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Neglected Tibial Pilon Fractures; Can Arthrodesis Be Avoided?

Abdel-Salam A. Ahmed, MD, Mohammed S. Singer, MD, and Hossam A. El Bigawi, MD

Objectives: To evaluate the outcomes of neglected pilon fractures treated by the Ilizarov fixator and to determine whether this technique was successful in avoiding an ankle arthrodesis.

Design: Retrospective case series.

Setting: Level 1 university trauma center.

Patients: Between January 2003 and March 2015, 18 patients (mean age of 42.17 years) with an untreated pilon fracture with late presentation (>1 month) were evaluated. Six patients were women and 12 were men. The mean duration from trauma to management was 11.17 weeks (range: 7–15). All fractures were Orthopaedic Trauma Association/Arbeitsgemeinschaft für Osteosynthesefragen 43 type C. Four cases were open fractures.

Intervention: Closed fracture reduction, correction of deformity, and restoration of alignment by the Ilizarov fixator.

Main Outcome Measurements: The radiographs were evaluated for tibial alignment, quality of reduction, and development of arthrosis. The American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale was used for functional assessment.

Results: The follow-up period ranged from 18 to 168 months (mean: 38.00). The quality of reduction was excellent in 2 cases, satisfactory in 13 cases, and poor in 3 cases. The external fixator period averaged 29.06 weeks (range: 6–7.3 months). All fractures healed without deep infection. Ankle dorsiflexion and plantar flexion averaged 8.67 and 25.67 degrees, respectively, in 15 cases. Arthrodesis was performed for the remaining 3 cases. The mean AOFAS Ankle-Hindfoot score was 82.67. One case had mild anterior translation, and another 1 had a procurvatum of 5 degrees. Arthrodesis developed in 6 ankles.

Conclusions: A satisfactory outcome was achieved after management by the Ilizarov fixator while avoiding arthrodesis in most cases of this series of neglected pilon fractures.

Key Words: tibial pilon fracture, plafond, ilizarov, circular fixator, neglected fracture

Level of Evidence: Therapeutic Level IV.

(J Orthop Trauma 2018;00:1–7)

INTRODUCTION

Intra-articular distal tibia fractures, known as plafond or pilon fractures, can result from high-energy axial compression injuries caused by falls or motor vehicle accidents or lower energy torsion mechanisms as in sporting accidents. They comprise about 5%–10% of tibial fractures and 1% of all lower extremity fractures. They are potentially devastating injuries that are usually associated with extensive soft tissue injuries, significant displacement and articular comminution, and fraught with complications and poor outcomes.

These fractures are difficult injuries to manage, and there is no consensus regarding their optimal treatment, with advocates for early open reduction and internal fixation (ORIF), a 2-stage approach with primary external fixation and later conversion to ORIF, as well as definitive treatment with a circular external fixator for example, the Ilizarov frame. ORIF with anatomical articular reconstruction is technically demanding in high-energy pilon fractures. The associated extensive soft tissue injuries may prohibit ORIF because of the high risk of infection and wound complications. Using the Ilizarov fixator for treatment of pilon fractures is beneficial in reduction of fracture fragments by ligamentotaxis while preserving the endosteal and periosteal blood supply. However, ligamentotaxis cannot reduce the impacted small articular fragments lacking capsuloligamentous attachments. Primary ankle arthrodesis has been advocated for management of unreconstructable pilon fractures to reduce complications, repeat surgeries, and long periods of disability.

We defined a neglected fracture as a fracture that is allowed to heal in a poor position because timing did not permit initial fixation (eg, because of excess swelling, delays because of transport, other injuries, etc.), but cannot be called a malunion because it is not fully healed. A neglected pilon fracture results in malalignment, displacement of the tibial plafond, and malalignment of the fibula. There is a lack of knowledge on the standard management protocol and follow-up of such patients. The purpose of this study was to evaluate the radiographic, clinical, and functional outcomes of the management of neglected pilon fractures by the Ilizarov...
external fixator and to evaluate whether this technique was successful in avoiding an ankle arthrodesis.

**PATIENT AND METHODS**

This retrospective study was conducted after approval of the institutional ethics committee of the university. The inclusion criteria included (1) pilon fractures with late presentation more than 1 month without definitive treatment, (2) management by the Ilizarov fixator, and (3) a minimum follow-up of 1.5 years. Acute fractures and 2 patients who were lost to follow-up were excluded. The study included 18 fractures treated between January 2003 and March 2015. The mean age was 42.17 years (range: 33–55; SD 6.82). Six patients were women and 12 were men. The original trauma was a fall from a height in 8 patients and motor vehicle accidents in 10. The mean duration from trauma to Ilizarov fixation was 11.17 weeks (range: 7–15; SD 2.18). All fractures were unilateral, with involvement of the left side in 11 cases and the right side in 7. According to the Orthopaedic Trauma Association/Ambulanzgemeinschaft für Osteosynthesefrage classification, 8 fractures were type 43-C2 and 10 fractures were type 43-C3. Four cases were Gustilo and Anderson type II fractures. These open fractures were managed initially by debridement and provisional fixation by K wires (2 cases) or an unilateral external fixator (2 cases including 1 with a fibular wire). Two of these cases had delayed wound healing and superficial infection at presentation. Cases with closed fractures presented with a cast. Smoking habit and comorbidities are summarized in Table 1.

Preoperative assessment also included plain radiographs, computed tomography scans, and neurovascular assessment. The surgical technique and its possible complications were discussed with the patients who met other patients during their treatment by the Ilizarov fixator to be familiar with the frame and its care. An informed consent was obtained from all patients.

**Operative Technique**

Patients were positioned supine on a radiolucent table under general or regional anesthesia. The fracture zone was gently manipulated to check the feasibility of acute reduction and facilitate later gradual reduction. Two cases required wound debridement. Fibular osteotomy was performed between the distal third and proximal two-thirds in 10 cases to facilitate reduction. Bone grafting from the ipsilateral iliac crest was applied to fill a metaphyseal defect in 2 cases.

The Ilizarov fixator was then mounted to the tibia and the foot. A ring block of 2 Ilizarov rings was applied to the tibial shaft and fixed by 1.8 mm wires tensioned to 120 kg and 5-mm Schantz screws. The foot frame was constructed using a calcaneal half ring, with forward extension by 2 straight plates that were connected by a forefoot half ring or transverse rod to constrain the frame. That was fixed to the calcaneus by 2 olive wires or 1 wire with a Schantz screw. Occasionally, a transverse talar wire was used to increase stability. The forefoot part was fixed by 1 or 2 metatarsal wires.

Then, the foot construct was connected to the tibial frame by rods with distraction while attempting a fracture reduction under an image intensifier as permitted by the contracted soft tissues. Thereafter, a carbon fiber ring was fixed to the distal tibia by wires, depending on the orientation of the bone fragments and the safe zones for insertion. That ring was placed parallel to the distal tibial articular surface in both planes and connected to the upper and lower constructs by rods. Finally, any skin tenting was

### TABLE 1. Patient Demographics, Follow-up, and Outcomes

<table>
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<th>Pt</th>
<th>Side</th>
<th>Time to Surgery (wk)</th>
<th>AO Type</th>
<th>Open Fracture</th>
<th>CoMorbidity</th>
<th>Smoking</th>
<th>Red. Q.</th>
<th>F. U. (mo)</th>
<th>Sp. D. (wk)</th>
<th>EFP (wk)</th>
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<th>ROM, Dor/Pla (Degrees)</th>
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<td>5–25</td>
<td>81</td>
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</tbody>
</table>

D.M., diabetes mellitus; Dor/Pla, dorsiflexion/plantar-flexion; DVT, deep venous thrombosis; F, female; F.U., follow-up; HTN, hypertension; Lt, left; M, male; Pt, patient; Red. Q., reduction quality; Rt, right; Sp. D., spanning duration.

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Ahmed et al  J Orthop Trauma • Volume 00, Number 00, Month 2018

2 | www.jorthotrauma.com

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relieved by small incisions; vascular integrity was checked; and a bandage was applied over dressings. The residual deformity was then gradually corrected postoperatively.

Postoperative Follow-up
The patients were mobilized on the second postoperative day with non–weight-bearing on the affected side. They were taught pin-site care and the importance of active range of motion (ROM) of the knee and toes. Cases with gradual correction of the deformed fractures were instructed how to turn the specific nuts for 1 mm daily adjustment between the upper tibial ring block and the distal tibial ring (Fig. 1). Ankle arthrodiastasis was performed by 1 mm daily distraction for 5 days between the tibial frame and the foot construct. The patients were followed up for the wounds of open fractures and bone grafting, pin-site care, fixator stability, motion of the knee and toes, alignment, and healing. Follow-up was performed weekly for a month, then every 2 weeks until complete deformity correction, monthly until frame removal, every 6 months for 1.5 years, and then annually.

After obtaining alignment, partial weight-bearing was started using modified shoe wear and gradually increased to full weight-bearing with complete union. With the early signs of healing on radiographs, the spanning foot frame was removed and followed by ROM exercises. The Ilizarov fixator was removed after achievement of union radiographically by the presence of crossing trabeculae with obliteration of the fracture lines and clinically by painless weight-bearing with a loosened frame. Thereafter, physiotherapy was continued for 3 months.

Outcome Measurements
Tibial alignment was checked radiographically by measuring the lateral distal tibial angle, which is normally 89 degrees (range: 86–92 degrees) and the anterior distal tibial angle which is 80 degrees (range: 78–82 degrees). The quality of reduction was graded as described by Conroy et al (see Table, Supplemental Digital Content 1, http://links.lww.com/JOT/A334), and arthrosis assessment was performed based on the criteria of Marsh et al (see Table, Supplemental Digital Content 2, http://links.lww.com/JOT/A335). ROM was assessed according to the grading system of Bone et al (see Table, Supplemental Digital Content 3, http://links.lww.com/JOT/A336). The American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale was used for functional assessment.

Statistical Analysis
The descriptive statistics were in the form of frequencies and percentages for categorical variables and mean values, SDs, and ranges for continuous variables. Correlation analysis was performed by the Spearman correlation coefficient. The level of statistical significance was set at \( P < 0.05 \). The statistical analyses were performed with IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp, Armonk, NY).

RESULTS
The patients were followed for an average of 38.00 months (range: 18–168; median: 27; SD 34.06) (Table 1). The evident immature callus allowed gradual correction without tibial osteotomy in 16 patients. Two cases had a metaphyseal

![Figure 1](https://example.com/figure1.png)

**FIGURE 1.** A, Left pilon fracture (case no. 9) 9 weeks after trauma. A, Preoperative radiographs. B, The first postoperative radiographs, showing fibular osteotomy and deformed tibial pilon fracture. C, Radiographs at 10 weeks after surgery, showing fracture reduction. D, Radiographs at 168 months of follow-up. E, Clinically at the last follow-up on standing and tip-toe stance.
bone defect, which was believed would predispose them to a nonunion and therefore were bone grafted at the time of ring application (Fig. 2). The quality of reduction, according to Conroy et al, was excellent in 2 cases, satisfactory in 13 cases, and poor in 3 cases. The ankle-spanning frame was removed after a mean of 14.78 weeks (range: 12–26; SD 3.15), whereas the external fixator period (EFP) averaged 29.06 weeks (range: 26–32; SD 1.96).

Fracture healing was successfully achieved in all cases. At the last follow-up visit, the ankle dorsiflexion ranged from 0 to 15 degrees (mean: 8.67; SD 4.81), and plantar flexion ranged from 10 to 30 degrees (mean: 25.67; SD 5.94) in 15 cases. Ankle motion was eliminated in 15 cases, good in 6 cases, and poor in 5 cases. The hindfoot motion was normal or mild restriction in 7 cases, moderate restriction in 8 cases, and marked restriction in 3 cases. Mild occasional pain was reported by 4 patients. Five workers changed to light jobs including the 3 who underwent arthrodesis. Those who returned to their previous work included 6 housewives, 5 farmers, and 3 other workers. Fifteen patients were walking without ambulatory aids and had returned to activities of daily living. The mean AOFAS Ankle-Hindfoot score was 82.67 (range: 45–100; SD 17.10). There was a significant positive correlation between the AOFAS score and reduction quality (Spearman rho = 0.714, P = 0.001), between AOFAS score and ROM grade of Bone et al (Spearman rho = 0.661, P = 0.003), and between follow-up and arthrosis (Spearman rho = 0.802, P = 0.000). There was a significant negative correlation between the AOFAS score and age (Spearman rho = −0.503, P = 0.033). There was no correlation between AOFAS score and smoking (Spearman rho = 0.326, P = 0.187) or between the ankle-spanning duration and ROM grade of Bone et al (Spearman rho = 0.279, P = 0.263).

Complications

Neither neurovascular injury nor deep infection was seen in this study. One case had a wire inadvertently anchoring the distal fracture fragments to the proximal main one. That wire was removed as it would prevent interfragmentary distraction and deformity correction. A pin track infection was reported in 14 patients and controlled by pin-site care and oral antibiotics. One case had mild anterior translation, and another 1 had a procurvatum deformity of 5 degrees. One patient also had a distal fibio-fibular synostosis. Surgical excision of a distal tibial bony protrusion limiting dorsiflexion was needed in 1 patient. Radiographic signs of arthrosis were found in 6 ankles (31.58%), with 5 Marsh grade 1 and 1 grade 2. Arthrodesis was performed for 3 ankles (15.8%) after frame removal.

**FIGURE 2.** A, Pilon fracture (case no. 4) at 15 weeks after trauma. A, Preoperative radiographs. B, Radiographs at 1 month after Ilizarov fixator application, bone grafting, and acute correction. C, Radiographs at 25 months of follow-up. Fibular implants were removed and distal anterior tibial bony prominence was excised.

**DISCUSSION**

As previously defined, neglected fractures represent challenging situations for orthopaedic surgeons in developing countries. In addition to initially infected open fractures and poor facilities, neglected fractures are largely secondary to the socioeconomic constraints that drive our patients to seek conservative methods. The University Hospital provided a free service regarding the admissions, surgical procedures, and follow-up visits in the OPD. The neglected pilon fractures in our series were complicated by diffuse osteopenia of the small distal bone fragments, associated deformity with the rapid healing capacity of the periarticular cancellous bone, the adaptively shortened or contracted soft tissues, ankle joint stiffness, and occasionally deficient bone stock.

Timely surgical intervention is one of the critical principles in the management of tibial pilon fractures. Meticulous reduction of acute high-energy pilon fractures via extensive dissection is difficult but with good soft tissue conditions, ORIF can be performed with adequate exposure by minimal soft tissue stripping and full-thickness skin flaps. Open reduction after 4 weeks is more arduous with difficult mobilization of the fragments, and excessive periosteal stripping can compromise fracture healing. In addition, the cartilage layer may be damaged or delaminated with manipulation. Thereafter, articular malunion is very difficult to manage. Moreover, restoring the articular surface does not always prevent secondary osteoarthritis. The small and osteopenic distal fragments may have limited fixation. Therefore, in the past, a delay in definitive operative treatment of the pilon fracture was considered an indication for primary ankle arthrodesis.

In our hands, complications related to closed management such as malunion or arthrosis are easier to treat than those after ORIF including infection and wound breakdown. The Ilizarov fixator permits percutaneous fracture fixation without extensive soft tissue stripping. The tensioned wires
provide adequate purchase of the small bony fragments contributing to considerable stability. However, it is associated with problems including complexity of application, a bulky frame needing patient compliance, risk of neurovascular injury, and pin track infection.

The ankle-spanning frame was removed after a mean of 14.78 weeks, which is longer than that reported in other studies. This longer period may be attributed to comminution, small osteopenic fragments, and the time required for gradual correction of the deformed fractures. The same reasons could explain the longer mean EFP (29.06 weeks) compared with other reports. The ankle-spanning period was equal to EFP in 1 case (26 weeks), with severe articular disruption and deformity preventing distal wire placement without proximal transfixion. This was the only case without wires in the distal tibial fragments. So, the foot frame...
could not be removed early to move the ankle (Fig. 3). The 3 patients with poor reduction quality had the lowest AOFAS scores, namely, 45, 51, and 55, and were managed by arthrodesis.

Healing was obtained in all cases without any deep infection. The reduced infection rate in this study might be attributed to the delayed treatment with improved soft tissue conditions and percutaneous management. Superficial pin track infection was, however, a common complication. Septic ankle arthritis did not occur despite using very thin distal wires in some cases. It is an uncommon complication in pilon fractures treated by thin wire external fixators, with an incidence of 0.6%. In their systematic review, Papadokostakis et al did not find sufficient data demonstrating any relationship between the position of the wires and septic ankle arthritis.

Strong correlation has been reported between the final functional result after pilon fractures and the accuracy of the articular reduction. In the current study, an ankle arthrodiastasis of 5 mm was performed to stretch the taut ligaments aiming at improving the ROM (Fig. 4). Yet, despite radiographic evidence of arthrosis in 6 cases, ankle function was satisfactory with a mean AOFAS score of 82.67, reflecting a satisfactory functional outcome. The risk of arthrosis after tibial pilon fractures can be as high as 75% and is attributed to chondral injury, joint incongruity, and malalignment, with chronic joint overload. However, functional outcome and patient satisfaction is not correlated with radiographic findings of arthrosis. De-Las-Heras-Romero et al found that the main predictors of patient quality of life after intra-articular tibial pilon fractures were fracture type, reduction quality, and development of arthrosis.

Few reports were published on malunited or nonunited pilon fractures. Over 21 years, Rammelt and Zwipp treated 14 cases of malunited pilon fractures with an intra-articular osteotomy and ORIF including 3 cases with additional focal metaphyseal nonunion, presenting at an average of 3 months after trauma. After a 5-year follow-up, all ankles had radiographic signs of osteoarthritis, with good-to-excellent subjective clinical outcome in 10 of 14 patients. Seven patients needed secondary intervention including bone grafting (2 cases), implant removal (3 cases), and arthrodesis (2 cases). They recommended this technique in selected, active, compliant patients with good bone stock and cartilage quality.

Schoenleber and Hutson reported on 8 cases of pilon nonunion or early malunion, with previous acute anatomic articular reduction and extra-articular distal tibial fractures presented after injury by a mean of 11.4 months. They used circular an external fixator for callus distraction and gradual deformity correction after percutaneous osteotomy in cases of bridging bone. None needed bone grafting. EFP ranged from 4.1 to 7.6 months. Their mean AOFAS score was 82.5 at a mean follow-up period of 30.4 months.

The current study has several limitations including the retrospective nature of the study, the long collection period, the small number of cases using the nonvalidated AOFAS score, and the relatively mid-term follow-up. Despite these limitations, our technique represents acceptable clinical and radiographic results in these difficult neglected fractures.

CONCLUSIONS

We have reported a satisfactory outcome with management of neglected pilon fractures using the Ilizarov fixator with a relatively low complication rate and the avoidance of arthrodesis in most cases. A future prospective, multi-center, case–control study with a uniform long follow-up duration is needed.

REFERENCES


