

Age (years)		43.7 (20-66)	Percentage
Sex	Female	5	25%
	Male	15	75%
Side	Left	7	35%
	Right	13	65%
Fracture types	A1	7	35%
	A2	4	20%
	A3	2	10%
	B1	3	15%
	B2	1	5%
	C1	1	5%
	C2	2	10%
Smoking		5	25%
Gustilo Anderson classification	Closed	15	75%
	Open Grade I	5	25%
Associated Injury		13	65%
Fibula Fracture		13	
Fibula fixation		11	
AOFAS Score	Excellent	>85	
	Good	70-80	
	Fair	55-65	
	Poor	<50	

The mean AOFAS ankle hind food was 86.6 and according to the AOFAS score, >85% had an excellent score, 70-80% had a good result, 55-65% had a fair result and <50 had a poor result. The AOFAS score for smokers group was significantly lower as  $p=0.003$  than the AOFAS score for non-smokers. The average time required for fracture union was 17.5 weeks in smokers group  $p=0.031$  than non-smokers group.



**Fig 1:** Image showing patient treated with MIPPO

Complications include, superficial skin infections for four patients which were treated with regular dressings and by appropriate antibiotics after pus culture and sensitivity test; deep infection for 1 patient; ankle stiffness for three patients with mild restriction ankle due to the in compliance of the patients to advised physiotherapy regimen as there was no means to monitor the physiotherapy of the ankle joint after discharge of the patient; minimal ankle oedema for two of ankle oedema which was treated by compression elastic bandage, serrati peptidase and chymoral forte drugs; one patient had implant exposure for whom regular dressings were done. As the fracture was still uniting, implant removal was planned on a later date. One patient had delayed union for more than six months.

**Table 2:** Distribution of subjects based on complications

Complications	No. of Patients	Percentage
Superficial skin infection	4	20
Deep Infection	1	5
<b>Ankle movement restriction</b>		
Normal or Mild restriction < 25%	2	10
Moderate restriction 25 – 75%	1	5
Severe restriction > 75%	0	0
Ankle edema	2	10
Delayed union	1	5
Malunion	1	5
Implant exposure	1	5

## Discussion

A vast number of different treatment strategies and fixation methods are presented for pilon fractures related to the development of novel treatment concepts. The aims of the surgical treatment of these fractures are anatomical reduction of the articular surface, stable fixation of the fracture, and restoration of the alignment. Minimal invasive treatment methods have recently become recognised methods that allow indirect reduction and stable fixation in fracture hematoma. Several clinical studies showed that minimal invasive techniques yielded good results with fewer complications [6-9]. However, there are a few challenges associated with the use of minimally invasive medial plate osteosynthesis in pilon fractures, including malunion, delayed union, and intra-operative saphenous nerve and vein injury [10-11]. In contrast to that, in our study, we could not find such complications. Shrestha *et al.* demonstrated that external fixation therapy for pilon fractures was effective when patients were chosen based on their soft tissue condition. Hence, a single-stage MIPPO protocol was followed that enabled short treatment duration. We did not perform preliminary external fixation as in the

Shrestha *et al.* series. We selected patients with apparently good soft tissue conditions. Thus, a single-stage MIPPO protocol was followed, thereby providing a shorter duration of treatment and preventing complications like wound dehiscence, sepsis, delayed or non-union. The MIPPO technique enables a bridging fixation without disturbing the comminute segments and the surrounding soft tissue. Unlike Shrestha *et al.*, we used an anatomically prebent plate to achieve stronger fixation in the metaphyseal region by allowing the insertion of 2 or 3 cancellous screws in the small distal segment [12].

As compared with studies by Baris A *et al* and Gopisetty Chaitanya Kishore *et al*, the median age of patients was 45.3 years and 47 years, which was comparable with the age of patients in our study [13-14].

The average time for bone union in our study was 17.5 weeks, which was a more appreciable treatment option when compared with studies by Gopisetty *et al.* and Raghu Kumar *et al.*, where they observed the fracture union at a range of 14–24 weeks [15].

Infection was the most common complication in our series, which was seen in four patients, all of whom had superficial wound infections with early onset and persistent wound drainage. The onset of infection is common in almost all the studies performed by Nasir *et al.*, Pramoddevkota *et al.*, and Ravindra *et al.* [16-18].

In 14 of 20 patients, the mode of injury was high energy trauma, i.e., road traffic accidents, which followed the same trend as other similar studies by Pramod *et al.* and Nasir *et al.*, whose studies also revealed a 70% (39 out of 53 cases and 11 out of 24 cases) injury [17, 16].

In our study, the fracture pattern was classified as per AO/OTA classification. We had a 65% type 43-A fracture pattern and 25% were type 43-B. Only 2 (10%) of the cases were of type 43-C. The present study had comparable results to other studies. A study by Nasir *et al.* showed 76% were type A, 20% type B, and 4% type C. [16] Another study by Ravindra *et al.*, also had 90% type A fractures and 10% of type B fracture pattern [18]. Study by Pramod *et al.*, also had fractures of 54% A, 16% B, and 15% C [17]. Raghukumar *et al.* study showed fractures classified according to AO/OTA and there were 10 A2 fractures, 9 A1 fractures, 1 A3 and 1 C1 type of fracture [15].

We studied 20 cases of tibial pilon fractures treated with LCP by the MIPPO technique and found 86.75% excellent to good results using the AOFAS score. This can be attributed to the fact that the technique of MIPPO with LCP preserves extraosseous blood supply and osteogenic fracture haematoma and leads to biologically friendly and stable fixation for distal

tibia pilon fractures in a study that established open reduction with plate and screw fixation as the standard, Ruedi and Allgower achieved 74% acceptable results in 85 patients. These results did not deteriorate for 9 years<sup>[19]</sup>.

The mean AOFAS ankle hind foot score was 86.6±9.1 (range, 62–100 points). According to the AOFAS score, 27 patients (43.5%) had an excellent score, and 26 patients (41.9%) had a good result. The mean Olerud-Molander score was 85.6±9.8 (range, 70–100 points) in the last follow-up. The AOFAS score for the group of patients that are smokers and have diabetes was significantly lower ( $p = 0.002$ ) than the AOFAS score for the group of patients that are non-smokers and non-diabetic<sup>[13]</sup>.

In our study, the mean duration between injury and surgery in our study was 8.5 days, ranging from 5 to 18 days. The surgery was planned after soft tissue swelling around the fracture subsided, as evidenced by the appearance of wrinkles on the skin. In a study by Bari *et al.*, in all 60 cases, the mean time until surgery was 2 days (range, 1–7 days)<sup>[13]</sup>. In the Gopisetty Chaitanya *et al.* study, all patients were operated on an average of 5.45 days from the time of injury, ranging from 2 to 9 days<sup>[15]</sup>. In a study done by Pramoddevkota *et al.*, the mean time from injury to operation was 9 days (range from 3 to 12 days)<sup>[17]</sup>. In Nasir Muzaffar *et al.*'s study, the surgery was performed after the stabilisation of skin and soft tissue conditions averaging 9.98 days, which ranged from 5-16 days.<sup>16</sup> In a study by Ravindra *et al.*, the mean duration to surgery from the day of presentation and injury was 4–7 days, with an average of 4.7 days<sup>[18]</sup>.

### Conclusion

Minimally invasive plate osteosynthesis is a good and safe technique for the treatment of distal tibial fractures, providing fracture healing, rapid functional recovery, and the avoidance of major complications. The achievements are fracture fixation without disturbing the soft tissue cover and relative fixation leading to secondary fracture union. As the implant is placed subcutaneously, there are increased risks of infection and implant exposure. This can be avoided by proper approximation of the edges of the wound while closing and strict limb elevation. As the implants are costly, manufacturers should try to develop implants with lower costs that will be useful for the majority of people with this fracture type.

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