

# Functional Outcome of Hybrid External Fixator in Tibial Pilon Fractures

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## ABSTRACT

**Introduction:** Tibial pilon fractures are difficult fractures mostly secondary to high-energy trauma. There are various options to treat these fractures, but the priority is always an anatomic reduction and articular congruity with good soft tissue handling. The aim of the study was to analyze the functional outcome of tibial pilon fractures managed with a hybrid external fixator as definitive management.

**Methods:** We evaluated 28 patients with tibial pilon fractures with a mean age of 34.8 years. All patients who fulfilled the inclusion criteria were taken to the operating room for debridement and application of a hybrid external fixator.

**Results:** The most common mechanism of injury was road traffic accidents and most of our patients had comminuted fractures. The fibula was fractured in 23 (82.14%) of our patients. The fractures united on an average of 15.28 weeks. Based on the Ovadia & Beals objective scoring system 75% of our patients scored excellent or good on objective scoring and subjective scoring 82.14% of our patients scored excellent or good. We had 12 cases of pin tract infection, 2 cases of delayed union, and 2 cases of malunion but no incidence of non-union, osteomyelitis, or septic arthritis. Eight of our patients had ankle joint stiffness.

**Conclusion:** Hybrid external fixator is an effective method of treatment for tibial pilon fractures with comparable union rate and complications to other modalities.

**Keywords:** Ankle; Hybrid External fixator; Tibial Fractures

## INTRODUCTION

The tibial pilon is the area extending 5 cm from the distal tibial articular surface which forms the roof of the ankle mortise.<sup>1</sup> These fractures are usually secondary to high-velocity injuries. Management of these fractures often poses a therapeutic dilemma whether to give priority

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to anatomic reduction or soft tissue healing. The decreased vascularity of the distal leg and poor soft tissue envelope along with the soft tissue injury often leads to wound problems, delayed union, nonunion, and malunions.<sup>2-5</sup> The ultimate goal in these fractures is the anatomic reduction of the articular surface, restoration of alignment, early ankle joint mobilization, bony union, and without any soft tissue complications.

The various modalities of treatment to tackle these challenging fractures are open reduction and internal fixation, Hybrid external fixator, and Ilizarov fixator.<sup>6-11</sup>

Various studies showed that ORIF can produce dramatic results in treating low-energy injuries of the pilon, however, an unacceptably high incidence of skin necrosis, wound slough, deep wound infection, nonunion, malunion, and amputation has been reported after high-energy compression injuries with bony comminution and severe damage to the thin soft-tissue envelope around the ankle.<sup>2,12-15</sup>

In several studies treated with a hybrid external fixator, the authors noted that a hybrid external fixator reduces the number of iatrogenic complications and proved to be a safe, reproducible, and effective treatment modality in fractures of the distal tibia.<sup>14, 16,17</sup>

Thus, there has always been a dilemma regarding the best option for treating pilon fractures. The study aimed to analyze the functional outcome of tibial pilon fractures managed with a hybrid external fixator as definitive management.

## METHODS

All patients diagnosed with tibial pilon fracture who came to the outpatient department or emergency department of Manipal Teaching Hospital, between January 1, to June 30, 2021, were enrolled in our study. Prior approval from the Institutional Review Committee of our hospital was obtained before starting the study. All patients between 18 years and 75 years with tibial pilon fracture either closed or open were included in our study to meet the

guidelines of the human subject committees. Our exclusion criteria included patients not willing to external fixator, polytrauma patients, patients who did not consent to the study, patients not fit for surgery, and patients with compromised distal neurovascular status of the limb. All patients were explained clearly about the study and informed consent was obtained from each of them.

**Pre-operative evaluation:** In the emergency department, once life-threatening injuries were ruled out, attention was focused on the ankle injury. Patients were carefully examined for the extent of the wound, amount of contamination, blisters, and swelling. Careful neurovascular examination of the extremity was documented. Other associated injuries were carefully looked for. The ankle was splinted to prevent further soft tissue injury. Open fractures were graded as per Gustilo and Anderson's classification system for open fractures and injection of tetanus toxoid and intravenous antibiotics and analgesics were given. Appropriate radiographs of the ankle were obtained for all patients. The demographic, clinical, and radiological parameters of all the patients were documented. Preoperatively all the fracture was analyzed and classified using AO classification.

**Surgical Debridement:** In case of open fractures, debridement was done under spinal or general anesthesia, to explore the wound, excise devitalized tissue, and remove foreign material. After debridement, irrigation, and reduction of the fracture, the wound was closed if possible.<sup>18</sup> If the wound couldn't be closed, relaxing incisions in the skin were given to bring the normal skin and subcutaneous tissue over the bone.

**Application of Hybrid External Fixator:** The first Kirschner wire (k-wire) was placed percutaneously from posterolateral to anteromedial, parallel to the ankle mortise, to fix the distal fragment of the tibia through safe corridors avoiding the neurovascular structures. An appropriately sized Ilizarov

ring was applied around the pilon. The k-wire was tensioned to 90-100 kg to increase the rigidity. An olive wire was used if compression between fracture fragments was necessary. An external fixator rod was connected to the ring and 2-3 Schanz pins were applied about 3cm apart in the anteromedial aspect of the tibia, perpendicular to the tibia. The fracture reduction and intra-articular congruity were confirmed on C-arm, and if acceptable 2 or 3 k-wires were added to the ring. (Figure 1)

The mean time interval between injury and the surgical intervention for both the open and closed fractures was noted. The operating time that included the debridement and application of the hybrid external fixator was also noted.

**Post-operative care:** Post-operatively, careful attention to the extremity and the frame construct was given to avoid problems common with external fixators. Elevation of the extremity to decrease edema, support of the dependent posterior soft tissue by dressings pads or slings, support of the ankle by appropriate splinting to prevent contractures, exercise of the joints proximal and distal to the fixator, and regular pin tract care were done to avoid pin tract problems. Patients were allowed for non-weight-bearing ambulation using a standard walking frame from the second postoperative day under the supervision of a physiotherapist.



*Figure 1: AO hybrid external fixator for fixation of tibial pilon fractures*

**Follow-ups:** All patients were followed up at 2 weeks, 6 weeks, 3 months, and 6 months. All patients were evaluated for soft tissue conditions, bony union, deformity, Visual Analogue Scale (VAS) Score, pin tract infection, and range of motion of the ankle. When we see a bridging callus at the fracture site, at least in three cortices in the anteroposterior and lateral radiograph, the fracture was considered to be united. Fixator removal was done after radiological evidence of union and a period of pain-free partial weight-bearing by the patient. After fixator removal, the posterior slab was applied for 2 weeks. When all the pin tracts healed well, patients were allowed for full weight-bearing with an ankle splint. The ankle splint was discontinued once the patient has regained a pain-free range of movement.

For analyzing the results, we followed Ovadia & Beals objective and subjective scoring system.<sup>19</sup>

## RESULTS

The most common mechanism of injury in our study was road traffic accidents accounting for 16 (57.14%). Most of our patients had a comminuted pattern of fracture with AO/OTA type C. The fibula was fractured in 23 (82.14%) of our patients. The mean time interval from the injury to the operation was 3.3 days (2.7 days for closed fractures and 4.6 days for open fractures). The mean operating time was 84 minutes for a closed fracture and 135 minutes for the open fractures. The fractures united on an average of 15.28 weeks (12-23 weeks). (Table 1)

Based on Ovadia & Beals, 21 (75%) of our patients scored excellent or good on objective scoring and 23 (82.14%) of our patients scored excellent or good on subjective scoring. (Table 2)

There were no intraoperative complications. However, on follow-ups, some complications were noted.

**Table 1: Demographic distribution of patients for tibial pilon fractures**

| Variables                               | Number | Percentage (%) |
|---|--------|----------------|
| <b>Gender</b>                           |        |                |
| Male                                    | 18     | 64.30          |
| Female                                  | 10     | 35.70          |
| <b>Fracture Characteristics</b>         |        |                |
| Open                                    | 9      | 32.14          |
| Closed                                  | 19     | 67.85          |
| <b>Fracture classification (AO/OTA)</b> |        |                |
| A2                                      | 2      | 7.14           |
| A3                                      | 6      | 21.42          |
| C1                                      | 6      | 21.42          |
| C2                                      | 10     | 35.70          |
| C3                                      | 4      | 14.28          |
| Fibula Fracture                         | 23     | 82.14          |
| <b>Mechanism of Injury</b>              |        |                |
| Road Traffic Accidents                  | 16     | 57.14          |
| Fall from height                        | 6      | 21.42          |
| Parachute                               | 4      | 14.28          |
| Physical Assault                        | 2      | 7.14           |

Twelve (42.85%) of our patients developed superficial pin tract infections, which resolved with daily dressings and appropriate oral antibiotics on an out-patient basis. Ankle joint stiffness was noted in 8 (28.57%) patients. This was probably due to the noncompliance to the advised physiotherapy regimen and the presence of intra-articular extension in these fractures. There were 2 (7.14%) cases

of delayed union which united with bone grafting. There were 2 (7.14%) cases of malunion but within the acceptable limits. However, there was no case of non-union. One of the patients had tethering of the extensor tendon of the great toe. None of our patients had osteomyelitis of the tibia or septic arthritis of the ankle joint. (Table3)

**Table 2: Outcomes according to Ovadia & Beals objective scoring system**

| Variables   | Number | Percentage (%) |
|---|--------|----------------|
| <b>Ovadia &amp; Beals objective scoring system</b>  |        |                |
| Excellent   | 13     | 46.42          |
| Good  | 8      | 28.57          |
| Fair  | 5      | 17.85          |
| Poor  | 2      | 7.14           |
| <b>Ovadia &amp; Beals Subjective scoring system</b> |        |                |
| Excellent   | 14     | 50             |
| Good  | 9      | 32.14          |
| Fair  | 4      | 14.28          |
| Poor  | 1      | 3.57           |

**Table 3: Outcome parameters of patients for tibial pilon fractures**

| Variables  | Number        | Percentage (%) |
|--|---------------|----------------|
| <b>The time interval between injury and operation (days)</b> |               |                |
| Open fracture  | 4.6           |                |
| Closed fracture  | 2.7           |                |
| <b>Meantime of union (weeks)</b>                             | 15.28 (12-23) |                |
| <b>Complications</b>   |               |                |
| Pin tract infection  | 12            | 42.85          |
| Delayed union  | 2             | 7.14           |
| Malunion   | 2             | 7.14           |
| Non-union  | 0             |                |
| Ankle stiffness  | 8             | 28.57          |
| Tendon tethering   | 1             | 3.57           |
| Osteomyelitis of tibia                                       | 0             |                |
| Septic arthritis of the ankle                                | 0             |                |

## DISCUSSION

Tibial pilon fractures are peri-articular fractures that pose difficulties in the treatment. The amount of soft tissue injury, the degree of comminution of the fracture, articular damage, and the treatment modality determine the outcome in these patients. The ultimate goal of the surgery is to obtain as anatomic reduction of the fracture as possible with the maintenance of the articular congruity and providing stability to the fracture as it heals. This is accomplished by using procedures that pose minimum osseous and soft tissue devascularization.<sup>20</sup> Hybrid external fixator qualifies most of the above requirements thus, can be the treatment of choice in these difficult fractures. The present study was thus undertaken to determine the efficacy and functional outcome of the hybrid external fixator in the treatment of these difficult fractures.

Similar to other studies, the average age of patients with such injuries in our study was 34.8 years. In our study, there were more males (64.28%), which was slightly higher than the study by Barbieri et al (59%).<sup>17</sup>

High energy trauma is mostly responsible for these difficult fractures. We had 20 (71.42%) of such fractures in our study, as compared to

93% in the study by Gaudinez et al., 87% in the study by Agarwal et al., and 46% in the study by Ovadia and Beals.<sup>9,19,21</sup> There were 9 (32.14%) open fractures in our study. This is comparable to other studies by Guadinez et al. (20%) and Barbieri et al. (30%).<sup>9,17</sup> The fracture pattern and type in our study was similar to Barbieri et al. (A1:9%, A2:9%, A3:10%, C1:16%, C2:32% and C3:24%).<sup>17</sup> The mean time interval from the injury to the operation was better in our study (3.3 days) as compared to other studies by Pugh et al. (2.9 days), Tornetta et al. (5-10 days), and Bhattacharya et al. (13 days).<sup>7,11,22</sup> This can be because of the availability of the orthopedic operating room at any time of the day in our hospital.

The average time for fracture union in our study was 15.28 weeks which was comparable to 16 weeks in Barbieri et al., 13.16 weeks in Rathod and Tailor, and 13 weeks in Gaudinez et al.<sup>9,13,17</sup>. The slight delay in union time in our study maybe because we did not use bone grafting primarily in any of our patients. We used bone grafting only in our 2 (7.14%) patients of the delayed union as compared to 42% by Tornetta et al. and 47% by Pugh et al.<sup>7,11</sup>

In our study, the outcome was based on the Ovadia & Beals objective and subjective scoring system. Based on this scoring system

76% of our patients scored excellent or good in the objective scoring and 80% of our patients scored excellent or good in the subjective scoring. These results were comparable to other studies, yet better than many other studies which scored excellent to good results ranging from 44% to 86%.<sup>13,23</sup>

The complications seen in our study was less than most of the study on these challenging fractures. The most common complication seen in various studies is pin tract infections. In our study, it was 42.85% which was less than in other studies.<sup>21,24</sup> The low incidence of pin tract care can be attributed to earlier definitive care and careful soft tissue handling as compared to other studies. The incidence of delayed union (7.14%) and malunion (7.14%) was comparable to other studies.<sup>25-28</sup> As compared to 3 cases of osteomyelitis in the study by Barbieri et al., we had no case of osteomyelitis or septic arthritis.<sup>17</sup> This may be attributed to early diagnosis of the superficial pin tract infection and timely management of these infections. The incidence of ankle stiffness in our study was 28.57% which was comparable to the study by Aggarwal et al. (24%) but better than the study by Rathod and Tailor (46.15%).<sup>13,21</sup> This may be attributed to the early mobilization of the joints with a stiff external fixator construct in our setting. In our experience, there were some limitations of the hybrid external fixator. They include difficulty in the visualization of the articular surface and the fracture union on radiographs because of the overlap of the construct, inability to dynamize the construct as compared to the Ilizarov construct, and because it doesn't provide enough stability, early full weight-bearing is not possible.

This study was an observational study that looked at the functional outcome of these difficult fractures. Thus, a comparative study of the hybrid external fixators to other modalities of treatment would give more insight into these fractures.

## CONCLUSION

Hybrid external fixators used for fixation of

tibial pilon fractures provide stable fracture fixation without further damaging the already compromised soft tissues. Postoperatively it provides good access to soft tissue and wound care.

Although the present study had a small patient number and shorter follow-up, it shows that a hybrid external fixator is an effective method of treatment for tibial pilon fractures with comparable union rate and complications to other modalities.

## CONFLICT OF INTEREST

None

## SOURCES OF FUNDING

None

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