OUTCOME OF CIRCULAR EXTERNAL FIXATORS OF ILIZAROV FOR DISPLACED PILON FRACTURES

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ABSTRACT

Background: Trauma surgeons always facing challenges in management of pilon fracture. To minimize complications of plate fixation technique, they use external fixation in injuries of tibial plafond leading to more success in stabilization of the fractures.

Objective: This work was done to assess the efficacy of treating pilon fractures by external fixation using ilizarov and evaluate fracture union, 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 Lizarov 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.

Results: None of the patients had deep venous thrombosis or compartment syndrome. Most of the infections were treated by local antiseptics or antibiotics since the occurred at superficial level and they were frequent, Two cases of malunion occurred, one of them required ankle fusion. Residual deformity occurred to one patient. Delayed union occurred in one case and managed by ilizarovdynamisation frame, while full union occurred to most patients with removal of the fixator after 12 to 28 weeks (mean range of 20 weeks).

Conclusion: Satisfactory outcome can be achieved by using ilizarov technique in management of pilon fracture. Without concern to damage of soft tissues, treatment of fractures was done just after the injury. Incidence of complications was low regarding both types of intra-articular and extra-articular fractures. Risk of osteoarthritis incidence tends to be lower since there was a normal range of residual deformities.

Keywords: External Fixators, Ilizarov, Displaced Pilon Fractures.

I. INTRODUCTION:

The expression "Plafond" refers to the relationship of the distal articular surface to the talus and it is French in origin. A plafond fracture therefore refers to a fracture line that crosses the articular distal tibia's weight-bearing joint surface (1).

A major and more complex subtype of ceiling fractures is "pilon" fracture. It refers to the talus as a hammer pounding in the articular distal tibia's weight-bearing joint surface(2).

The fractures of the tibial plafond constitute about 10 percent of fractures of the lower extremities.
In particular, pilon fractures could account for 7 to 10 percent of tibial fractures in general and around 1 percent of fractures of lower limbs, however, the fracture frequency may grow (3).

Plafond fractures due to high energy causes must be carefully and respectfully treated since complications are high and there is a low possibility of satisfactory functional ankle.

Evaluation of the energy level leading to fractures and meticulous planning of the joint reconstruction will in most circumstances lead to satisfactory results. (4).

The following were traditional treatments plaster pins, casts, fibular fixation and open reduction and internal fixation (ORIF) which could sometimes to cause an undesirable wound-breakdown ankle and higher rates of infection, wound breakdown, unfortunate anatomy alignment and post traumatic osteoarthritis (5).

Using grafts and percutaneous lag screws gives good results for joint reduction and supporting the fragment intra-articularly. Ilizarov apparatus as tension wires with hybrid frames use and spanning half pin frames were suggested for external fixation of fractures after reconstruction of distal tibia is done at joint level. Ilizarov give an advantage of decreased soft tissue complications (6).

External fixation technique minimizes the prevalence of early problems rather to the fixation with a platform. This method has effectively stabilized these fractures for high grade tibial plafond injuries. While this method may not prevent the inevitable post-traumatic sequelae, it provides appropriate stability and enables early ambulation. Moreover, because this approach of external fixation reduces the number of major insults for the soft tissues(6).

We aimed in this work to assess the efficacy of treating pilon fractures by external fixation using ilizarov and evaluate fracture union, and rate of complications.

II. 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 Ilizarov apparatus; 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 Helsinki), 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.
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 calcaneal ring if there is sufficient bone of distal segment to fix with ilizarov k-wires or only 5/8 calcaneal 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.

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 the 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.

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.

III. RESULTS

Age distribution, sex of patients, side of fractures, and duration from injury to surgery are shown in (Table 1)

58.3% of patients showed range of motion of 15-20 degree in dorsiflexion and 58.3% of patients showed 35-40 degree in plantar flexion (Table 2).

Regarding complications local infection was found in 6 cases and treated with local antiseptics. Malunion was in 2 cases. Arthritis in 5 cases and ankle arthrodesis in 1 case, 2 malunion cases occurred despite sufficient external reduction was done. The final alignment was found to be neutral ±5° for about 10 fractures in the coronal plane. One malalignment occurred in 1 case with 20 degrees valgus. 26 years female that was of type 43 BII fracture, suffered from 5 degrees valgus deformity after use of Ilizarov fixation (Table 3).

All fractures were neutral in alignment ± 5 degrees in the sagittal plane. Arthritis was diagnosed radiologically in 5 patients with ankle arthrodesis in one patient.

Table 1. Demographic data, duration from injury to surgery and side of fracture
Table 2. Range of motion after surgery

<table>
<thead>
<tr>
<th>Range of motion</th>
<th>No. of patients</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsiflexion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-20</td>
<td>14</td>
<td>58.3%</td>
</tr>
<tr>
<td>10-15</td>
<td>8</td>
<td>33.3%</td>
</tr>
<tr>
<td>0-10</td>
<td>2</td>
<td>8.3%</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>100%</td>
</tr>
<tr>
<td>Plantarflexion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35-40</td>
<td>14</td>
<td>58.3%</td>
</tr>
<tr>
<td>20-35</td>
<td>8</td>
<td>33.3%</td>
</tr>
<tr>
<td>0-20</td>
<td>2</td>
<td>8.3%</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 3. List of complications

<table>
<thead>
<tr>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin tract infection</td>
<td>6</td>
</tr>
<tr>
<td>Osteomyelitis</td>
<td>1</td>
</tr>
<tr>
<td>Malunion</td>
<td>2</td>
</tr>
<tr>
<td>Delayed union</td>
<td>1</td>
</tr>
<tr>
<td>Arthritis</td>
<td>5</td>
</tr>
<tr>
<td>Arthrodesis</td>
<td>1</td>
</tr>
<tr>
<td>Shortening</td>
<td>0</td>
</tr>
<tr>
<td>Ankle instability</td>
<td>0</td>
</tr>
<tr>
<td>Blood vessels injury</td>
<td>0</td>
</tr>
<tr>
<td>Nonunion</td>
<td>0</td>
</tr>
</tbody>
</table>

IV. DISCUSSION:

Particularly pilon fractures constitute about 1% of lower extremity fractures. The injury is produced primarily through axial loads caused by high energy trauma due to traffic accidents or drops by a significant increase (7).

Surgical approaches like intramedullary nailing, percutaneous or kirschner wires, external fixation and modern plates can be applied (8).

It has been revealed by Ruedi and Allgower (9) that an excellent or good functional outcome of 74 pilon fractures with open reduction and internal fixation was obtained when examined 84 pilon fractures. The four concepts which they recommended were: (1) fibula length restoration; (2) articular surface reduction; (3) cancellous metaphysical defect grafting; and (4) medial medial buttress plate stabilization.
Other authors agreed with these good results as R. Bourne (10) while Helfet et al. (11) reported higher rates of complications and less satisfying results.

Eleven cases of 30 patients were reported to have deeper infection by Teeny and Wiss (12). Also, major complications were examined in 21 of 52 patients by McFerran et al. (13). Three cases of amputation among 19 patients who were managed by internal fixation and open reduction were recorded by Wysch et al. (14).

In a study of tibial pilon fractures that done on 47 patients most of them were males (70.2% while females represented 29.8%) with mean age of 45.8 years performed by Golubovi et al. (15), tibia and fibula in 22 patients were managed by open reduction and internal fixation in 2 separate incisions in one group, the other group included 25 cases who were treated by external fixator, and all of them were followed up for 2 years, it was found that higher number of complications occurred in the open reduction and internal fixation group when compared to the external fixator group.

Pilon fractures due to high energy trauma could be managed by external fixation. Bone et al. in managing 20 open pilon fracture patients caused by high energy trauma, they used ankle spanning external fixators, they reported that external fixation with or without minimal internal fixation showed much better outcomes than osteosynthesis using plates as none of them had any infections (16).

No osteomyelitis or other deep infection was recorded by McDonald et al. (17) after management of 13 pilon fractures by external fixation, twelve of them were type II or III.

Minimal soft tissue dissection and stability are the major good outcomes obtained by ring fixators. Bone transport could be achieved by circular fixator. Early weight bearing is one of the major advantages of ilizarov fixator better in its stability and strength than hybrid types which could prevent the peri articular osteopenia. Axial micromovement also is an advantage of tensioned wires which help in better union of bony fractures (8).

In the present study, 6 patients developed pin site local infection that was treated successfully with antibiotics and local antiseptics.

Plafond fractures that was treated by internal fixation were assessed by Etter and Ganz (18) to examine the quality of reduction, fracture pattern in 41 patients, post traumatic osteoarthritis was lower to occur with better prognosis and good anatomical reduction was obtained.

Residual deformity incidence which could be is still a debate. It is hard to compare the clinical results after operation and the post-operative radiological results to use as prognostic factor (19).

Marsh et al. classified the reduction quality as acceptable at 14 ankles, fair at 15 and poor at 6 with 10 B3, 3 C1, 10 C2 and 12 C3 fractures. They found no link between the fracture type and the measurements for the clinical result. The majority of patients in their study have certain limitations in terms of recreational activities (20).

Management of pilon fractures using ilizarov fixator is an excellent way especially when they adequately applied.

Early mobilization of the ankle joint is another advantage of the ILIZAROV device.

Therefore, stability could be obtained using tensional small-wire fixation when dealing with reduced fracture fragments, none of the cases lost fixation, compression of fracture fragments could be obtained by use of olive wires, periosteal and endosteal blood supply could be preserved by use of ilizarov, also to arrest subcondral bony parts and small metaphyseal bones. Ilizarov also useful for compression of fracture fragments by olive wires. It also assesses the process of fracture healing through correction of deformities. Ankle joint early mobilization is a great is a great advantage of the ilizarov device.

V. CONCLUSION

Satisfactory outcome can be achieved by using ilizarov technique in management of pilon fracture. Without concern to damage of soft tissues, treatment of fractures was done just after the injury. Incidence of complications was low regarding both types of intra-articular and extra-articular fractures. Risk of osteoarthritis incidence tends to be lower since there was a normal range of residual deformities.
REFERENCES


