# Tibial Plafond Fractures: Limited Incision Reduction with Percutaneous Fixation

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*This study was a retrospective review of 18 patients with 19 pilon fractures treated with limited incision reduction and percutaneous plate fixation of the tibia. Patients were treated with either a 1- or 2-stage protocol. The latter consisted of placement of an external fixator followed by definitive reduction. The emphasis of analysis was placed on the identification of complications to the soft tissue envelope or bone-healing problems within the first 6 months after surgery. A major complication was defined as an unplanned operation within the first 6 months. Minor complications were any superficial wound defects that did not require operative intervention to resolve or any malunion or delayed union. With this protocol, no major complications were encountered. Minor complications were identified in 4 patients (4 fractures) of which 2 were minor wound problems. One patient developed a malunion, and the other had a delayed union. Four patients requested removal of prominent hardware. These results indicate that limited incision reduction and percutaneous plate fixation lead to safe methods of stabilization. The authors also provide guidance and strategies for the consistent execution of this technique.* (The Journal of Foot & Ankle Surgery 46(4):261–269, 2007)

Key words: pilon fracture, limited incision, percutaneous, plafond

Fractures of the tibial plafond are complex injuries that are often associated with severe soft tissue injury. The character and pattern of skeletal injury vary depending on forces imparted to the distal tibia at the time of injury and can vary from simple rotational fracture patterns to severe articular comminution with metaphyseal defects and severe soft issue injury. This combination of osseous and soft tissue pathology creates an intellectual and technical challenge in treatment. Failure to appreciate the soft issue damage with any injury predictably leads to unforgiving complications. Historically, surgical management of the higher energy variety had significant complications (1–3), with a rate ranging from 10% to 55% (4–11). Ruedi and Allgower introduced the use of open reduction and internal fixation (ORIF) for tibial plafond fractures with good overall functional results (12). The results of their patients improved in a 9-year follow-up study (13). Because these were primarily low-energy injuries, they evaluated high-energy injuries in another study and found that the overall results were not as good as those in patients with lower-energy injuries (14). This suggests the severity of the injury and soft tissue damage predicts a less favorable prognosis. Other studies also showed good results with ORIF of tibial plafond fractures (5, 6, 15–17); however, contradictory studies were also published with poor results (7, 10, 18–20).

Although the outcomes are dependent on several factors, the optimal technique for surgical correction of more complicated pilon fractures remains controversial (4, 15, 21, 22). Surgical techniques such as limited ORIF, percutaneous reduction and fixation, and external fixation alone or in combination with internal fixation have been described with variable results (17, 23–29). Despite disagreement on the most appropriate surgical technique, these authors agree that the avoidance of soft tissue complications has to be a primary focus and factored into any surgical plan. Although anatomic reduction and stable fixation contribute to the final outcome, Watson et al found that treatment based on the degree of soft tissue compromise yielded better results (17). There is evidence to corroborate the notion that high-energy injuries generally predict a less favorable prognosis and higher risk of wound complications and infection (2, 3, 11, 22).

The ideal method of treatment would achieve excellent articular reduction and stability while minimizing soft tissue compromise and devascularization of the fracture fragments. To achieve this, a 2-stage protocol has been recommended, which consists of initial use of external fixation until the soft tissue envelope recovers sufficiently to allow for definitive ORIF of the tibia (1, 2, 22, 30–34). By means of this 2-stage protocol, some have transitioned from formal

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ORIF to a limited incisional approach for reduction (35, 36). The exposure required in this limited approach is only large enough to achieve reduction, thereby allowing for a direct approach over the fracture while maintaining the vascular soft tissue attachments to the periarticular fragments. In this study, a retrospective review was performed to evaluate the treatment of tibial plafond fractures with a modified staged protocol. We wanted to analyze the rate of complications of the soft tissue envelope to other approaches and the existing literature. In addition, we wanted to provide guidance for the consistent execution of the technique.

## Patients and Methods

This review focuses on the identification of soft tissue complications in the short-term perioperative period. Patients who sustained pilon fractures that were treated with operative reduction and percutaneous delivery fixation were included in the study. Inclusion criteria were a limited or percutaneous incisional approach and percutaneous delivery of tibial fixation. Patients meeting these criteria who were operated on by 2 of the authors (J. M. S. and S. M. R.) over the past 3 years were retrospectively reviewed. All patients received their follow-up care with their respective surgeon.

Complications were defined as minor or major depending on the severity of the wound. Major complications were defined as events that required an unplanned operation as a direct result of morbidity from the fracture or the treatment method such as osteotomies for malunions or nonunions, deep infections, wounds requiring soft tissue coverage, and failures of fixation (10). All other events that did not require formal operative intervention such as superficial wounds and infections, and delayed or malunions were therefore considered minor local complications. These events were excerpted from the medical records by one of the authors (H. L. S.).

## Treatment Protocol

Patients were evaluated in the emergency room where initial resuscitative maneuvers were performed if necessary. Primary assessment of the extremity was performed with respect to deformity, damage to soft tissue, and characterization of injury based on the mechanism. Open fractures were treated with emergent irrigation and debridement in the operating room. The primary indications for immediate external fixation were open fractures, grossly unstable fractures, significant shortening, and severe soft tissue damage (Fig 1, A). Two half pins were placed in the tibia above the zone of injury; 1 pin was placed in the midfoot or talus and another in the calcaneus, all from the medial side of the leg (Fig 1, B). Distal axial traction was applied across the ankle until the talus was directly under the axis of the tibia. Fluoroscopic control was used to assure proper length rotation and axial alignment (Fig 1, C). In the absence of open wounds, fracture blisters, significant shortening or instability, the injured extremity was immobilized in a short-leg, padded splint.

Thin-section computed tomography (CT) images were obtained after fixator placement to assist in incision placement and reconstruction. Definitive operative reduction was performed after sufficient time had elapsed for recovery of the soft tissue envelope. The latency between injury and definitive surgical treatment was determined by the surgeon, but was based on the recovery of the soft tissue envelope. In those cases without open wounds or blisters, resolution of ankle edema and return of skin lines were the most common determinants.

At the time of definitive reduction, the external fixator, if present, was removed. Fibular fractures were reduced and plated with a one-third tubular plate or reconstruction plate through an open or percutaneous technique. Attention was then directed to the distal tibial where the primary incision was made over the dominant fracture line as determined by CT scan (Fig 2). Exposure of the distal tibia and joint was done through the fracture corridor to minimize soft tissue dissection and maintain vital soft tissue attachments to periarticular fragments. The ankle capsule was not detached from the distal articular fragments unless absolutely necessary. The joint was reduced with manipulation through the dominant fracture exposure under fluoroscopic control. If there was minimal displacement of the articular surface, the joint was reduced with percutaneous manipulation and arthroscopic assistance with a medial and lateral portal. Temporary fixation of the reduced fragments consisted of Kirschner wires delivered through the incision or directly through the skin. Final fixation of the larger metaphyseal, articular fragments was done with screws placed through the incision or percutaneously.

A distal tibial locking plate was then tunneled subcutaneously through a 1.5-cm vertical incision just distal to the medial malleolus. The corridor for passage of the plate was developed in an extraperiosteal fashion with a long, curved packing forceps (Fig 3, A). A plate long enough to provide 2 holes proximal to the most proximal extent of the fracture was selected. It was secured to the medial surface of the tibia with percutaneously placed screws using fluoroscopic guidance. A combination of locking and nonlocking screws was used (Fig 3, B). Any widening of the syndesmosis was reduced and maintained with trans-syndesmotic fixation from lateral to medial.

## Results

Eighteen patients, 12 men and 6 women, with a total of 19 tibial plafond fractures were identified. The average patient age


**FIGURE 1** (*A*) Anteroposterior radiograph of patient 18 with distal tibial fracture. Note the varus posture of the tibia and fibula. (*B*) Clinical photograph of external fixator in place. In this example, 2 centrally threaded pins were placed distally. One is in the calcaneus, and the other is in the midfoot distal to the talus. (*C*) Intraoperative fluoroscopic view of the completed reduction. The varus deformity has been corrected, and the tibia and fibula are out to length with near normal rotation.

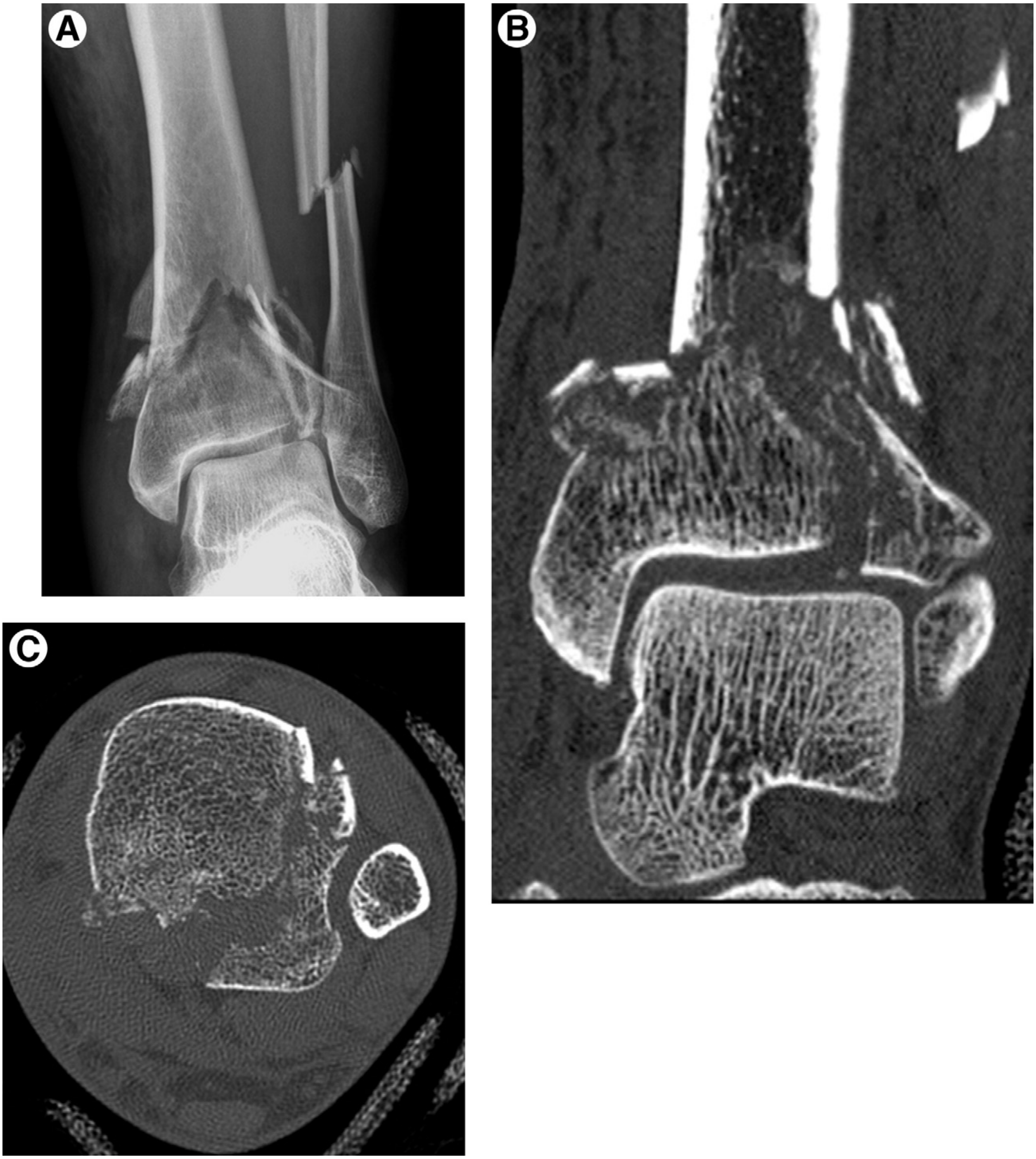


**FIGURE 2** (*A*) Mortise radiograph of patient with comminuted fracture pattern. The fibula has also been fractured. (*B*) CT scan of same patient after fixator placement. Note that the dominant fracture line is lateral, which would make the anterolateral approach most optimal to access the articular surface and fracture fragments. If the fibula had been repaired before incision planning, the anterolateral approach might be too close to the incision used for ORIF. (*C*) Axial section slightly proximal to joint, again demonstrating the optimal surgical corridor.

was 43.4 years (range, 18-74 years). The mechanism of injury for 74% (n = 14) of patients was a high-energy axial load including 7 falls from a height, 4 vehicular accidents (car, motorcycle, and jet ski) and 3 pedestrian versus automobile. The remaining 26% (n = 5) of fractures were the result of low-energy injury mechanical falls. Fifteen patients had associated fibular fractures, and 3 patients sustained ipsilateral metatarsal fractures. One patient had a contralateral ankle fracture.

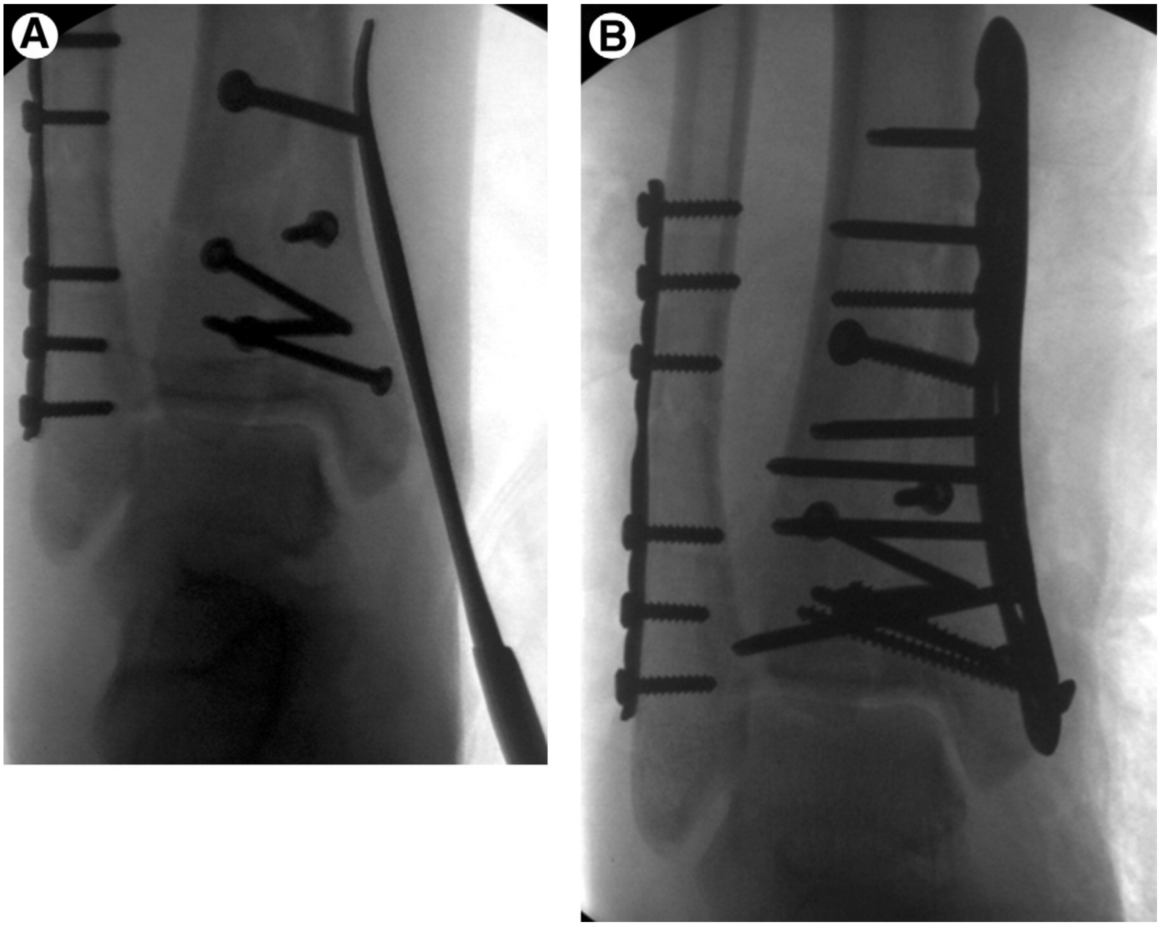


**FIGURE 3** (*A*) Intraoperative fluoroscopic view with the long, curved surgical instrument used to develop the pathway for medial distal tibial locking plate. (*B*) Completed reconstruction showing the proximal extent of the medial distal tibial locking plate.

## Classification

The fractures were classified according to the AO-ASIF system (37) (Table 1). Thirteen patients (74%) sustained type C fractures, 4 patients (21%) had type B injuries, and 1 patient had a type A fracture. Seventeen of 19 fractures were closed injuries, and 2 patients had open injuries (38). One open fracture was grade I (patient 16), and the other was grade II (patient 1). Three patients with type C fractures developed fracture blisters (patients 7, 8, 11).

## Treatment

External fixation was initially used in 8 patients. Two of these had open fractures, 3 had fracture blisters, and 3 more required the external fixator for gross instability or loss of length.

In 15 cases, an ancillary limited incision was necessary to achieve tibial articular reduction. Three cases were treated with arthroscopic assistance. Of the 15 concomitant fibula fractures, 3 were plated percutaneously. In 1 case, the fibula fracture was stable and well aligned and did not require fixation. The remaining 11 were treated with ORIF.

## Time to Surgery

The average delay to definitive treatment for all 18 patients was 11.2 days (range, $<$ 24 hours to 52 days). The 2 patients with open fractures had the longest delays of 35 and 52 days until definitive treatment.

## Complications

According to the established criteria, no major local complications were identified. However, 4 minor local complications, including 2 wounds, 1 delayed union, and 1 mild valgus malunion, were identified in this series. These 2 wound problems represented an 11% complication rate. One medial ankle wound (patient 14) required 2 courses of

**TABLE 1 Patient data**

| Pt # | Age and sex | Mechanism of injury | Soft tissue | AO/ ASIF | Ex-fix | Fibula fixation | Concomitant fractures | Days to definitive fixation | Reduction technique | Complications | Follow-up (mo) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 55M | Fall from height | Open grade II | C3 | + | ORIF | | 52 | Limited | | 10 | HWR |
| 2 | 39M | Pedestrian vs. auto | Closed | C2 | − | PC | | 12 | Limited | | 6 | |
| 3 | 37F | Fall from height | Closed | B2 | − | Stable fracture | | 1 | Limited | | 6 | |
| 4 | 61M | Pedestrian vs. auto | Closed | B2 | + | ORIF | L 5th metatarsal | 9 | Limited | Lateral ankle wound | 6 | |
| 5 | 74F | Mechanical fall | Closed | B2 | − | PC | | 1 | Limited | | 11 | |
| 6 | 33M | Fall off jet ski | Closed | B2 | − | ORIF | | 1 | Limited | | 8 | |
| 7 | 62M | Fall from height | Closed | C3, C3 | + | ORIF L | | 10 | Limited | Valgus malunion | 6 | Fracture blisters |
| 8 | 45M | Fall from height | Closed | C3 | + | ORIF | | 20 | Limited | | 6 | Severe fracture blisters |
| 9 | 43M | Motor bike | Closed | C1 | + | ORIF | | 14 | Scope | | 8 | |
| 10 | 42F | Mechanical fall | Closed | C2 | − | ORIF | R 1-3 metatarsals | 1 | Limited | | 21 | HWR |
| 11 | 55M | Fall from height | Closed | C3 | + | ORIF | | 15 | Limited | | 15 | HWR; fracture blisters |
| 12 | 33F | Mechanical fall | Closed | C1 | − | None | L 2-5 metatarsals | 1 | Scope | | 10 | |
| 13 | 40M | 50” motorcycle jump | Closed | C1 | − | None | | 4 | Scope | | 9 | |
| 14 | 36F | Mechanical fall | Closed | C1 | − | ORIF | | 1 | Limited | Medial ankle wound | 18 | HWR; pregnant at DOI, smoker |
| 15 | 54F | Mechanical fall | Closed | C1 | − | ORIF | | 1 | Limited | Delayed union | 7 | IDDM, hypothyroidism |
| 16 | 52M | MVA | Open grade I | A3 | + | PC | R ankle | 35 | PC | | 8 | Ex-fix at OSH |
| 17 | 45M | Fall from height | Closed | C3 | − | None | | 14 | Limited | | 6 | |
| 18 | 18M | Pedestrian vs. auto | Closed | C2 | + | ORIF | | 11 | Limited | | 6 | |

Abbreviations: PC, percutaneous; OSH, outside hospital; IDDM, insulin-dependent diabetes mellitus; DOI, date of injury; HWR, hardware removal; MVA, motor vehicle accident; L, left; R, right; ORIF, open reduction, internal fixation; M, male; F, female.

oral antibiotics followed by hardware removal but healed without further complication. The second wound problem (patient 4) was a partial-thickness ulceration located over the lateral ankle hardware that also healed uneventfully.

The patient who developed the delayed union was started on a bone stimulator before its identification because of his comorbidities (patient 15), and the fracture went on to heal without complication. The valgus malunion occurred in a patient with bilateral pilon fractures and was a type C3 fracture with fracture blisters (patient 7).

### Follow-up

The patients followed up with their respective surgeons an average of 8.8 months (range, 6-21 months). At the time of follow-up, 4 patients had removal of prominent symptomatic hardware at an average of 14.6 months after definitive treatment. Patients were followed up for at least 6 months to evaluate for soft tissue complications, similar to McFerran et al (10). They found that the majority of complications occurred in the first 3 weeks and all within 6 months.

## Discussion

With surgical treatment of tibial plafond fractures, minimizing the soft tissue damage is vital to prevent potentially catastrophic complications (4–11). These include surgical wound dehiscence, deep infection, osteomyelitis, infected nonunions, and amputations (1, 4–11). Teeny and Wiss reported that superficial wound problems increased the risk for deep infection 6-fold (11). Other reports indicate an incidence of superficial wound problems ranging from 27% to 36% of cases after ORIF (7, 39). Without adequate soft tissue coverage, the rate of osteomyelitis can be has high as 55% (7). Often, these soft tissue complications require additional surgeries. McFerran et al had a 40% rate of major local complicating events requiring 77 additional unplanned procedures such as debridement and flap coverage (10). The rate of these complications can be influenced by the surgical approach, timing of surgery, osseous stability, as well as the delivery method of the fixation.

Although "closed" reduction techniques such as percutaneous and external fixation would be least traumatizing to the tissue, inadequate anatomic joint reduction can be a complication, particularly in the more complicated pilon fracture patterns (28). Pugh et al found that external fixation resulted in a decrease in soft tissue complications but was complicated by inadequate articular reduction (27).

Recognition of the morbidity associated with both the soft tissue and osseous complications has influenced surgeons to use alternative techniques for exposure and definitive stabilization (1–11, 39). Minimal incision approaches have been used with tunneled plates or percutaneous screws, which have been shown to have a lower incidence of wound complications (35, 36). The authors in these 2 studies in particular used fracture corridors similar to ours as a technique to minimize dissection and exposure. Further, our results were similar to those of Tornetta et al who had 1 superficial infection, 1 late deep infection, 1 varus malunion, and 3 pin tract infections in 17 intraarticular distal tibia fractures treated with combined limited internal and prolonged external fixation (29). No pin tract infections were seen in our study because the external fixators were only applied for a short period before definitive treatment (17, 24, 29).

Most commonly, a biplanar delta frame was used with 2 pins in the tibia and 2 pins in the foot. In some instances, a transcalcaneal pin was the sole form of fixation distal to the fracture site. Although this provided some stabilization, it was usually inadequate to completely immobilize the foot on the leg and fracture. We also tried to avoid the neck of the talus as an insertion point for one of the distal fixator pins, particularly later in our series. Although it was rare for the incisional approach to extend distally enough to communicate with the neck of the talus, potential contamination of the surgical site was a concern. The optimal insertion point for the second pin was either the navicular, medial cuneiform, or first metatarsal.

Not all of our patients were stabilized with external fixation as the initial surgical maneuver. In some instances, patients were triaged in another hospital, placed in a cast or splint, and sent to us for definitive care. In other cases, the fracture was deemed to have acceptable alignment. Although external fixation provides better stability than simple cast or splint immobilization, we did not feel it necessary to place all of those patients who were encountered initially in a fixator arbitrarily, particularly those with lower-energy injuries and minimal displacement.

Timing of surgery has been recommended either immediately after the injury (19, 21, 30, 32) or after recovery of the soft tissue envelope. The latency has been suggested to range from 7 to 21 days (1, 21, 23, 30–31, 34). It has been suggested that after a 3-week postinjury interval, accurate surgical reduction becomes more difficult (9). More recently, a 2-stage protocol involving temporary external fixation followed by delayed, limited incision ORIF has been recommended (25). Fractures treated with ORIF 3 to 5 days after injury have also been associated with higher rates of soft tissue complications (39). By delaying definitive tibial treatment, soft tissue injury is thereby limited. The delay to definitive treatment in our study was an average of 11 days, similar to the 5- to 10-day delay by Tornetta et al (29). Treatment of patients with extensive soft tissue wounds or blisters often extends the latency but increases the difficulty at mobilization of the fracture fragments with a more limited approach. Yet, we did not critically evaluate the degree of difficulty of fracture reduction in our series.

The vascular supply to the distal tibia can influence the ultimate healing process of the fracture (40, 41). In the tibial plafond, there is a limited and precarious blood supply due to the sparse soft tissues surrounding the distal tibia. Additional soft tissue stripping required for reduction and fixation further compromises the vascularity to the bony fragments and surrounding soft tissues. It can be argued that anatomic articular reduction leads to a better outcome (5, 9, 12–15, 18, 21, 22). Even though immediate postoperative radiographs may indicate an anatomic reduction, the ultimate outcome is often influenced by the fate of the articular cartilage. The combination of avascular necrosis of bony periarticular fragments and a latent manifestation of undetectable cartilage damage often culminates in posttraumatic arthritis in higher-energy injuries (5, 11, 15, 18, 20, 39, 42, 43). Further, the perioperative consequences of soft tissue damage are often devastating (2, 3, 10, 15, 17, 22). The minimally invasive approach used in this series arguably may have sacrificed perfect articular congruity in the higher-energy injuries. Yet, we experienced a very low incidence of soft tissue complications. Most likely, the blend of latent definitive reduction and the minimally invasive approach was responsible.

The long-term outcome of the patients in our series was not evaluated. Posttraumatic arthrosis will likely be observed in some of our patients in the future, particularly in the high-energy fractures. However, in addition to minimizing soft tissue complications, we sought to achieve a stable, well-aligned articular-metaphyseal fragment so that salvage operations required in the future would be simplified. On the other hand, we believe that we achieved anatomic articular congruity in the lower-energy injuries through careful incision planning, arthroscopic assistance, and considerable experience in these injuries.

Several authors have recommended operative stabilization of the fibula at the same time as fixator placement or as an isolated initial operation. The premise is that it adds lateral stability and provides a "starting" point for reconstruction (5, 9. 12, 13, 21). In this series, the fibula was not plated until definitive reduction was performed. We believe that early stabilization often compromises the strategy of incision placement based on the dominant fracture lines (Fig 2). The optimal incisional approach can best be determined by CT scan. However, in the higher-energy, comminuted injuries, it is often difficult to determine the optimal surgical approach before the extremity is brought out to length. Selection of the surgical approach is best done after fixator placement has restored stature to the extremity. Although this philosophy may not apply to low-energy, simple fracture patterns, it has served well in many of the injuries. An underutilized approach for articular reconstruction is the anterolateral corridor. If the universal lateral approach to the fibula has been done as an initial or isolated procedure, the proximity of the 2 incisions may be perilous, if the anterior lateral approach is over the dominant fracture line.

## Conclusion

A series of 19 pilon fractures treated with a limited incision and percutaneous medial plate fixation has been presented. A 1- or 2-staged protocol was used. There were no major complications and 4 minor complications to the soft tissue envelope. This treatment scheme compares favorably with the more extensile exposures used for operative reduction of the distal tibia.

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