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## Tibial pilon fracture treatment with staged open reduction and internal fixation with LCP versus primary hybrid fixation: A randomized prospective study

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### Abstract

**Introduction:** Distal tibial fractures remain one of the most substantial therapeutic challenges for orthopedic traumatology. Despite the advances that have been made in management, these fractures can be challenging to deal with, especially when associated with significant soft-tissue injury. Treatment of pilon fractures ranges from nonoperative to various operative options. Among operative, the two most controversial methods include the Staged procedure using open reduction internal fixation and using a primary hybrid fixator.

**Objective:** This study aims to compare the outcomes of tibial pilon fracture treatment with staged open reduction and internal fixation with LCP and primary hybrid fixation and evaluate its results.

**Material & Methods:** This Prospective Randomized comparative study was done in a tertiary level health care center. The patients were included in the study after fulfilling inclusion and exclusion criteria. The patients were then randomized in either of the two groups and treated accordingly by a single orthopaedic surgeon to avoid the bias. Follow-up was done after 3 weeks and then reviewed every one month up to 6 months. At 6 months IOWA score was assessed. Fracture union was assessed based on clinical and radiographic criteria. Clinically the ability to fully weight bear with no pain at the fracture was considered to represent the clinical union.

**Results:** According to the IOWA ankle score, 32% in group A and 40% in group B had an excellent results, 40% in group A and 52% in group B had a good results, 20% in group A and 8% in group B had a fair result and 8% had a poor result in group A due to deep infections (osteomyelitis) in bone. The mean IOWA Ankle Score at the Final follow-up in Group A was  $82.64 \pm 10.27$  and of Group B was  $86.96 \pm 5.07$ , which was non-significant. In terms of functional results, the excellent result was observed in 8 patients in Group A and 10 in Group B.

**Conclusion:** The management of pilon fracture with both of them procedure were equally effective, but aims was to reduce surgical tissue trauma, deep infection and preservation of periosteal vascular integrity and osteogenic fracture haematoma all cause early union, which was much more possible by hybrid fixator group.

**Keywords:** Distal tibial fractures, LCP, orthopedic traumatology

### Introduction

Tibia and fibula are the most common injured bones of the lower extremity. Distal tibial fractures remain one of the most substantial therapeutic challenges for the orthopedic traumatology. Management of pilon fractures is often difficult & challenging because of their intra-articular involvement, comminutions and inadequate soft tissue coverage. Despite the advances that have been made in management, these fractures can be challenging to deal with, especially when associated with significant soft-tissue injury<sup>[1]</sup>.

Controversy and debate continue about the management of these fractures due to the high rate of complications irrespective to the mode of treatment. To decrease the treatment-related complications, management strategies have changed significantly in the lasts 2-3 decades, but till today there is no universally acceptable mode of treatment available<sup>[2]</sup>.

The treatment of pilon fractures ranges from nonoperative to various operative options. Non-operative treatment by closed reduction followed by plaster immobilization has reduced the cost of treatment and it avoids all surgical complications, but it has some disadvantages like

plaster sore, tightened plaster, difficulty in wound management, joint stiffness, arthritis, non-union, mal-union, shortening, reflex sympathetic osteo-dystrophy and longer hospital stay [3].

Operative methods involve various strategies such as Calcaneal pin traction, Combined external fixation or JESS fixator that span the ankle while fibula is plated or intramedullary stabilization. The advantage of these procedures is minimal soft tissue dissection and less chance of neurovascular injury. It has some disadvantages like patient keep without weight-bearing till union, loss of reduction, joint stiffness, mal-union, non-union, etc. [4-6]

Other methods include intramedullary nailing, ilizarov fixator, etc. Among these, the two most controversial methods include the Staged procedure using open reduction internal fixation and via using a primary hybrid fixator.

This study aims to compare the outcomes of tibial pilon fracture treatment with staged open reduction and internal fixation with LCP and primary hybrid fixation and evaluate its results.

### Material and methods

This Prospective Randomized comparative study was done in the department of orthopaedics at a tertiary level health care center From April 2016 to November 2017. While we included patients with isolated unilateral Close or open pilon fracture, type 1<sup>st</sup> & type 2<sup>nd</sup> compound fracture (Gustillo-Anderson) and Patient who has given consent for the study, we excluded Type 3<sup>rd</sup> compound fracture (Gustillo-Anderson) and patients with vascular injury. The data was Analyzed in MS Excel, Primer, and SPSS softwares.

The patients were included in the study after fulfilling inclusion and exclusion criteria. The physical examination was done that included a comprehensive orthopaedic examination, not only of the injured limb, but all four limbs, to avoid missing associated injuries. The involved extremity was examined for swelling, deformity, discoloration, skin integrity, neurological, motor, and vascular compromise, and signs or symptoms of compartment syndrome.

The patients were then randomized in either of the two groups and treated accordingly by a single orthopaedic surgeon to avoid the bias. Follow-up was done after 3 weeks and then reviewed every one month up to 6 months. At 6 months, we assessed IOWA ankle score. Fracture union was assessed based on clinical and radiographic criteria. Clinically the ability to fully weight bear with no pain at the fracture was considered to represent the clinical union.

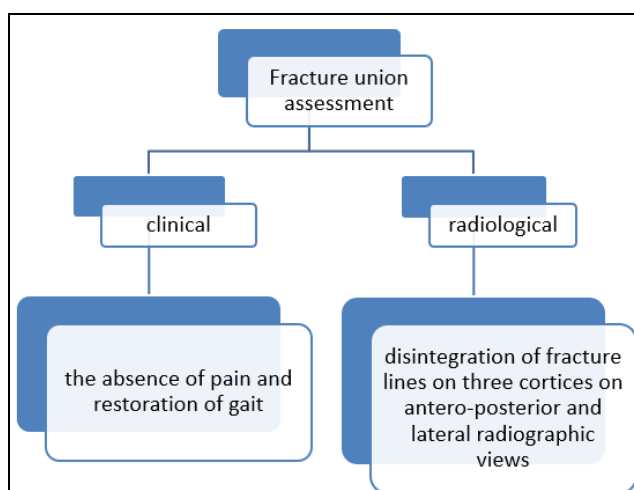


Fig 1: Fracture was considered to represent clinical union

### Operative technique

#### a. Primary hybrid fixation

- 1. Position of the patient:** Supine with the affected leg elevated on a pillow/sandbag for distal end fractures and Compound wounds are thoroughly debrided.
- 2. Securing articular fragments:** After reducing the peri-articular fragment, it was secured using three Ilizarov wires. The wires (bayonet tipped) were pushed manually until it hit the cortex, then drilled across both the cortices and hammered out through the opposite soft tissue. Nerves and vessels were avoided based on the safe corridor for pin insertion in the leg. Olive wires were used in cases where compression of the longitudinal split is needed. Under fluoroscopic control, the first wire was passed parallel to the joint in a lateral to a medial direction. It is fixed to an appropriate size ilizarov 5 /8 or 3/4 ring so as to leave at least 2 cms between the leg and the ring on all sides. One wire each from posterolateral to anteromedial and posteromedial to anterolateral were passed under fluoroscopic control, keeping an angle of 30 to 60 degrees between the wires. The axial plane of the wires was perpendicular to bone and about 5 to 30mm proximal to the joint and as parallel to each other as possible. If any internal fixation using cancellous screws was deemed necessary, it was done before the passage of the wires. The wires were fixed to the rings using slotted wire connecting bolts and tensioned using a dynamometric tensioner. Skin traction by the wires, if any were released using minimal incisions on the side of the skin stretching.
- 3. Securing the diaphyseal fragment:** Three 4.5 mm Shanz pins or tapper pins were placed 3 - 4 cm apart on the anteromedial or anterolateral surface of the tibia perpendicular to its longitudinal axis. All the pins were placed in the different sagittal planes. The pins were connected to the two connecting rods with the pin clamps.
- 4. Fracture reduction and frame assembly:** Fracture reduction was obtained using longitudinal traction (Ligamentotaxis) under the image intensifier. The pin fixator assembly was connected to the ring assembly using a connecting clamp. All nuts and bolts were tightened. The compound fractures were treated with primary or secondary split-thickness skin grafting after healing of the wound.
- 5. Fibula fixation:** Fibula was not fixed in all cases. Whenever it was fixed, plates Or k-wire was used.
- 6. Final check:** Before closing the wound, we checked the c c screw lengths and position of olive wire under image intensifier control and ensured that they did not penetrate the articular surface.

**b. Staged ORIF:** The timing of definitive plate fixation was established using daily evaluation of skin or wound condition. In case of an open wound, early debridement and calcaneal pin traction or jess fixator applied, in some fibula also fixed with k- wire or plate. In case of compound fracture, the patient discharged or a plastic surgery referral is done after temporary fixation. Patients were reviewed accordingly after healthy skin conditions. All patients in the ORIF-group were operated on under a tourniquet.

- 1. Position of the patient:** Supine with the affected leg elevated on a pillow/sandbag for distal end fractures and Compound wounds were thoroughly debrided.
- 2. Incision:** Medial or anterolateral plane in distal leg.

3. **Securing articular fragments:** Intraarticular reduction was achieved using direct manipulation of the fragments and provisional fixation with K-wire.
4. **Securing the diaphyseal fragment:** Hold with reduction or bone holding clamp.
5. **Fracture reduction and plate fixation:** The polyaxialtibial locking plates & fibular plates Or k-wire were used for patients of the ORIF-group, minimal internal fixation of the tibia was performed by means of screws.
6. **Final check:** Before closing the wound, we checked the screw lengths and position of the plate under image intensifier control and ensured that they do not penetrate the articular surface.

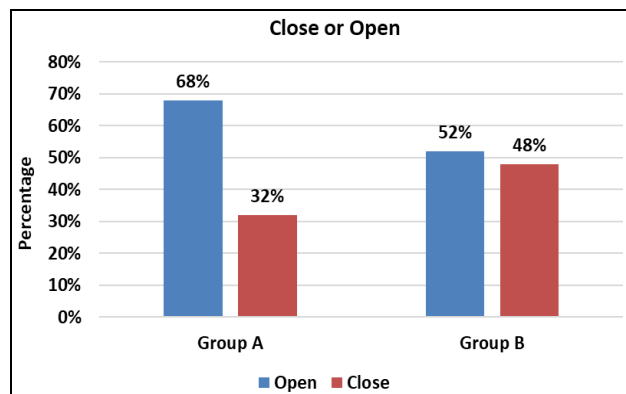
**Results**

Fifty patients were evaluated in this study and were divided into two groups. Group A = ORIF (Stage Procedure) and Group B = Primary Hybrid Fixator. The demographic profile is listed in Table 1.

**Table 1:** Demographic Profile

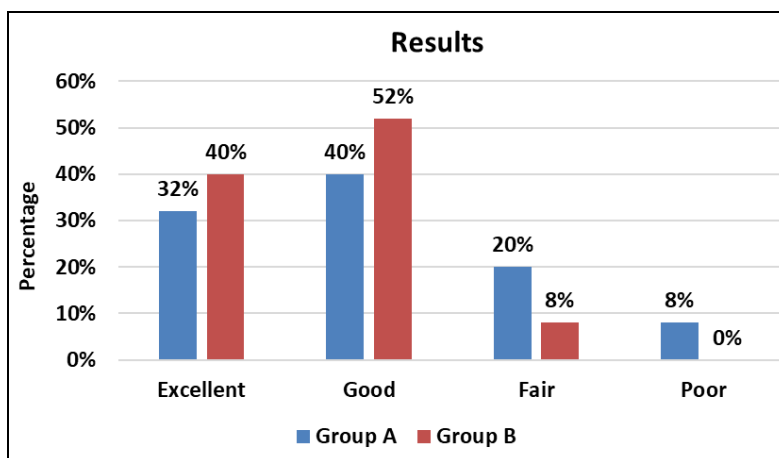
	Group A		Group B		Total	
	No.	%	No.	%	No.	%
Male	23	92.0	24	96.0	47.0	94.0
Female	2	8.0	1	4.0	3.0	6.0
Total	25	100.0	25	100.0	50.0	100.0
	Mean Age		SD		P-value	
Group A	40.20		11.87		0.832	
Group B	39.48		12.13			

While 17 patients presented with Open fractures in Group A, 13 patients presented with open fractures in group B, which was non-significant (Fig 2)



**Fig 2:** Close and Open fractures in both groups

According to the IOWA ankle score, 32% in group A and 40% in group B had an excellent result, 40% in group A and 52% in group B had a good result, 20% in group A and 8% in group B had a fair result and 8% had a poor result in group A due to deep infections (osteomyelitis) in bone. The mean IOWA Ankle Score at the Final follow-up in Group A was 82.64±10.27 and of Group B was 86.96±5.07, which was non-significant. In terms of functional results, the excellent result was observed in 8 patients in Group A and 10 in Group B. While 2 patients reported poor results in group A, none of them reported poor results in Group B. (fig 3)



**Fig 3:** Functional Results

**Discussion**

Pilon fractures are mainly produced by either shearing forces that split bone fragments or compressive forces resulting from axial loading. The severity of the injury is greater when there has been more comminution, displacement and impaction. Significant damage often accompanies the soft tissue envelope that surrounds the ankle along with fracture. Surgical management of pilon fracture appears to improve results, although this observation is based on uncontrolled comparisons among published series of the retrospectively selected patient (Arlettaz Y 1998) [7]. Most authors have reported poor results from open reduction and internal fixation of severe tibial plafond fractures and have suggested less invasive alternatives (Marsh JL 1995) [8]. Borrelli *et al.* (2001) [9] demonstrated that the distal metaphyseal region of the tibia has a relatively rich extrasosseous blood supply, provided primarily by a branch of

anterior tibial and posterior tibial arteries. They also demonstrated that open plating in this region produced a significantly greater disruption of this extrasosseous blood supply than minimal internal fixation with external fixation. The majority of patient in the present study belong to mean age in group A 40.20 years and group B 39.48 years, these are comparable to each other and P-value is not significant. The mean age of both groups is quite comparable with other studies like Babis G C *et al.* (2006) [10] showed a mean age of 45.6 years, while Liuz *et al.* (2013) [11], with mean age of 35 years. In our stud, the weight-bearing time after surgery in group A was 58.16 days and group B was 9.28 days. P-value is <0.05, which is significant in our study. It is due to much more stable construction in hybrid fixators then ORIF. Mean radiological union in our study in group A was 20.96 weeks and group B was 18.36 weeks and P-value is 0.014

which is statically significant. After radiological union hybrid fixator was removed and in some cases BK slab/cast was applied for some days and then removal done after some time. In ORIF group BK slab/cast was removed after the radiological union. It is also comparable to Cisneros LN *et al.* (2016) <sup>[12]</sup> the meantime from fracture to radiological union was  $133.82 \pm 37.83$  days for hybrid fixator, and  $152.8 \pm 72.33$  days for staged ORIF, respectively. Liuz *et al.* (2013) <sup>[11]</sup> staged ORIF union in all type 3B is 26 weeks. Babis G C *et al.* (2006) <sup>[10]</sup> mean radiological union with hybrid fixator was 13 weeks, they had a faster union rate 83% had chosen close fracture. Galante U N *et al.* <sup>[13]</sup> mean union time with hybrid fixator was 18 weeks. In our study, mean union time is more because most cases were to due RTA so the magnitude of soft tissue injury was much more than prior study.

In our study most common complication in ORIF is pain and stiffness in 5 cases, which were treated with physiotherapy. Infection (osteomyelitis) was in 2 cases which were treated with early plate removal after union, antibiotics and below knee casting. Wound dehiscence and delayed union were present in 2 cases which were treated with antibiotics according to culture and dressing and below knee casting. In 2 cases were verus, which were in an acceptable range and 1 case was valgus, which was in an acceptable range. There was 1 case of nonunion which required cancellous bone grafting at 20 weeks, which united at 30 weeks. So Out of 25 cases, 13 had complications which were managed well.

In case of the Hybrid fixator group, out of 25 cases, 9 cases had a complication. Out of 9 cases, in 4 cases pin track infections were present, which were treated with oral antibiotics and pin track care. 3 cases had mild varus and 1 case had mild valgus deformity, which were in the acceptable range, so did not require any treatment. Out of 9 cases, 1 case was with pain and stiffness which was treated with physiotherapy. So no one major complication happened in the hybrid fixator, all were managed very well. Out of 25 cases, 10 cases were in poor compliance to hybrid fixator, but 9 cases were managed with the proper council and in 1 case, early removal of fixator at 13 weeks which was managed with below knee casting till radiological union [17 weeks].

Final results in our study were assessed according to the IOWA ankle score. We observed excellent results in 32% in group A & 40% in group B, Good results in 40% in group A & 52% in group B, fair results 20% in group A & 8% in group B and poor result 8% in group A. Mean IOWA ankle scoring for group A was 82.64 and group B was 86.96 and *P*-value is 0.065 which is statically not significant.

Finally from the finding, both Staged ORIF and hybrid fixator statically not significant in terms of *P*-value of IOWA ankle score. Staged ORIF is more compliance procedure than a hybrid fixator. But in terms of hospital stay, the time between injury and operation, weight-bearing after surgery, visible callus and radiological union and cost-effectiveness hybrid fixator group had better results than staged ORIF procedure.

## Conclusion

The management of pilon fracture with both of them procedure were equally effective, but aims was to reduce surgical tissue trauma, deep infection and preservation of periosteal vascular integrity and osteogenic fracture haematoma all-cause early union, which was much more possible by hybrid fixator group.

Very few comparison studies had been done to evaluate the results of management of these fractures with staged ORIF and hybrid fixator. The present study may not be large

enough, but results which were achieved are encouraging. A larger study with longer follow-up is necessary to establish the difference between the above two procedures and to establish the better technique as a safe and effective management option for distal end leg bone fractures.

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