Efficacy of Using Ilizarov External Fixator in Treating Pilon Fractures

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Abstract

Background:Pilon fractures remain one of the most substantial therapeutic challenges that confront the trauma surgeon. Numerous features are responsible for this. The use of external fixation, instead of fixation with a plate,and use of ilizarov decreases the prevalence of early complications.

Aim of work:To evaluate the efficacy of using ilizarov external fixator in treating pilon fractures regarding fracture union, clinical outcome and rate of complications.

Patients and methods:Twenty four pilon fracture patients were incorporated in a prospective study.The fractures have been treated with the Ilizarov apparatus. 3 or 4 rings were used according to the fracture type. Pre- and post-operatively conventional radiographs, post-operative pain assessment and complications were evaluated. Pain assessment after operation, radiology, definitive outcomes and complications post-operation were performed, the follow up were done after 6 months.Clinical outcomes were evaluated according to the ankle-hindfoot score devised by the American Orthopaedic Foot and Ankle Society (AOFAS).

Results:No patient developed compartment syndrome or deep venous thrombosis. Pin infections were frequent, but they were mostly superficial and were treated with antibiotics and local antiseptics.2 cases of malunion occurred, one of them required ankle fusion. Another patient had a severe residual deformity. One case experienced delayed union and was treated with dynamisation of ilizarov frame, otherwise all fractures united and the fixator was removed after a mean of 20 weeks (range 12–28). The clinical outcome according to AOFAS score was excellent in 12 patients, good in 6, fair in 4 and poor in 2.

Conclusion:

The study demonstrated that it is possible to achieve a satisfactory outcome, in pilon fractures, with the Ilizarov technique allowing early definitive treatment. The fractures were treated immediately after the injury, regardless of soft-tissue damage. This was done with a similar low complication rate in both the extra- articular and the intra-articular fractures. Patient compliance was good. The residual deformities were within the range in which the risk of developing post- traumatic osteoarthritis can be expected to be low.

Keywords:External Fixators, Ilizarov, Displaced Pilon Fractures.

1. Introduction:

Pilon fractures remain one of the most substantial therapeutic challenges that confront the trauma surgeon. Numerous features are responsible for this, but perhaps none are as difficult as the accompanying soft tissue injury that is frequently present **(1).**

The term "Plafond" is French for ceiling and refers to the relation of the distal tibial articular surface to the talus. Therefore, a plafond fracture refers to any fracture line traversing the weight-bearing articular surface of distal tibia **(2).**

"Pilon" fracture is an important and more complicated subtype of plafond fractures. It refers to the talus acting like a hammer driving into the weight-bearing articular surface of distal tibia **(3).**

Tibial plafond fractures account for less than 10% of all lower extremity fractures and more common in male than female patients. Pilon fractures in particular constitute only approximately 1% of lower extremity fractures and 7% to 10% of tibial fractures. However, the frequency of these fractures maybe increasing **(4).**

Tibial plafond fractures are high-energy injuries, and the primary component of force is vertically directed through the talus into distal tibia. This vertical compressive force may act alone on the distal tibia, or may represent a component of complex forces, including shear and/or rotation **(5).**

High-energy plafond fractures should be treated with great care and respect because the risk of complications is high and the likelihood for good functional ankle is less predictable.
Assessment of the degree of energy causing the fracture and careful planning of the joint reconstruction will lead to acceptable results in most cases **(6).**

A whole spectrum of treatment options has been advanced over years. Most authors would agree the goal of treatment of any displaced intra- articular fracture should be:

a. Restoration of articular congruity.
b. An anatomic restoration of the joint to the shaft, and early restoration of motion, and hence, functional recovery.
c. Also, it has been stated that the status of the soft tissue is one of the most important factors that influence the treatment and prognosis of the patient **(7).**

Regarding treatment the traditional techniques were Casts, pins in plaster, fibular fixation alone and open reduction and internal fixation (ORIF) which often results in unacceptable function of the ankle and higherrate of wound breakdown, infection, poor anatomical alignment and subsequently post traumatic osteoarthritis **(8).**
Recently, percutaneous lag screws maintained the reduction of the joint, and graft supports the impacted intra-articular fragment. Once the distal tibia is reconstructed at the level of the joint the remaining fracture is treated with external fixation. Both hybrid frames that use tensioned wires (Ilizarov apparatus) and spanning half pin frames have been recommended. The main advantage of this approach is the lower rate of soft tissue problems **(9).**

The use of external fixation, instead of fixation with a plate, decreases the prevelance of early complications. This technique for high grades tibial plafond injuries has resulted in effective stabilization of these fractures. Although this approach may not prevent the post traumatic sequelae that inevitably results, it does provide adequate stability and allows early ambulation. Furthermore, because this technique of external fixation limits additional surgical insult to the soft

tissues and to biology of fractures healing, the number of major complications appears to be minimized **(9).**
We aimed in this study to evaluate the efficacy of using ilizarov external fixator in treating pilon fractures regarding fracture union, clinical outcome and rate of complications.

2. Patients and Methods:

This work was a prospective trial including twenty-four patients aged 20 years to 63 years old with displaced pilon fracture treated with the Ilizarovapparatus; 24 patients came to Orthopedic Department, Zagazig university hospital from September 2020 until December 2020 and followed up for 6 months. Patients with sub-trochanteric extension, unstable pattern of fracture and patients with open physis, pathological fractures, and neurological lower extremity deficit were excluded.

Ethical approval: Institutional Review Board (IRB) approval was taken from Zagazig University and also informed written consent was taken from patients and/or their caregivers. We performed this study with respect to (Declaration of Heliniski), ethics code of World Medical Association regarding human studies.

Pre-operative:

All patients underwent full history taking, detailed orthopedic examination and clinical and radiological evaluation
After primary stabilization of the patient, strict elevation of the injured part to minimize swelling and edema. Anti-edema measures were taken to reduce swelling. Pre-operative antibiotics were administered 30 min before the operation.

Surgical Technique:

Spinal anesthesia was done to all patients, the participants were placed in the supine position, after positioning of the patient, and parenteral antibiotics were administrated, wound debridement and closure prior to the use of ring fixator were done to all open fractures type. In cases of there is blisters it's treated with a protocol of sterile unroofing with the application of non-adherent dressings. During reduction, insertion of pin and frame assembly biplane fluoroscopy was used. Image intensification was applied using ligamentotaxis. Internal fixation for the lateral malleolus was initially necessary in 21 cases and obtained with K wire to restore fibular length. Internal fixation was initially required for the lateral malleolus to restore fibular length in 21 cases and achieved by K wire.Fragment specific fixation with mini-internal fixation for intra-articular fractures using 4.5 mm canulated screws was used.

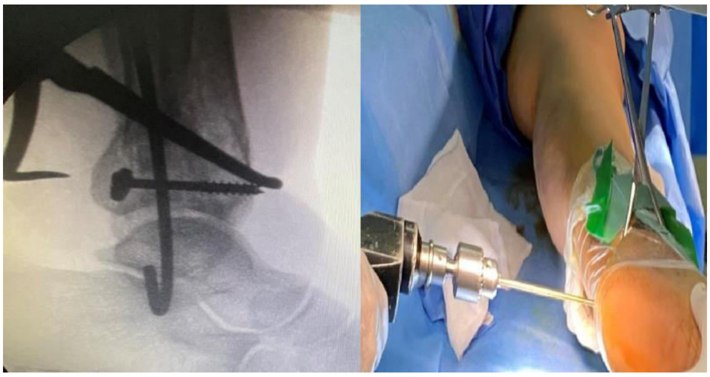

Figure1: Minimal internalfixationofintraarticular fragments.

Steps of frame construction

Proximal construct made of two rings connected by four rods and distal construct made of either one ring and 5/8 calceneal ring if there is sufficient bone of distal segment to fix with ilizarov k-wires or only 5/8 calceneal ring in cases of highly comminuted articular surface. Twin ring construct was used in some cases with low juxta-articular fractures allow for early removal of calcaneal 5/8 ring. A reference wire was introduced under fluoroscopy guide and another fixation wire in the proximal ring, then distraction and insertion of calcaneal 5/8 ring. To stabilize anterolateral and anteromedial fragments with each other, pins were used after confirmation of anatomical reduction by fluoroscopy. In some cases, olive wires were used to fix intra-articular components of the fracture.

Figure 2. Circular frame for comminuted intra articular fracture made of 2 rings proximally and one ring with 5/8 calceneal ring distally

Progressive construct ring assembly

The first ring was passed exactly parallel to the joint above it in both planes. The second ring is the most distal one, which was fixed parallel to the lower joint, a little above the joint line in the metaphyseal area. Short or medium threaded rods were anchored to both these rings, the length of the rods depending entirely on the level of the fracture which is being fixed. Each aligned exactly parallel to the joint adjacent to it, would meet at the apex or the deformity or CORA.

The hinges were applied and additional olive wires, slotted threaded rods or telescopic rods attached to the appropriate points, to complete the assembly.

Preconstructed ring assembly:

Patient joint lines and the apex of the deformity marked with a marker pen. A frame is assembled around the preoperatively. This was a loose telescoping adjustable frame, which has angles matching the fracture, with hinges or telescopes in the appropriate region. Here the order of wire placements is critical, and the following description and terminology is based on Dr. Jishnu Baruah's simplified prefab construct fixation.

A provisional pre-constructed telescoping frame is fabricated, with dual connecting rods left loose on both sides. This was preoperatively slid over the patient's limb to ensure that the rings are parallel to adjacent joints and the apex of the actual deformity corresponds to the hinge placement.

Each Ilizarov-wire has a name that indicates its purpose. The first, the Reference K Wire,was passed parallel to knee in postero-lateral to anteromedial direction. The preconstructed frame is slid over the limb and the most proximal ring is held parallel and flush (but not fixed) to the Reference K Wire by an assistant, who also maintained the patella in correct position.

Figure 3: preconstructed frame slide over the limb and fluh the reference wire

The second Rotation K Wire is the principal wire controlling rotation. This was passed in the anterolateral to posteromedial direction above the ankle, again ensuring that the direction is exactly parallel to the joint. The distal most ring of the telescoping frame was held flush to this wire by another assistant.After this step, the fixator behaves like a jig and rotation was committed. Second wires at appropriate latero-medial corridors were passed and extra connected rods passed to complete the frame.Wires number 3 and 4, called The Reduction Wires were passed after fine tuning of shifts and angulation on the middle 2 rings. Long threaded rod has been placed through fixator and put parallel to medial cortex of tibia to verify the alignment. Adequate fixation completion in segments was done after good reduction in both planes.
To ensure that sufficient fixation have been done for better stability, we used three wires or 2 and half in 3 points of fixation.

Post-operative follows up:
Follow up of patients were done after 6 months, through joint space opening way by stress radiograph the ankle instability was assessed. We graded damage of soft tissues in the closed fractures by 5 grades with reference to Tscherne classification, 11 cases were grade I, 4 cases were grade II, and 4 cases were grade III. Radiology was done to assess the healing of bones in lateral and AP views by considering healing was done if bridging callus occurred at least 3 of the 4 cortices. Ovadia and beals criteria was used to evaluate reduction of articular fragments.Clinical outcomes were evaluated according to the ankle-hindfoot score devised by the American Orthopaedic Foot and Ankle Society (AOFAS)

3.Results

Age distribution, sexof patients, side of fractures, and duration from injury to surgery are shown in (Table 1).
The clinical outcome according to AOFAS score was excellent in 12 patients, good in 6, fair in 4 and poor in 2. (Table 2, Figure 1).
Reduction was judged good in 4 patients, fair in 6, and poor in 2 (Table 3).

Table 1. Demographic data, duration from injury to surgery and side of fracture

Age	Numberofcases	Percentage
20-40 y	16	66.67 %
40-60 y	4	16.67 %
Morethan60y	4	16.67 %

Sex	No.(patients)	%
Male	14	58.33
Female	10	41.67

Days		
0-2 d	10	41.67 %
3-5 d	10	41.67 %
More than 5 d	4	16.67 %

Side	No.(patients)	%
RT	13	54.16
LT	11	45.8

Table 2. Clinical outcome according to AOFAS score

Clinical outcome according to AOFAS score	**Number of cases**	**Percentage**
Excellent	**12**	**50 %**
Good	**6**	**25 %**
Fair	**4**	**16.67 %**
Poor	**2**	**8.33 %**

Table 3. Quality of reduction.

Quality of reduction	Number of cases	Percentage
Good	8	33.33 %
Fair	12	50 %
Poor	4	16.67 %

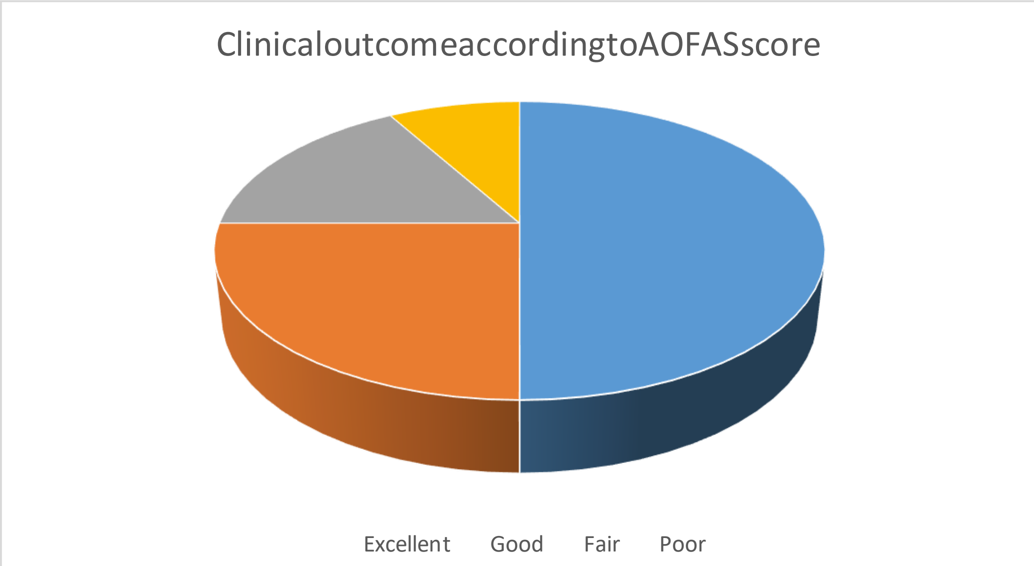

Figure 1: Clinical outcome according to AOFAS score

4.Discussion:

Pilon fractures are often complex injuries, with regard to both the bony component and the management of the soft tissue problem. They accountfor less than 10% of all lower extremity fractures and more common in male than female patients. Pilon fractures in particular constitute only approximately 1% of lower extremity fractures. The damage is caused by high-energy trauma mainly in axial load as the usual consequence of road accidents or falls from a considerable height **(10).**

Surgical methods may be used, such as external fixation, the intramedullary nail, the percutaneous synthesis or Kirschner's wires and a synthesis with modern plates **(11).**

Teeny and Wiss (12) reported 11 (37%) of 30 patients having deepinfection. **McFerran et al. (13)** reported 21 (40%) of 52 patients havinga major complication. **Wyrsch et al. (14)** reported three (16%) amputations of 19 patients having open reduction and internal fixation.

These reports reflect the fact that with extensive surgical dissection to achieve an anatomical reduction, the vascularity of the bony fragments is often jeopardizedand these devascularized fragments will act as foci for infection.

Extra-articular fractures could be possibly treated with open reduction and internal fixation using intramedullary nails or plates. However, the use of intramedullary nails in extra-articular distal tibial fractures is technically demanding, because of the widening of the medullary canal in the metaphysis, which raises concern regarding the biomechanical stability and the subsequent increased risk of malunion **(15).**

In our study quality of reduction was judjed good in 8 patients, fair in 12, and poor in 4 according to criteria described by ovadia and beals**(16).**

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Williams et al. (17) determined which fracture- and patient-specific variables affected the outcome most in 29 patients with tibial plafond fractures. They evaluated their patients a minimum of two years from the time of the injury Outcome was assessed by four independent measures; radiographic osteoarthritis score, subjective ankle score, the Short Form-36 (SF-36), and the patient's ability to return to work. Interestingly, the four outcomes did not correlate with one another. They also found that the ability to return to work was affected by the patient's level of education and highlighted the difficulties of predicting patient outcome in, these severe articular fractures.

Mitkovic et al (18) described 26 patients with 28 Type C3, distal intraarticular tibial (pilon) fractures treated by dynamic external fixation.

Follow-up was at least two years, and the results (subjective and objective) were classified according to the Ovadia system, they found 71% subjectively and 67% objectively excellent results. The mean to fracture union was 14 weeks (range: 12-20 weeks). There were no cases with nonunion or deep infection despite a high frequency of infections (11%) and osteoarthritis (15%). Based on these results, this treatment with closed reduction and dynamic external fixation allowing early motion appears as a suitable method for treatment of comminuted intraarticular tibial pilon fractures **(10).**

Lovisetti et al (19)) reported astudy of thirty cases of AO type 43 C tibial fractures were treated by transosseous osteosynthesis (Ilizarov technique). there were excellent and good restoration of articular structure in 27 cases and good clinical results in 14.

A retrospective study of 21 patients with high energy tibial pilon fractures treated with Ilizarov technique, **Vidyadhara et al (20)** found encouraging results with good functional outcome in 76% patients. There wereno-long-term problems with fracture union, and no patient required an ankle arthrodesis.

In this study, the Ilizarov fixator is found to be an excellent method in treating pilon fractures especially when adequately applied.

Thus, Tensional small-wire fixation gives good stability to reduced fracture fragments, none of the patient had loss of fixation. The use of olive wires in opposition helps compression of fracture fragments. The ILIZAROV percutaneous fixator preserves endosteal and periosteal blood supply, helps capture the small metaphyseal and subchondral bony fragments, and also helps compression of fracture fragments using the olive wires. The rigidity of fixation can be adjusted to suit stage of fracture healing. It also allows correction of deformity during the process of fracture healing. Early mobilizaton of the ankle joint is another advantage of the ILIZAROV device.

5.Conclusion

The study shows that it is possible to achieve a satisfactory outcome, in pilon fractures, with the Ilizarov technique allowing early definitive treatment. The fractures were treated immediately after the injury, regardless of soft-tissue damage. This was done with a similar low complication rate in both the extra- articular and the intra-articular fractures. Patient compliance was good. The residual deformities were within the range in which the risk of developing post- traumatic osteoarthritis can be expected to be low.

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