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FUNCTIONAL AND RADIOLOGICAL OUTCOME OF TIBIAL PILON FRACTURES TREATED WITH MINIMALLY INVASIVE PLATE OSTEOSYNTHESIS

Orthopaedics

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ABSTRACT

Background: Distal tibial fractures are a common injury that poses challenges in terms of treatment and outcomes. Minimally invasive plate osteosynthesis (MIPO) has emerged as a promising technique, reducing the need for large incisions while promoting faster recovery and fewer complications compared to traditional open reduction and internal fixation (ORIF). This study evaluates the clinical and radiological outcomes of MIPO in patients with distal tibial fractures. **Aim:** The aim of the study is to assess the functional and radiological outcome of tibial Pilon fractures treated with minimally invasive plate osteosynthesis technique. **Materials and Methods:** Patients who arrived at the orthopaedics department from 1st July 2021 to 30th July 2023 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 one year. Union time, complications, and AOFAS scores were evaluated. Results: According to AO/OTA classification, 10 patients were type A1 fractures, 4 were type A2, 2 were type A3, 3 were type B1, 2 was type B2, 1 was type C1 and 3 were type C2 fractures. The mean AOFAS score was 86.76±9.1. Minimal complications were noticed in patients. **Conclusions:** MIPO offers favourable outcomes in the treatment of distal tibial fractures, with significant improvements in fracture healing, functional recovery, and pain reduction. The technique is associated with a low complication rate, making it a viable option for managing these fractures.

KEYWORDS

Fractures of Pilon, AOFAS score, MIPO, Fracture healing

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 feature. 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 communication, 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).**

Aim

To analyze the Functional and Radiological outcome of Distal Tibia Pilon fractures treated with ORIF with MIPO Fixation in Department of Orthopaedics Chettinad Medical College and Hospital, Kelambakkam from July 2021 to July2023.

Materials and methods

This study is a prospective analysis of 25 patients who underwent MIPO for distal tibial fractures at department of orthopedics, Chettinad Medical College and Hospital, Kelambakkam from July 2021 to July 2023. The primary objective was to evaluate the clinical and radiological outcomes of MIPO in terms of fracture healing, complication rates, functional recovery, and patient satisfaction. The study was approved by the institutional review board, and patient consent was obtained for the use of medical records

Inclusion criteria

Age more than 18 years

Isolated distal tibial fractures (fractures occurring within 6 cm of the ankle joint)

Closed or grade I open fractures

Fractures treated with MIPO technique and fractures classified according to the AO/OTA classification system were included

Exclusion criteria

Age less than 18 years

Patients with fractures with associated ipsilateral fractures (e.g., fibula or tibial plateau fractures)

Gustilo-Anderson grade II and III open fractures

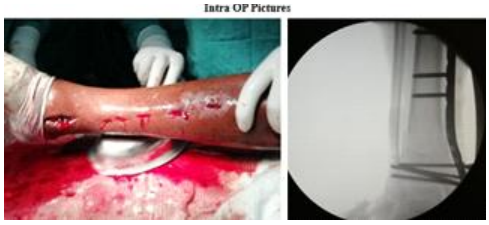
Patients not for surgery (e.g., severe comorbidities, inability to tolerate anaesthesia) were excluded. **(6)**.

Surgical technique

The MIPO technique was performed under general or regional anaesthesia with the patient in a supine position. A small incision (approximately 2-3 cm) was made on the medial or lateral aspect of the tibia, depending on the fracture site. The fracture was reduced using percutaneous manipulation, and a pre-contoured locking plate was inserted through the incision using a minimally invasive approach, avoiding excessive soft tissue dissection. Fracture fixation was achieved with locking screws, ensuring stable fixation while minimizing disruption to the surrounding tissues. Intraoperative fluoroscopy was used to confirm proper fracture reduction and plate positioning.

Postoperatively, patients were monitored for complications such as

infection, compartment syndrome, and neurovascular injury. Post-operative X-ray was done to document proper reduction and fixation of fracture fragments. Ankle mobilization was started from 2nd or 3rd post-operative day according to the tolerance of patients or associated injuries. Weight-bearing status was gradually allowed based on radiological healing. Antibiotics were administered prophylactically for 24-48 hours post-surgery. Regular follow-up was assessed through serial radiographs at 6, 12 and 24weeks post-surgery to assess fracture healing, evaluating callus formation, alignment, and the time to union (7).



RESULTS

A total of 25 patients were included in this prospective study, all of whom underwent MIPO for distal tibial fractures. The mean age of the patients was 42.5 years (range: 20–66 years). The fractures included in the study were classified according to the AO/OTA system, with most of the fractures being of type 43-A (closed fractures, non-displaced or minimally displaced).

Gender and Mode of injury of the participants

Among the study population males 15 (60%) were commonly affected than females 10 (40%). (Table 1). The mechanism of injury was Road Traffic Accident (RTA) in 20 (80 %) patients while 5(20 %) had history of fall.

Side of injury of the participants

Out of 25 patients, thirteen of them (52%) had right tibia fracture while the rest (n=12, 48%) had fracture of the left tibia (Table 2).

AO/OTA classification of the participants

According to AO/OTA classification, 10 patients were type A1 fractures, 4 were type A2, 2 were type A3, 3 were type B1, 2 was type B2, 1 was type C1 and 3 were type C2 fractures (Table 3).

Functional Outcome based on AOFAS score (American Orthopaedic Foot and Ankle society)

The functional outcome was excellent (AOFAS score > 85) in majority of the cases (n=22 88%) while the rest (n=3 12%) had good (AOFAS score of 70-80) outcome The mean AOFAS score at the last follow-up (12 weeks) was 86.76±9.1, indicating good to excellent functional outcomes (Table 4).

Table 1: Gender distribution

Gender	Frequency	Percentage
Male	15	60
Female	10	40
Total	25	100

Table 2: Side of injury

Side Involved	Frequency	Percentage
Right	13	52
Left	12	48
Total	25	100

Table 3: AO/OTA Classification

Fracture type	Frequency	Percentage
A1	10	40
A2	4	16
A3	2	8
B1	3	12
B2	2	8
C1	1	4
C2	3	12
Total	25	100

Table 4: Functional Outcome based on AOFAS score

Functional Outcome	Frequency	Percentage
Excellent (>85)	22	88
Good (70-80)	3	12
Fair (55-65)	0	0
Poor (<50)	0	0
Total	25	100

Table 5: Incidence of complications

Incidence of complications	Frequency	Percentage
No complications	22	88
Infection	2	8
Stiffness	1	4
Total	25	100

Duration of fracture union

The time taken for the union of fracture is an indicator of treatment effectiveness. Literature shows that the duration of fracture union to be between 16-28 weeks. The present study showed a mean duration of 18.1 weeks. This is similar to the treatment using locking compression plates from other studies which reported $p<0.05$ (Statistically significant). The following table shows the comparison of various studies with the present study.

Study	Method	Average Fracture Union
Cory Collinge et al	MIPO	21 Weeks
Abid Mushtaq et al	MIPO	22 Weeks
Hazarika et al	MIPO	19.3 Weeks
Shrestha D et al	MIPO	18.5 Weeks
Present study	MIPO	18.1 Weeks

Incidence of complications

Out of 25 patients, 88% (n=22) did not have any complications whereas five of them had complications namely stiffness (n=1, 4%) and infection (n=2, 8%). There were no intraoperative complications. Post-operatively, superficial skin infections were present in few cases that was treated with antibiotics (after pus culture and sensitivity) and surgical debridement/dressing. There was no instance of deep skin infections. Minimal ankle Oedema was present in two cases. There were no cases of implant failure or non-union (Table 5).

DISCUSSION

The management of distal tibia fractures, whether or not accompanied by intra-articular extension, presents treatment modalities adequately meet the specific requirements associated with the fracture characteristics of the distal tibia. The distal tibia exhibits a circular cross-sectional area characterized by a thinner cortical layer, in contrast to the triangular diaphysis, which possesses a thicker cortex. The intramedullary nail, engineered for a tight interference fit at the diaphysis, is unable to offer equivalent stability at the distal fracture site. Additional possible complications associated with nailing include malunion, which occurs in 0-29% of cases, and implant failure, observed in 5-39% of instances (8). ORIF utilizing a conventional plate that necessitates the stripping of the periosteum is not considered an optimal treatment approach. This is primarily due to the tibia being a subcutaneous bone, where the periosteum contributes approximately two-thirds of the blood supply. The incidence of non-union and delayed union, as well as infection, has been documented to range from 8.3% to 35% and 8.3% to 25%, respectively, in cases involving ORIF with plating (9). External fixators, employed as a definitive treatment modality for distal diametaphyseal tibia fractures, have been associated with an elevated incidence of infection, implant failure, and malunion or nonunion. Consequently, their use is advised primarily as a temporary stabilization method in cases of open fractures accompanied by significant soft tissue injury (10). The advancement of the MIPO technique utilizing locking compression plates (LCP) has facilitated the preservation of extraosseous blood supply and the maintenance of osteogenic fracture hematoma. This approach offers a biologically compatible and stable fixation method for distal diametaphyseal tibia fractures. The indirect reduction method, along with subcutaneous tunneling of the plate and the application of locking screws through small skin incisions in the MIPO technique, effectively mitigates the risk of iatrogenic injury to the vascular supply of the bone. In contrast to traditional plates, LCP represent a friction-independent, self-stabilizing construct that offers both angular and axial stability. This design significantly reduces the risk of secondary loss of reduction, facilitated by a threaded interface between the screw heads and the plate body (11). In our study, most of the patients were aged between 18- 30 years. 13 patients between age of 18-30 years (52%) and 8 patients between 41-50 years (32%) 4 patients between 51-60 years (16%). It showed that distal third tibial fractures are more common in younger individuals and they are attributed to high-energy trauma. Most of the patients were male 15 (60%) and female are 10(40%) Singer BR, McLauchlan GJ, Robinson CM, et al (1998) reported distal tibial fractures has high incidence in males (12). In our series most of the fractures were due to road traffic accidents. 20 out of 25 (80%) were due to road traffic accidents and remaining were due to fall from height and injury at work place due to fall of heavy objects. In our series of 25 patients, 13 (52%) patients had right side involvement. 12 (48%) had left side involvement. The incidence depending on the fracture configuration in our series according to Campbell's text book of operative orthopaedics (13), Nicoll E.A. Fractures of tibia (14), Gestern M, Tscherne H. et al (15), As per Reudi & Allgower of distal tibial pilon fractures. In our series, 25 patients were treated with open reduction and internal fixation with locking compression plate and screws; we had 88% excellent results, 12% good results. Average union time was 18.1 weeks. 3 patients had superficial infection and skin necrosis at suture site but they healed without any intervention. In

these patients last 10° of dorsiflexion and plantar flexion was restricted. In a study conducted by im GI, Tae SK (2005) (16), average union time with open reduction and internal fixation with plate was 20 weeks. They reported 15% had superficial infections and 15 % had deep infections. According to Olereud & Karlstrom (17), they had healing difficulty in 19% but end results were good. In plating fracture reduction is accurate, degree of angulation is less & anatomical reduction will be achieved. Has higher rates of infection, ranging from superficial infection to deep infections. Deep infection patient required further surgery in the form of debridement and required further hospital stay for intravenous use of antibiotics. Range of movements at ankle like dorsiflexion and plantar flexion are restricted. Plating has little higher average time of union and had higher operative times. This group had delayed weight bearing as plate is load bearing device.The functional recovery, as measured by the AOFAS scores, demonstrated significant improvement over time. The mean AOFAS ankle hind foot score was 86.76±9.1 (range, 62–100 points). According to the AOFAS score, 22 patients (88%) had an excellent score, and 3 patients (12%) had a good result. The AOFAS score increased from 71.50±12.10 at 6 weeks to 83.10±11.20 at 12 weeks, and further improved to 86.76±9.1 by 24 weeks, indicating a good to excellent functional outcome. These improvements were statistically significant (p 0.05) The findings suggest that MIPO not only facilitates fracture healing but also promotes faster functional recovery, which is a crucial aspect of patient satisfaction and quality of life. Likewise, in a study done by Ranjan et al there was a significant improvement in the AOFAS score when compared preoperative and 6 months post-operative in patients undergoing MIPO for distal tibial fractures [18].

CONCLUSION

The functional outcome of tibial Pilon fractures treated with minimally invasive plate osteosynthesis (MIPO) has shown promising results in terms of fracture union, restoration of ankle function, and minimization of soft tissue complications. This technique preserves the periosteal blood supply and minimizes surgical trauma, which is particularly beneficial in managing these complex intra-articular injuries. Patients demonstrated satisfactory ankle mobility and weight-bearing capabilities during follow-up, with reduced incidence of infection and wound-related complications compared to traditional open reduction methods. Radiological union was achieved in most cases within an acceptable time frame, and the majority of patients resumed daily activities with minimal discomfort. Overall, MIPO offers a reliable, less invasive alternative with good functional outcomes and fewer soft tissue complications, especially in cases with high-energy trauma where soft tissue preservation is critical.

Declaration of patient consent:

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed

Conflict of interest: Nil
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