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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DOI: https://doi.org/10.22271/ortho.2022.v8.i1d.3023

Abstract

Introduction: Distal tibial fractures remain one of the most substantial therapeutic challenges for the 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 non operative to various operative options. Among operative, two most controversial methods include Staged procedure using open reduction internal fixation and via using 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 single orthopaedic surgeon to avoid the bias. Follow up was done after 3 week and then reviewed every one month up to 6 month. At 6 month IOWA score was assessed. Fracture union was assessed on the basis of clinical and radiographic criteria. Clinically the ability to fully weight bear with no pain at the fracture was considered to represent clinical union.

Results: According to IOWA ankle score 32% in group A and 40% in group B had excellent result, 40% in group A and 52% in group B had good result, 20% in group A and 8% in group B had fair result and 8% had poor result in group A due to deep infections (osteomylitis) in bone. 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, 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 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 \(^1\).

Controversy and debate continues about the management of these fractures due to high rate of complications irrespective to mode of treatment. To decrease the treatment related complications management strategies have changed significantly in lasts 2-3 decades but till today there is no universally acceptable mode of treatment available \(^2\). The treatment of pilon fractures ranges from non operative to various operative options. Non-operative treatment by closed reduction followed by plaster immobilization has reduced cost of...
treatment and it avoids all surgical complications but it has some disadvantages like plaster sore, tighten plaster, difficulty in wound management, joint stiffness, arthritis, non-union, mal-union, shortening, reflex sympathetic osteo-dystrophy and longer hospital stay [1].

Operative methods involve various strategies such as Calkaneal pin traction, Combined external fixation or JESS fixator that span the ankle while fibula is plated or intra-medullary stabilization. The advantage of these procedures is minimal soft tissue dissecion and less chance of neurovascular injury. It has some disadvantage 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, two most controversial methods include Staged procedure using open reduction internal fixation and via using 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 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 1st & type 2nd compound fracture (gustilo-anderson) and patient who has given consent for the study, We excluded Type 3rd 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 single orthopaedic surgeon to avoid the bias. Follow up was done after 3 week and then reviewed every one month up to 6 month. At 6 month we assessed IOWA ankle score. Fracture union was assessed on review every one month up to 6 month. At 6 month we avoid the bias. Follow up was done after 3 week and then treated accordingly by single orthopaedic surgeon to avoid the bias.

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3. Securing the diaphyseal fragment: Three 4.5 mm Shanz pins or taper pins were placed 3 - 4 cm apart on the anteromedial anterolateral surface of tibia perpendicular to its longitudinal axis. All the pins were placed in the different sagittal plane. 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 case. Whenever it was fixed plates or k-wire was used.

6. Final check: Before closing the wound, we checked the c screw lengths and position of olive wire underimage intensifier control and ensure that they did not penetrate the articular surface.

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

1. Position of the patient: Supine with affected leg elevated on a pillow/sand bag 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 by means of 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 polyaxial tibial locking plates & fibular plates or k-wire were used for patients of the ORIF-group, minimal internal fixation of the tibia were performed by means of screws.

6. **Final check:** Before closing the wound, we checked the screw lengths and position of plate under image intensifier control and ensure that they do not penetrate the articular surface.

**Results**

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

<table>
<thead>
<tr>
<th>Table 1: Demographic Profile</th>
<th>Group A</th>
<th>Group B</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
<td>No. %</td>
</tr>
<tr>
<td>Male</td>
<td>23 92.0</td>
<td>24 96.0</td>
<td>47.0 94.0</td>
</tr>
<tr>
<td>Female</td>
<td>2 8.0</td>
<td>1 4.0</td>
<td>3.0 6.0</td>
</tr>
<tr>
<td>Total</td>
<td>25 100.0</td>
<td>25 100.0</td>
<td>50.0 100.0</td>
</tr>
<tr>
<td>Mean Age SD P value</td>
<td>40.20 SD 11.87 0.832</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to IOWA ankle score 32% in group A and 40% in group B had excellent result, 40% in group A and 52% in group B had good result, 20% in group A and 8% in group B had fair result and 8% had poor result in group A due to deep infections (osteomyelitis) in bone. 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, 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)

**Discussion**

Pilon fractures are mainly produced by either shearing forces that split apart bone fragment or compressive forces that result from axial loading. Severity of 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 retrospectively selected patient (Arlettaz Y 1998) [7]. Most authors have reported poor result 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 extraosseous blood supply, provided primarily by branch of anterior tibial and posterior tibial arteries. They also demonstrated that open plating in this region produced significantly greater disruption of this extraosseous blood supply then minimal internal fixation with external fixation.

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. Mean age of both group is quite comparable with other studies like Babis G C et al. (2006) [10] shown mean age of 45.6 years while Liu et al. (2013) [11] with mean age 35 years. In our study weight bearing time after surgery in group A was 58.16 days and group B was 29.28 days. P value is <0.05 which is significant in our study. It is due to much more stable construction in hybrid fixator 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 removed after radiological union. It is also comparable to Cisneros LN et al (2016) the mean time from fracture to radiological union was 133.82 ± 37.83 days for hybrid fixator, and 152.8 ± 72.33 days for staged ORIF respectively. Liuaz et al (2013) staged ORIF union in all type 3B is 26 weeks. Babis G C et al. (2006) mean radiological union with hybrid fixator was 13 weeks, they had faster union rate 83% had chosen close fracture. Galante U N et al. (2011) mean union time with hybrid fixator was 18 weeks. In our study mean union time is more because most cases were due RTA so 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 acceptable range and 1 case was valgus which was in acceptable range. There was 1 case of non union which require 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 Hybrid fixator group out of 25 cases, 9 cases had complication. Out of 9 cases, in 4 cases pin track infection 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 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 hybrid fixator, all managed very well. Out of 25 cases, 10 cases were poor compliance to hybrid fixator but 9 cases were managed with proper council and in 1 case early removal of fixator at 13 weeks which was managed with below knee casting till radiological union. Final results in our study were assessed according to IOWA ankle score. We observed excellent result in 32% in group A & 40% in group B, Good result 40% in group A & 52%i in group B, fair result 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 term of P value of IOWA ankle score. Staged ORIF is more compliance procedure than hybrid fixator. But in term of hospital stay, 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 above two procedures and to establish the better technique as a safe and effective management option for distal end leg bones fractures.

**References**