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## Prospective and retrospective study of managing tibial pilon fractures using various modalities of treatment

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### Abstract

**Aim:** Tibial pilon fracture is always a challenge to treat, because of limited soft tissues, the subcutaneous location and poor vascularity. It is a controversial subject despite advances in implants and operative techniques. The goal is to realign the fracture, restoring articular surface, realign limb length and early functional recovery. The aim of our study is to assess the outcome of management of high energy tibial pilon fracture with various modalities of treatment

**Materials and methods:** It was a prospective and retrospective study conducted after ethical committee approval. Patient in age group of > 18 yrs with distal tibial fracture of Ruedi and Allgower type - I, II, III were included in this study. patients associated with vascular and neurology injury were excluded. Functional results were analysed.

**Results:** The total number of patients included in this study was 25 with age range between 20-64 with a mean age of 32.8 yrs. We had a minimum follow up of 1 yr and maximum follow up of 2 yrs. The union was achieved with a mean time of 12-16 wks. The mean duration from hospital admission to definite surgery was around 10-14 days. Anatomical reduction was achieved in about 14 cases with good alignment.

**Conclusion:** Tibial pilon fractures are complex injury that are difficult to treat. The combination of articular cartilage injury, Metaphyseal Comminution and soft tissue insult has often resulted in poor outcomes. Respect the soft tissue envelope is the first step in minimizing complications. Internal fixation can be considered as a reliable modality of management of distal tibial fracture and it has to be done either within 24 hrs of injury before the edema sets in or a delay of 8 to 12 days for the edema to settle down and wait for the wrinkle sign to appear, for such cases, external application is preferable. Do not Operate too early through compromised skin, instead wait till the soft tissues is amenable for surgery. Good functional result depends on reasonable anatomical reduction of the articular surface. For all pilon fractures, no single method of fixation is ideal. Choice of surgery depends on fracture pattern, soft tissue injury, patients profile and surgical expertise.

**Keywords:** Distal tibia, soft tissue injury, internal fixation, external fixation, anatomical reduction

### Introduction

#### Definition and mechanism of injury

Tibial pilon fractures are fractures involving weight bearing surface of the ankle joint which usually results from an axially directed force with/or rotational force. Rotational force may produce spiral fracture which may be extra-articular or intra-articular. These fractures are usually closed with less soft tissue injuries, whereas axial compressive forces are high energy intra-articular fractures of distal tibia because the talar dome which is convex impacts the concave plafond of the distal tibia. Position of the foot at the time of impact and the amount of energy decides the severity of articular injury. On plantar flexion, most of the forces directed towards the posterior articular surface and leads to formation of posterior fragments largely. On the otherhand when on dorsiflexion, dome of the talus impacts the anterior part of the tibial articular surface. But on neutral position, there will be 'y' shaped separation of anterior and posterior fragments due to central joint impaction.

#### Epidemiology and concomitant injuries

Road traffic accidents and high velocity trauma makes this fracture most common. Incidence of tibial pilon fractures are 7-10% of all tibial fractures.

Fibula fracture is also seen in 70% to 80% of the cases which are complex injuries. 50% of population may have additional lower extremity injuries mostly ipsilateral calcaneal or tibial fractures. Multiple injuries occur in 6% of the population. For extra-articular fractures, xrays are enough for surgical planning but once intra-articular fractures suspected, CT provides additional information for surgical planning.

Main challenges are comminuted fracture, displaced fragments, fracture at metaphyseal region. Managing these fractures are challenging and controversial because complications are higher. Different modalities of treatments are available. Of those, Operative option like ORIF, MIPPO technique, external fixation with limited fixation/hybrid fixators are available. But problems like, prolonged bed rest, stiffness, angulation, deformity, shortening joint incongruity, malunion, muscle wasting and post traumatic osteo arthritis will arise. Swelling and fracture blisters decides the timing of treatment. Satisfactory outcome is not possible always in pilon fracture and in many studies significant complication rate continues to persist. So, in our study, we have executed different modalities of treatment of pilon fractures in adults and observed the final functional score and complication rates.

#### Inclusion criteria

1. Age above 18 yrs with tibial pilon fractures
2. Closed fractures and open fractures
3. No specific duration of illness
4. Both males & females

#### Exclusion criteria

1. Age less than 18 yrs.
2. Pathological fractures
3. Associated spinal injuries (paraplegia and quadriplegia)/ head injuries /chest injuries
4. Patient with bleeding disorders
5. Associated fractures of other bones of same limb (except fibula)

#### Diagnostic work-up

When patient brought to casualty always rule out head and chest injuries. Do a complete traumatic survey, then only x ray to be taken, both AP and lateral views and Mortice view of the ankle joint. The axial cuts of the CT define the fracture line, fracture pattern and the number of fragments.

On admission detailed history was taken regarding past and associated illness. The fractures were classified based on Ruedi-Allgower classification I, II, III. Out of 25, 8 patients were type I, 10 were type II & 7 were type III. Examine the ankle for presence of any residual swelling, deformity and condition of wound, tenderness and ankle ROM. After surgery assess the patient according to AOFAS guidelines regarding any pain, any difficulties in walking, change in daily activities and change in occupation. Look the patients attitude and gait, weakness of triceps surae and any neurological deficits in foot. Follow up X-ray were taken to assess fracture union, condition of the implant (operated cases), evidence of early ankle arthrosis and any residual deformities.

#### Treatment

Patient with high risk co-morbidities and extremely high risk for anaesthesia or patients refusal for surgery are managed conservatively. Immobilization for long time poses risks of thrombosis, embolism and post traumatic joint contractures.

Four surgical steps proposed by Ruedi & Allgower for classic ORIF includes,

1. Reduction & fixation of the fibula.
2. Reconstruction of tibial articular surface.
3. Depressed articular & metaphyseal defects requires bone grafting.
4. Medial plate is used for fixation of metaphysis to diaphysis.

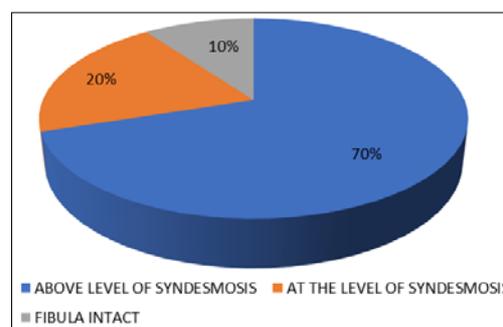
Several authors proposed staged protocols. First stage includes, application of external fixation. Second stage is definitive fixation of distal tibia to be done after oedema settles down. Today this dual staged surgical strategy has universally accepted. Resolution of fracture blisters & appearance of wrinkle sign are indications for definitive fixation.

**Fixation of fibula:** Fixation of fibula facilitates partial reduction of antero-lateral and/or postero-lateral fragments by ligamentotaxis and also prevents valgus tilt of the distal tibia. In simple fibular fracture with varus deformity of tibia means 1/3<sup>rd</sup> tubular plate used which acts as a tension band plate. In comminuted fibular fracture with valgus angulation, rigid implants are used. In transverse fracture IM fixation may be considered. Fixing fibula spontaneously reduce postero-lateral fragment which is a key fragment.

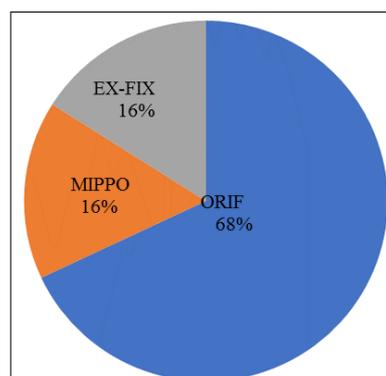
**Bone Grafting:** Autologous bone graft or bone substitutes are used for comminuted depressed zones

#### Surgical Approach

1. Antero-medial approach for the fractures involving medial column and anterior part of the plafond.
2. Antero-lateral approach for the fractures involving lateral column, anterior part of the plafond & fibula fractures.
3. Extensile anterior approach advocated for both medial & lateral column involvement.

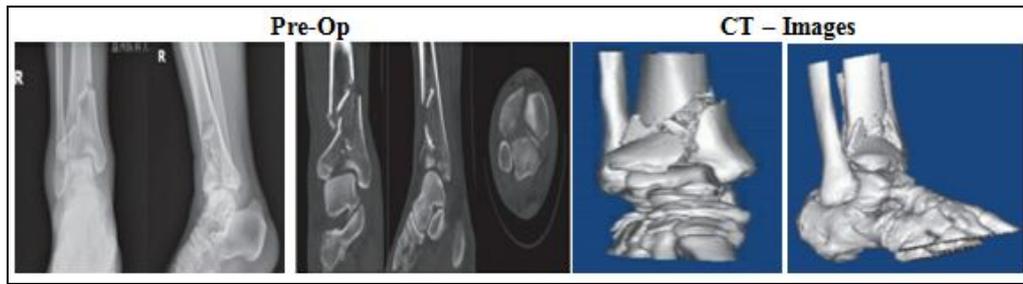


Graph 1: Incidence of fibula fracture

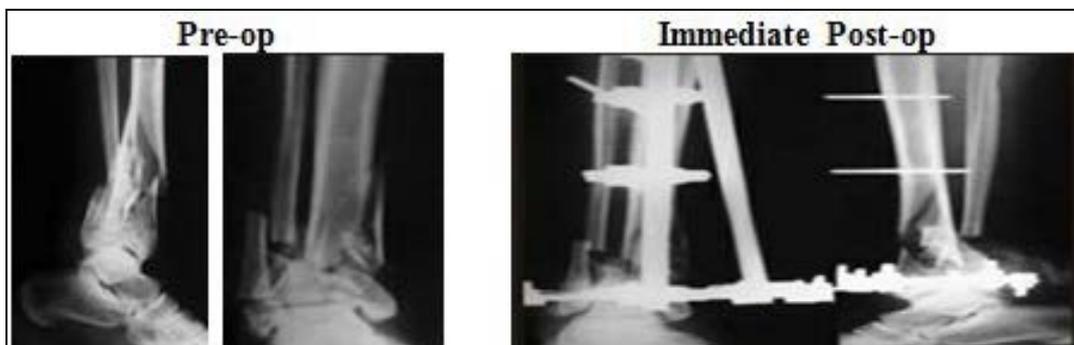


Graph 2: Various modalities of management

**Case 1.**

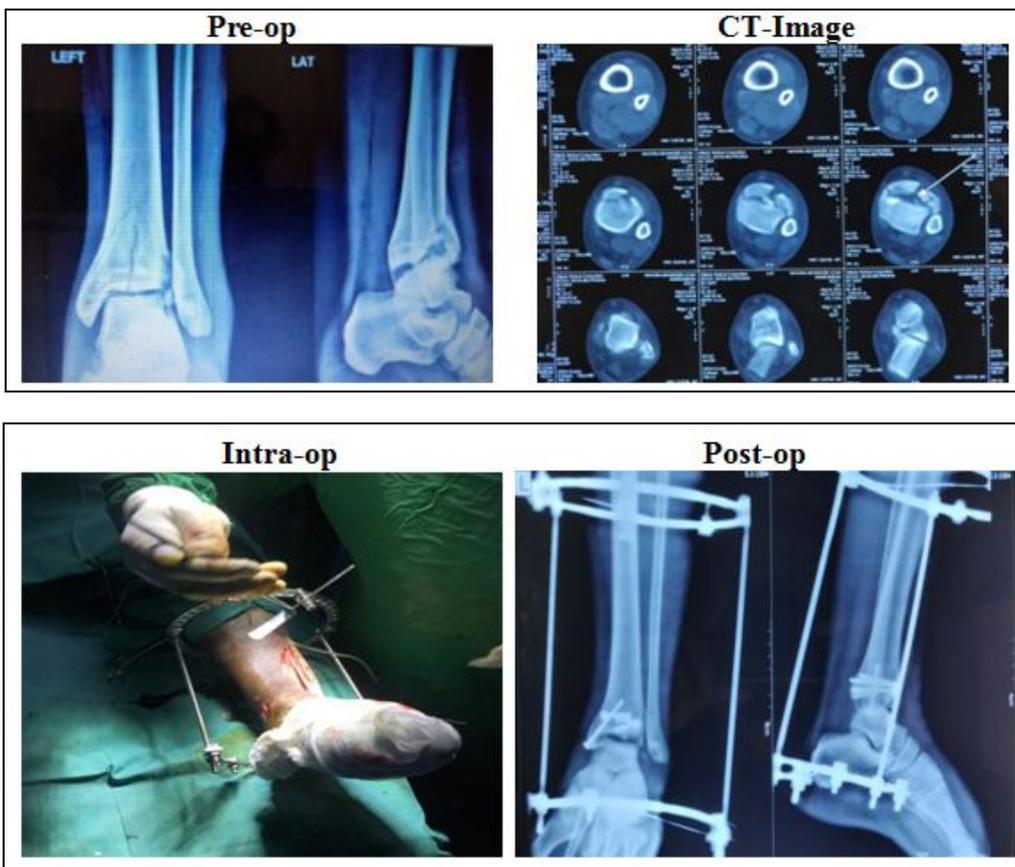


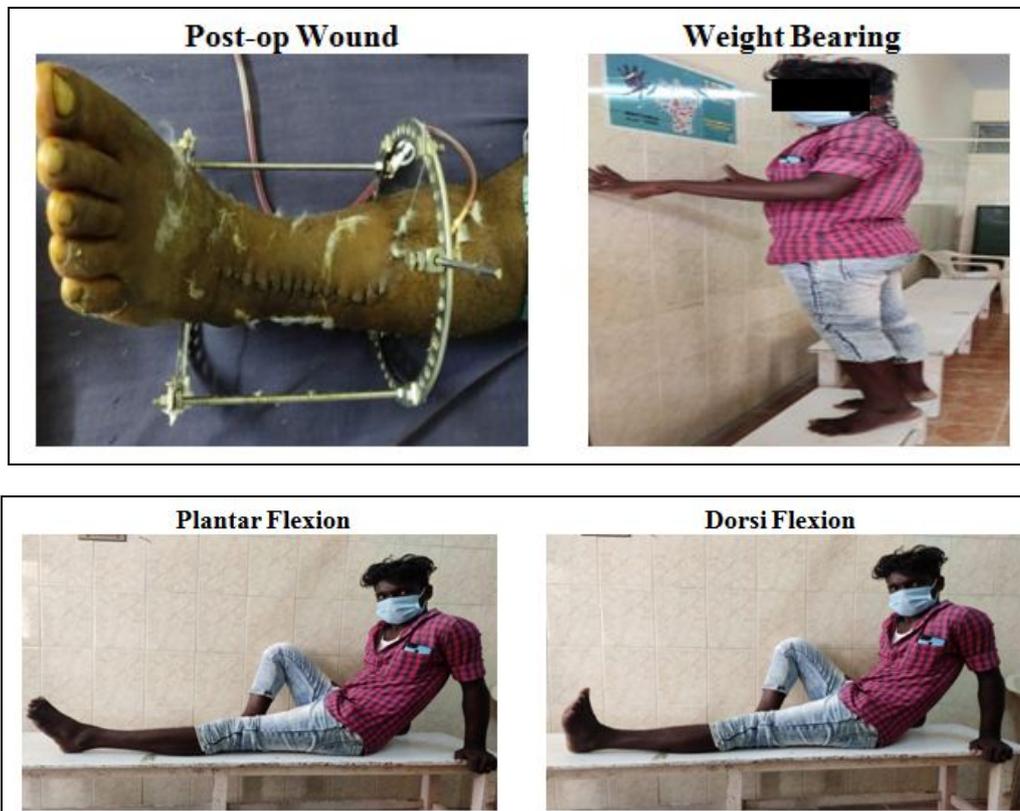
**Case 2.**





Case 3.





### Complications

Alexandr *et al.* <sup>[1]</sup> noticed 12% wound complications & 5% deep infections in 84 Pilon fractures. One patient had skin necrosis for which appropriate antibiotics started after culture and sensitivity, wound debridement and secondary suturing done since the patient is a known diabetic the infection had not settled, vacuum suction management done, after that Split Skin Grafting was done. Infection persisted for which transcutaneous advancement flap was done & then wound healed well. But the patient had stiffness and put on physiotherapy.

### Result

The present study comprised of 25 patients of open and closed pilon fractures with no or minimal soft tissue injuries. Male predominate the female with a ratio 3:1. Average age of patients 38.6 years with range between 20-60 years. Most of the cases (50%) occur due to RTA followed by fall from height (30%) & sports injury (20%). Out of the 25 cases 8 cases (50%) are type I followed by 10 cases (40%) are type II and 7 cases (10%) are type III according to Ruedi and Allgower classification. patients were followed up to 12-24 month 15 cases (60%) united in between 16-20 weeks, 6 cases (20%) united in 12-16 weeks and rest 4 cases unite after 20 weeks. 2 Superficial skin infections and 1 deep infection noted in 17 cases of primary ORIF and superficial skin infection noted in 1 case of MIPPO. Pin tract infection occurs in 1 case of external fixator. Final functional outcome in our study is 14 patients (56%) had excellent result and 8 cases (32%) good & 3 had fair (12%) result.

### Discussion

Managing tibial plafond fractures are always challenging and controversial. Despite multiple treatments are available, there is no level 1 optimal treatment.

Alexandre *et al.* <sup>[1]</sup> propose 25% to 50% of post-traumatic arthritis in surgically treated patient despite advanced treatment in tibial pilon fracture. Arjun *et al.* <sup>[2]</sup> had 3 excellent results, 9 good results, 5 fair & 1 poor result on

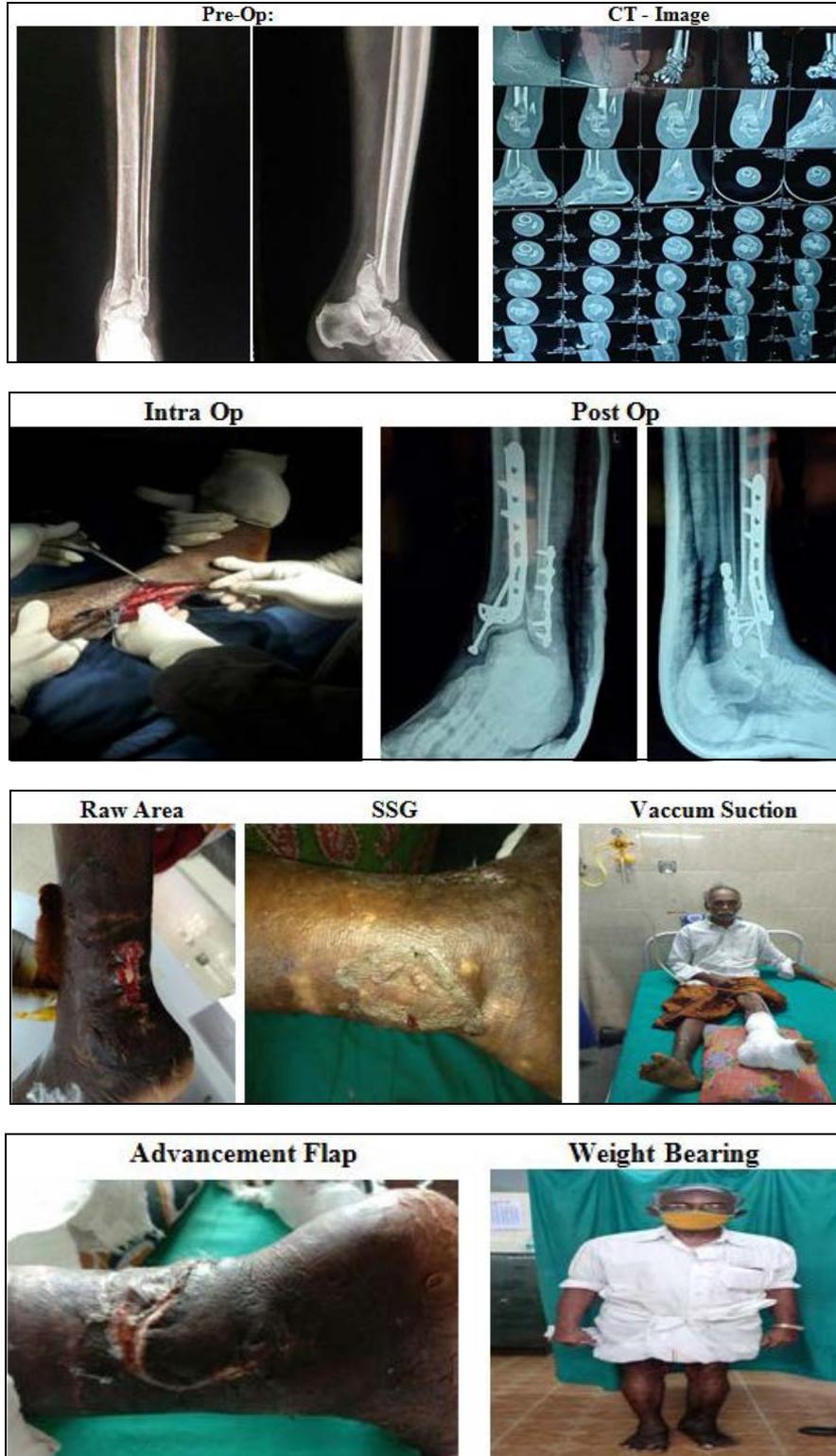
using locking plate for 18 pilon fractures by MIPPO technique. Two had scar dehiscence and one had fixed equines deformity. Fifteen of eighteen fractures united at 12 wks, three had union at 6 months. Blauth *et al.* <sup>[3]</sup> prefer a two-step procedure for the treatment of pilon fracture with extensive soft tissue injury. Thirteen of 51 patients got infected and 5 patients developed osteomyelitis. Faisal *et al.* <sup>[4]</sup> suggest rehabilitation program for pilon fractures to achieve good range of movements. In 2020 Yan *et al.* <sup>[5]</sup> proposed two stage treatment for 27 patients and he reports superficial infection in 5 patients, traumatic arthritis in 3 patients, 1 patient had skin necrosis. Justin <sup>[6]</sup> E. Richards, Mark Magill reported only 3.7% of infection rate and 3.7% of nonunion rate in staged procedure, when compared to external fixator group 11% infection and 22% non-union was reported. Mark *et al.* <sup>[7]</sup> reported 18 plastic surgeries which includes 13 free muscle flaps, 1 rotation flap, 1 bi-pedicle flaps, 2 secondary free muscle flaps & 1 cross leg flap for 51 treated pilon fractures. Thomas <sup>[8]</sup> *et al.* followed 4 sequential principles to reconstruct the articular surface and achieved 70% excellent results. Sirkin <sup>[9]</sup> *et al.* follows two techniques to limit complications. First is to limit incisions and using external fixation, second is staged reconstruction which are fibula plating and trans-articular external fixation or ORIF. Nebu <sup>[10]</sup> follows two stage procedure of initial external fixation followed by ORIF later. Mohamed <sup>[11]</sup> *et al.* reported 3 excellent results, 5 good, 3 fair & 1 poor results based on AOFAS ankle & foot scale. Mukara <sup>[12]</sup> showed 50% excellent, 30% good, 10% fair & 10% poor results by using MIPPO technique which preserves osseous vascularity fracture haematoma favouring more biological repair. Dillin <sup>[13]</sup> *et al.* reported 55% of osteomyelitis, 36% of delayed wound healing with only 3% of patients had union with minimum complications. Surgeons with less experience produce more disastrous results. Bournes <sup>[14]</sup> *et al.* reported 47% excellent, 41% fair and 12% poor results in a study of 17 patients. Mitkovic <sup>[15]</sup> *et al.* proposed using external fixator for type III pilon fracture and achieved

71% external results. Etter <sup>[16]</sup> *et al.* noticed fracture reduction at the time of surgery was good in 58%, fair in 39% & poor in 2.5%. Satisfactory results obtained in severe tibial pilon fractures by ORIF. Xueliang <sup>[17]</sup> *et al.* demonstrate two stage strategy is associated with less complication.

In our study, patients were followed up to 12-24 month 15 cases (60%) united in between 16-20 weeks, 6 cases (20%)

united in 12-16 weeks and rest 4 cases unite after 20 weeks. 2 Superficial skin infections and 1 deep infection noted in 17 cases of primary ORIF and superficial skin infection noted in 1 case of MIPPO. Pin tract infection occurs in 1 case of external fixator. Final functional outcome in our study is 14 patients (56%) had excellent result and 8 cases (32%) good& 3 had fair (12%) result.

**Case 4.**





### Conclusion

Restoring an anatomic articular surface & maintaining mechanical alignment and joint stability, achieving fracture union and restoring functional and good range of movements are the ultimate goals of treating pilon fracture. Understanding the mechanism of injury is far important because this reflects on the soft tissue injuries. Fractures with no or little displacement (R-A type I, II) has yielded much better functional results than that of more severe fracture pattern (R- type III). The patient should be observed closely for displacement and weight bearing should be restricted for at least 8 weeks. If the stability of the fractures is uncertain, external fixator with minimal fixation can be used. External fixation provides the same goal of fracture reduction through ligamentotaxis and allow the patients to get mobilized earlier, but the pin tract infection are most common if pin tract dressings are not done properly. While ORIF remains mainstay of treatment, additional modalities such as external fixation and primary arthrodesis are emerging and considered. Excellent and good results are seen with primary ORIF with plate and screw or MIPPO among various studies, for treatment of pilon fractures. But the surgeon should be careful for the complications like wound breakdown and infection. Open and high energy wound should not be treated with this technique because of fewer successful rate and devastating complications.

Despite we have multiple options for surgery, there is no level I evidence for ideal management. Remember multifragment, intra-articular fractures of the distal tibia, the depressed articular fragments have no soft tissue attachments, so performing an open reduction could be the optimal treatment. Restoring the displaced articular fractures by open reduction and internal fixation and reconstructing the posterior column remains the mainstay of treatment. Fixation of fibula facilitates partial reduction of antero-lateral and/or postero-lateral fragments by ligamentotaxis and also prevents valgus tilt of the distal tibia. Fixation of fibula facilitates partial reduction of antero-lateral and/or postero-lateral fragments by ligamentotaxis and also prevents valgus tilt of the distal tibia. Satisfactory results are obtained with open reduction and internal fixation in severe plafond fracture. For severe comminution external fixation could be the ideal choice.

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