Posterolateral approach to distal tibia and fibula fractures

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Abstract
Background: Distal tibial and tibial shaft fractures with high energy trauma are often associated with complications of soft tissues injuries, especially in the anterior or medial aspect of the tibia. These fractures are some of the most problematic fractures for the reason of incision breakdown, infection, or skin necrosis, necessitating secondary operations. Evaluation of the soft tissues healing after using a posterolateral approach in fixation of distal tibia and fibula fractures was the aim of the study.

Patients and methods: This study was conducted on 20 patients with acute distal tibia and fibula fractures. The youngest patient was 18 years and the oldest was 60 years old. The mean age was 39.93 years using a single posterolateral incision one cm behind fibula both tibial and fibular fractures were fixed.

Results: Post-operative radiographs presented an anatomical reduction associated with a congruent ankle joint in all cases. The mean operative time was 114±19.93 (range = 90-150 minutes). There were two patients (10%) with superficial wound infection, which were successfully treated with antibiotics. One patient (5%) suffered from skin edge necrosis at two sutures which improved by time. There was no presence of deep infection, wound breakdown or hardware exposure.

Conclusion: The posterolateral approach is a single incision approach that allows satisfactory wound healing with better cosmo. Being unfamiliar to many orthopedic surgeons and its limitation in fractures with anterior comminutions, it is not considered a standard technique for distal tibia fractures and is not recommended to be used routinely. It may be a valuable alternative option when soft tissue envelope compromise is a major concern together with absence of anterior comminution.

Keywords: Distal tibia, posterolateral, ankle.

Introduction
Fractures of distal tibial and tibial shaft with high energy trauma are frequently accompanied with soft tissue injuries complications, specifically in the anterior or medial aspect of the tibia. These fractures are particular of the most problematic fractures for the reason of incision breakdown, infection and skin necrosis, necessitating secondary operations (1). The skin and soft tissue status around the ankle joint after fracture is one of the determining factors for the timing and outcome of surgery. Wound complications lead to skin infection, necrosis, and implant exposure. For closed fractures, the best time for fixation is 8 to 12 hours after injury, or surgery should be delayed until any soft tissue swelling has decreased (2). The principle of presence of a delay between injury and incidence of definitive fixation, well described more than ten years ago, (3) that has substantially reduced complications of soft tissue. The standard of care described as an ankle-spanning external fixator, as well as pins placed in the tibia far from the fracture proximally, that is applied at the time of injury, with no endeavor to directly approach the fracture of pilon. Fixation of the fibula that attempted at the time of application of the external fixator, is supposed to be essential (4, 5) and has become uncommon over time and less regularly advocated. (6).

Others (8) believed that fixation of the fibula must be performed as the first step in open reduction internal fixation (ORIF) of the pilon fracture. There are many approaches for tibial plafond namely anteromedial, anterolateral, posteromedial and posterolateral which can be used depending on fracture patterns. Each approach has their particular advantages and disadvantages. Posterolateral technique for open reduction and internal fixation of tibial plafond fractures is better alternative to routine anteromedial technique which has more chances of wound breakdown (9). However, this technique demands specific fracture array in distal tibia. This approach is recommended when comminution is located mainly in the posterior tibia in association with the fibular fractures and when anterior technique is not recommended for the reason of condition of soft tissues. The advantages of this approach are lesser incidence of soft tissue complications and hence further infection (10,11) and ability to fix both fibula and tibia with the same incision and also less implant prominence as if we compare it to routine anteromedial technique due to sufficient soft tissue coverage.

Patients and Methods
This study was conducted on 20 patients with acute distal tibia and fibula fractures within the period from January 2017 till the end of June 2018, and
the mean follow up period was three months (range = 2 - 4 months). Written informed consent was obtained from patients of all subjects of the study. Any possible complications were notified for all patients and were written in the consent. Confidentiality was taken in consideration by Using code number or letters which refer to the name and address of the patient. Hiding the names and addresses of patients when using their reports and investigations, using the results of investigation in the scientific publishing. Inclusion criteria are acute fractures that the time between the injury and operation equal to or less than 14 days, Type A,B and type C1-2 distal tibia fractures based on AO /OTA classification , Grade 1or 2 closed soft tissue injury based on Tscherne classification. Type 3 open fractures according to Gusteillo Anderson classification, Old fractures that the time of interval between the injury and operation over 15 days, Presence of neurovascular injury, Presence of active infection, Uncontrolled diabetes, Fractures amenable for nailing, are excluded. The youngest patient was 18 years and the oldest was 60 years old. The mean age was 39.93 years. There were 9 males (45%) and 11 females (55%). The right side was affected in 12 cases (60%), and the left in 8 cases (40%). The injury was caused by falling from height in 9 cases (45%) and by road traffic accident in 7 cases (35%) and by falling down (twisting trauma) in 4 cases (20%). According to AO /OTA classification 11 (55%) cases were type B fracture and 9 (45%) cases were type C fracture. According to the Oestern and Tscherne classification in closed fractures 11 (55%) cases were grade 1 and 9 (45%) cases were grade 2. The variation in waiting time for surgery was due to the need to stabilize the patients. Three patients were waiting for more than 10 days after trauma due to excessive swelling and soft tissues injury. Once swelling has subsided, internal fixation was done through posterolateral approach. The mean follow up period was three months (range = 2 - 4 months).

Preoperative evaluation
History taking including age, sex, occupation, medical history, mode of trauma, time of trauma, presence of associated injuries and special habits (smoking) and history of previous trauma or previous surgical procedures.
Local examination included evaluation of the severity and location of soft tissues injury, assessment of the peripheral circulation and neurological examination of the affected limb. Routine plain X-ray and CT scan were done for assessment the pattern of the fracture.

First aid treatment
According to the severity of the soft tissues injury and the degree of the edema, cases with mild edema were put in a below knee splint and were operated within 24 hours. In presence of sever edema and sever soft tissue injury patients were put in external fixator or a calcaneal skeletal traction with anti-edematous measures till the skin condition allows the surgical intervention.

Surgical technique
Spinal anesthesia was used in all patients. The patients were positioned prone or lateral on a radiolucent operating table with the tourniquet applied over the proximal thigh as shown in figure 1. One cm behind the fibula, a longitudinal skin incision was applied along the posterolateral side of the ankle, at the fracture site as shown in figure 2. The short saphenous vein and sural nerve were identified and protected as shown in figure 3. After that the fibular fracture was exposed by medially retracting the peroneal muscle group. The fibular fracture was fixed with a 3.5-mm small fragment plate placed on the posterior surface of the fibula as shown in figure 4. After that the peroneus brevis muscle and the peroneus longus tendon were retracted laterally. The lower third of flexor hallucis longus muscle was released from fibula and medially retracted. Using the same incision, the distal tibia and Volkmann’s triangle were exposed as shown in figure 5. The distal tibial articular surface was restored after reduction of the distal tibial fragment. Both tibial and fibular fractures were fixed by plates and screws in all cases. This procedure was done under fluoroscopic guidance.

Figure 1: Intra operative position of the patient.
Figure 2: The site of skin incision
Postoperative management
After surgery the fractured limb was put in a short leg splint for 12 to 14 days then removal of the sutures and ankle joint mobilization exercises were started as much as the fixation allows. Partial ambulation was started after 8 to 12 weeks then progress to full weight-bearing according to the fracture healing and the follow-up X-rays.

Postoperative assessment
During follow up, we assessed the quality of surgical fracture reduction using Ovadia and Beals criteria on the post-operative ankle radiographs. Wound healing evaluated based on REEDA scale (redness, edema, ecchymosis, discharge and approximation). Primary incision pain intensity evaluated using Visual Analog Scale (VAS). VAS is commonly used as the measure for the pain. It is offered as a 100-mm horizontal line as the patient’s pain intensity is signified by a point between the extremes of “worst pain imaginable” and “no pain at all”. The degree of scaring was evaluated using Vancouver Scar Scale (VSS). It assesses 4 variables: vascularity, height/thickness, pliability, and pigmentation. Presence of any complication as infection, skin slough, wound breakdown or implant exposure was reported.

Table 1: Ovadia & Beals fracture reduction classification.

<table>
<thead>
<tr>
<th></th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral malleolus</td>
<td>Anatomical or ≤ 1.0mm displacement</td>
<td>2.0–5.0mm displacement</td>
<td>&gt;5.0mm displacement</td>
</tr>
<tr>
<td>Medial malleolus</td>
<td>≤ 2.0mm displacement</td>
<td>2.0–5.0mm displacement</td>
<td>&gt;5.0mm displacement</td>
</tr>
<tr>
<td>Posterior malleolus</td>
<td>Proximal displacement ≤ 2.0mm</td>
<td>Proximal displacement 2.0–5.0mm</td>
<td>Proximal displacement &gt;5.0mm</td>
</tr>
<tr>
<td>Mortise widening</td>
<td>≤ 0.5mm</td>
<td>0.5–2.0mm</td>
<td>&gt;2.0mm</td>
</tr>
<tr>
<td>Talus tilt</td>
<td>≤ 0.5mm</td>
<td>0.5–1.0mm</td>
<td>&gt;1.0mm</td>
</tr>
<tr>
<td>Talus displacement</td>
<td>≤ 0.5mm</td>
<td>0.5–2.0mm</td>
<td>&gt;2.0mm</td>
</tr>
</tbody>
</table>

Values expressed are millimeters, corresponding to measurements made from final intraoperative or initial postoperative radiographs.
Table 2: Vancouver Scar Scale (VSS).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigmentation (P)</td>
<td>0</td>
<td>Normal: color closely resembles the color over the rest of the body</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Hypopigmentation</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Hyperpigmentation</td>
</tr>
<tr>
<td>Vascularity (V)</td>
<td>0</td>
<td>Normal: color resembles the color over the rest of the body</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Pink</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Red</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Purple</td>
</tr>
<tr>
<td>Pliability (P)</td>
<td>0</td>
<td>Normal</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Supple: flexible with minimal resistance</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Yielding: giving way to pressure</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Firm: inflexible, not easily moved, resistant to manual pressure</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Banding: rope-like tissue that blanches with extension of the scar</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Contracture: permanent shortening of scar producing deformity or distortion</td>
</tr>
<tr>
<td>Height (H)</td>
<td>0</td>
<td>Normal: flat</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>&lt;2 mm</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2-5 mm</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>&gt;5 mm</td>
</tr>
</tbody>
</table>

The Vancouver Scar Scale (VSS; table 2) was first introduced in 1990 and has been validated and extensively described in the literature. (16)

Case presentation
Case 1: 48 years old female patient presented to the hospital by trauma to left ankle with history of falling down. The patient had no history of medical illness. Surgical intervention done after 4 days.

A: Preoperative x-ray and skin condition B: Postoperative x-ray and skin condition after 3 months

Case 2: 28 years old male patient presented to the hospital by trauma to left ankle with history of road traffic accident. Patient had no history of medical illness. Surgical intervention was done 10 days after admission.

A: Preoperative x-ray and skin condition. B: Postoperative X-ray and skin condition after 3 months
Case 3: A 50 years old male patient presented to the hospital by trauma in right ankle with history of falling from height (3 meters). Patient had no history of medical illness. Surgical intervention was done after 14 days.

Results
Post-operative radiographs showed an anatomical reduction with a congruent ankle joint in all cases. According to the scoring system 16 patients (80%) had good results, 4 patients (20%) had fair results. No significant difference regarding age, sex or side was found. The mean waiting time for operation after admission was 7.67±4.54 (range = 1-14 days). The variation in waiting time for surgery was due to the need to stabilize the patients. Three patients were waiting for more than 10 days after trauma due to excessive swelling and soft tissue injury. Once swelling had subsided, internal fixation was done through posterolateral approach. The mean operative time was 114±19.93 (range = 90-150 minutes). Patients associated with high energy trauma had more comminuted fractures with more soft tissue injury and swelling. The operative time increase with type C fractures (p value = 0.002). Primary incision pain intensity was measured using the visual analog scale after 2 weeks, the mean score was 42.67±10.14 (range = 30-60). The score increased with patients associated with more soft tissue swelling and contusion (p value = 0.003).

Discussion
Treatment of the distal tibial fractures is still a challenge that faces orthopedic surgeons for the reason of the high incidence of soft tissues injury and variable fracture patterns. Ruedi and Allgower presented their initial results using open reduction and internal fixation for 84 fractures in 1969. In their report, 70% of the results were good or excellent. This report has become the classic paper, because of both the outstanding results and the clear demonstration of treatment principles: restoration of fibular length, reconstruction of the tibial joint surface, filling the defect with bone graft and stable fixation by buttress plating. However, other surgeons have found significant complications when using open reduction and internal fixation that occurs in high-energy pilon fractures. Infection rates range from 6% to 55% and soft tissues complications range from 11% to 27%. McFerran et al. noted 24% rate of wound breakdown and 17% of infection rate, with one patient requiring an amputation. Teeny and Wiss noted that 50% of their patients had at least one major complication such as a skin slough, infection, wound dehiscence, malunion, nonunion, or implant failure. Skin slough or wound dehiscence was present in 27% of the patients. There were three patients developed superficial infections, and 11 with deep infections. 50% of the patients required other additional operations included irrigation and debridement of infected fractures, metal removal or revision of fixation, arthrodesis and wound coverage procedures. So they were searching for alternative methods for treating pilon fractures with lower complications rate. The use of external fixation reduces the rate of infection. However, this method still has the problems of pin tract infection which predispose to deep infection, loss of fracture reduction, and joint stiffness. In his comparative study Anglen published early results of 34 fractures treated with hybrid external fixation regardless of performing limited internal fixation and 27 fractures with open reduction and internal fixation. The study findings showed a worse clinical outcome score, higher rate of complications, and higher rate of nonunion and slower return to function for patients treated with hybrid fixation, compared with patients treated with internal fixation. Anglen found 7 cases of non-union, 7 wire site infections, 3 half-pin site infections, 3 wound healing problems, and 1 case of septic arthritis in the group who had hybrid external fixation. The ORIF group had minor complications; one had minor sensory loss and one had superficial skin slough. So he concluded that when patients are carefully selected and timing is appropriate, internal fixation of pilon fractures can be
performed safely and with good results. (22) As an attempt to reduce the incidence of soft tissue complications, Konrath and Hopkins reported the use of posterolateral approach in two patients. Results were good in both patients. It was possible to stabilize the tibia and the fibula through the same incision. They noted some disadvantages of this approach, the prone position of the patients and the limitation of visualization of the ankle joint, so if anterior comminution exists reduction will be difficult. They concluded that posterolateral approach is merely offered as an additional option for the orthopaedic surgeon. (23) Bhattacharyya et al. examined the complications associated with the use of the posterolateral approach for pilon fractures in 19 patients. Complications occurred in nine of the 19 patients. Six patients (31%) had wound problems (three superficial infections, three deep infections). Four patients (21%) had nonunion, three patients required ankle arthrodesis, and one patient had a 3-mm step-off. The authors concluded that the posterolateral approach did not reduce the occurrence of wound complications compared with other approaches. They recommended this surgical approach only for pilon fractures in which the articular displacement and comminution are predominantly located posteriorly or when an anterior approach is not recommended because of the condition of the soft tissues. (24) The posterolateral approach has the advantage of fixation of both the fibula and tibia using the same incision. Traditional open reduction and internal fixation required two incisions, a lateral incision for fixing the fibula and the anteromedial incision for the distal tibia and medial malleolus. The width of the skin bridge between the dual incisions must be at least 7 cm; otherwise, circulation around the wound would be compromised. The single incision using the posterolateral approach does not have the problem of an adequate skin bridge. Borrelli et al found that the tibial diaphysis have relatively few extraosseous vessels in the posterior region. The anterior tibial artery supplies the diaphysis through the branches in the interosseous membrane. The diaphysis also received a contribution from the posterior tibial artery. In the distal tibia, the two arteries form an arterial network in the medial aspect of the metaphysis. They concluded that open plating of the medial aspect of the distal tibia caused a greater disruption of this extraosseous network, which slows healing and increase the risk of delayed union and nonunion. (25) The soft tissues over the posterior aspect of the tibia are thicker with multilayer coverage. Therefore, the risk of bone and implant exposure are lower. Soft tissue complications of the posterior aspect of lower leg are easily to be treated, and flap transfer is rarely needed. Moreover, the muscle bulk of the flexor hallucis longus over the implant acts as a buffer between the implant and the skin to prevent extension of superficial skin infection to deep infection which reduce patient hospital stay and the time of the treatment. In this study one patient (5%) suffered from skin edge necrosis which improved by time. There was no patient with wound breakdown or hardware exposure. There were two patients (10%) with superficial wound infection, which were successfully treated with antibiotics. There was no patient with deep infection. With this approach a stable fracture fixation can be done allows early mobilization and rehabilitation of the ankle joint decreasing the chance of the ankle stiffness. We start early range of motion after two weeks of the operation. Cosmetically, this approach is also more accepted when compared with the dual incision approach. The mean score of vancouver scar scale was 3.40±1.32 and the mean score of visual analog scale was 42.67±10.14. The main limitation of this approach is that it remains useful mainly for those patients with a large posterior tibial fragment. Visualization of the ankle joint and anterior comminution is limited so the reduction mainly depends on fluoroscopic guidance which may be misleading in some cases. This approach also lacks familiarity to many orthopedic surgeons as the patient is placed in prone position.

Conclusion

Treatment of distal tibia fractures should be individualized according to the fracture pattern and soft tissue condition. The posterolateral approach is a single incision approach that allows satisfactory wound healing with better cosmesis. Being unfamiliar to many orthopedic surgeons and its limitation in fractures with anterior comminutions, it is not considered a standard technique for distal tibia fractures and is not recommended to be used routinely. It may be a valuable alternative option when soft tissue envelope compromise is a major concern together with absence of anterior comminution.

References


