Fragment-Specific Pilon Fracture Fixation Using Mini Fragment Plates

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Summary: Internal fixation or external fixation, with or without limited internal fixation, is considered the treatment of choice for the majority of displaced pilon fractures. However, regardless of the chosen method, surgical stabilization of pilon fractures is challenging and technically demanding. Anatomic reduction of the articular surface, which is one of the main goals of operative treatment, is often difficult to obtain and maintain, especially in complex fracture patterns. Even precontoured periarticular distal tibial plates cannot optimally address every fracture pattern and do not always offer optimal screw trajectory. Mini fragment plates allow for fragment-specific fixation, can be used independently or as a useful adjunct to conventional plates, and enable the orthopaedic traumatologist to expand their internal fixation armamentarium for the treatment of these complex injuries. The objective of this article is to illustrate the successful use of mini fragment plates for fragment-specific pilon fracture fixation.

Key Words: pilon fractures, tibial plafond fractures, ORIF, mini fragment plates, fragment-specific fixation

INTRODUCTION

Surgical management of pilon fractures continues to be challenging and technically demanding. Pilon fractures comprise a wide spectrum of skeletal and soft tissue injuries and typically result from higher energy mechanisms, with significant axial loading of the distal articular surface of the tibia. Complex fracture patterns involving articular surface impaction, comminution, and significant soft tissue compromise are common. Despite advances in implant technology, surgical approaches, and timing of surgical intervention, the rate of postoperative complications is still substantial, and the clinical outcome is not always favorable.

Optimal treatment of pilon fractures is still controversial, and a wide variety of treatment strategies have been described. Depending on the injury pattern and soft tissue condition, treatment options may range from nonoperative treatment (for completely nondisplaced fractures or patients who cannot tolerate surgery) to primary ankle arthrodesis in extremely rare selected unreconstructable cases. However, for the majority of displaced pilon fractures, internal fixation or external fixation, with or without limited internal fixation, is considered the treatment of choice. The main goals of operative treatment include anatomic reconstruction of the articular surface; restoration of length, alignment, and rotation of the distal tibia; and stable fixation to maintain reduction until healing and to allow early joint motion.

Precontoured periarticular distal tibial plates are commonly used to achieve stable fixation and maintain reduction. Mini fragment plates, however, may provide an additional and useful tool to restore joint congruity in pilon fractures and allow for fixation of individual fragments with separate implants (ie, fragment-specific fixation) which may facilitate fracture stabilization in cases in which precontoured plates may not be optimal. The variety of mini fragment plate configurations, low profile size, distal screw cluster, and variable angle locking screws may offer numerous options for fixation of...
individual fracture components and thus may be helpful to reach treatment goals. It is important to note that mini fragment plates should not be used in lieu of standard larger plates in cases of complete articular injuries; however, they can be used as an adjunct form of fixation. The purpose of this report therefore is to illustrate the use of mini fragment plates for fragment-specific pilon fracture fixation.

**PATIENT INFORMATION**

A 72-year-old woman sustained a right closed comminuted pilon fracture and an associated closed distal third fibula fracture after a fall from a ski lift. The patient was osteopenic and on immunomodulators for a recent history of breast cancer. Radiologic workup at an outside hospital included standard ankle radiographs after the patient had a splint placed (Fig. 1); full-length radiographs of the tibia and fibula as well as computed tomography (CT) imaging were obtained on presentation at our institution (Fig. 2).

At admission, neurovascular injuries were ruled out, and systematic physical examination did not reveal additional injuries. The soft tissue envelope around the ankle was closed and moderately swollen. Preoperative radiographs and CT images displayed an OTA/AO43-B3 (Rüedi and Allgöwer type 3) pilon fracture with multifragmentary articular surface fracture, but without metaphyseal comminution. There was significant impaction particularly anteriorly and in the central zone of the tibial plafond. The associated distal third fibula fracture was transversely oriented, not comminuted, and displayed minimal varus malalignment (Fig. 1).

A staged management was chosen, and it consisted of initial ankle-spanning external fixation with fibular fixation and delayed definitive open reduction internal fixation (ORIF) of the tibia using fragment-specific fixation after the soft tissue swelling had subsided.

**SURGICAL TECHNIQUE**

On the day of admission, the associated fibula fracture was percutaneously stabilized, and an ankle-spanning external fixator was applied. Preoperative analysis of the fracture pattern revealed a tension-based failure laterally at the fibula and a compression-based failure of the medial aspect of the tibia at the joint (Figs. 1 and 2). Because of the poor skin status of this elderly patient, the use of immunomodulators, and because of the fact that it was a tension-based failure laterally, we decided against an ORIF of the fibular fracture with a plate but rather opted for percutaneous intramedullary screw fixation. The patient was positioned supine under general anesthesia. A small skin incision was made distal to the tip of the lateral malleolus, and the entry point for the screw was determined under anteroposterior and lateral fluoroscopic guidance, with the start site centered on the canal of the fibula on both views. The minimal varus displacement of the distal fibula was percutaneously reduced using a Schanz pin, and thereafter, a 3.5-mm drill was advanced from the entry point proximally to the level of the fracture, and a 2.5-mm drill was passed into the medullary cavity (Fig. 3A). A 3.5-mm cortical screw was then inserted and lagged by a technique across the fracture (Figs. 3B–D). In the second step, an ankle-spanning triangular external fixator was applied to stabilize the tibial component of the injury, with 2 Schanz pins placed through the proximal tibial diaphysis, one transcalcaneal pin and an additional pin placed from the...
medial to the middle cuneiform to neutralize the foot. Distraction was applied with the correction of coronal and sagittal deformities using appropriate vector adjustments through the bars and clamps. It is critical to restore the relationship of the talus to the plafond on the sagittal view. In cases of significant anterior plafond impaction, the talus has the tendency to escape anteriorly, and this should be corrected with the frame.

Ten days after admission, the soft tissue swelling had sufficiently resolved, and the patient was brought to the operating room again for definitive ORIF of the multifragmentary articular fracture of her distal tibia. She was positioned supine on a radiolucent table under general anesthesia. A small bump was placed under the ipsilateral hip, and the operative leg was positioned on a soft ramp cushion to facilitate lateral fluoroscopy. Her lower extremity was prepped and draped in the usual sterile fashion with a tourniquet on her right thigh. The decision was made to use an anteromedial approach which would allow excellent visualization of the medial gutter comminution and reduction of the large anterolateral fragment which appeared to have excellent cortical reads based on CT. The incision started proximally 1 cm lateral to the tibial crest and sharply curved medially at the joint line to a point approximately 1 cm distal to the medial malleolus. The saphenous nerve and vein were identified and protected distally. After dissection was performed through the skin, subcutaneous tissue, and fascia, the tibialis anterior tendon was identified. After sharp incision just medial to this tendon, a full-thickness flap medial to the tendon was elevated, the fracture was exposed, and arthrotomy was performed over the anterior sagittal fracture line. The severe comminution in the medial gutter anteriorly became visible. The external fixator was now adjusted, and approximately 1.5 cm length was gained through the distractor bars, and the joint was visualized. Once the exposure was performed, the tourniquet was elevated. This is a standard practice of the senior author for the treatment of pilon fractures. Delayed elevation of the tourniquet allows more time for the tourniquet to be elevated during the joint reduction, which allows for better visualization in addition to the added benefit of cauterizing punctate bleeding in the soft tissues that could potentially be missed if the tourniquet is elevated during the exposure.

The next step involved reducing the multiple articular fragments and obtaining an anatomic reduction of the articular surface. There were 3 separate areas of significant impaction with 1 large central impaction zone. After external rotation of the anterolateral fragment, the articular reduction sequence started working from posterior to anterior using a Freer elevator and multiple osteotomes to reduce the impacted pieces of articular cartilage. Then, the reduction sequence proceeded from the lateral to medial direction to obtain what was thought to be an anatomic reduction of the articular surface. The obtained reduction was provisionally stabilized with multiple K-wires. Of note, the central impacted fragments were initially reduced with reference to the presumably unviolated posterolateral articular surface. Lateral fluoroscopic imaging, however, revealed that the reduction resulted in an apical deformity of the articular surface, which is not uncommon. This is routinely due to marginal impaction of the posterior lateral joint surface, also known as the “skid zone” (Fig. 4A). To avoid an apical deformity of the tibial plafond, the K-wires were removed and the impacted anterior aspect of the posterolateral joint surface was disimpacted using curved and straight osteotomes (Figs. 4B–D). After an adequate posterior

**FIGURE 3.** Fluoroscopic images showing drilling (A) for percutaneous intramedullary screw fixation of the associated fibula fracture. A percutaneous screw placed into the lateral malleolus guides fracture reduction. B, Insertion of a 3.5-mm cortical screw across the reduced fracture. C and D, Anteroposterior and lateral fluoroscopic images after fibula stabilization.
reduction was obtained, the joint surface was built off the anatomically reduced posterior articular surface and provisionally stabilized with multiple K-wires (Fig. 5A). The severely comminuted medial gutter and medial malleolus fracture were addressed in the last step, and additional K-wires were used to obtain and maintain a reduction of this area. Cancellous allograft bone chips were then

FIGURE 4. A, Lateral fluoroscopic image exhibiting that the reconstructed joint surface is too steep (underreduced) because of initially missed marginal impaction of the anterior aspect of the posterolateral joint surface (“skid zone”). B and C, Disimpaction of the skid zone using osteotomes. D, Satisfactory joint surface restoration without apical deformity.

FIGURE 5. A, Provisional K-wire fixation with distraction temporarily increased to visualize articular surface. B, First, mini fragment T-plate placed anterolaterally to maintain reduction of the Chaput fragment and the disimpacted central articular fragments. C, Partially threaded 4.0-mm cannulated screw placed across the medial malleolus fracture to obtain compression.
packed into the metaphyseal voids left after reduction of the impacted articular fragments.

Fragment-specific mini fragment fixation was performed using 3 plates and was started from the lateral side toward the medial side. Of note, mini fragment fixation alone is not recommended for C-type injuries; however, in this B-type partial articular fracture, it is appropriate. First, a T-plate (DePuy Synthes, variable angle LCP T-fusion plate 2.4/2.7) was placed on the anterolateral side to secure the anterolateral Chaput fragment and to maintain reduction of the disimpacted central articular fragments (Fig. 5B). A partially threaded 4.0-mm cannulated screw was then placed across the medial malleolus fracture to obtain compression (Fig. 5C). Subsequently, a Smith & Nephew EVOS mini fragment 2.4-mm locking T-plate was applied just medial to the first plate to gain further fixation into multiple articular fragments and to provide an area to prevent subsidence (Figs. 6A, B). An additional 2.4-mm EVOS straight tine plate was finally used as a buttress plate to gain further fixation of the medial malleolus fragment (Figs. 6A, B) and to prevent varus collapse. Two Kirschner wires that entrapped the medial gutter pieces were bent and tamped into the cortical surface as described by Firoozabadi et al. The tourniquet was released, and punctate bleeding was stopped with electrocautery. Radiographs were obtained to verify reduction (Figs. 6A, B). The wound was closed by a periosteal closure to the tibialis anterior fascia and skin sutures in the Allgöwer–Donati fashion.

The external fixator bars were then readjusted and reattached to obtain a neutral foot position. Final radiographs verified that the talus was appropriately centered beneath the anatomic axis of the tibia at the end of the procedure (Figs. 6A, B).

The external fixator was left in place for 4 additional weeks and was then removed in the clinic. The patient was kept non–weight bearing on crutches for 12 weeks after definitive fixation. Follow-up x-rays at 6 weeks and 12 months postoperatively are shown in Figures 7 and 8, respectively. At 12 months, the patient reported no complaints except for an “odd sensation” over the anterior aspect of her ankle during cold weather.

**DISCUSSION**

Despite the wide variety of pilon fracture patterns, the goals and principles of the surgical treatment remain the same: anatomic reconstruction of joint congruity; restoration of distal tibial and fibular alignment; minimization of soft tissue trauma; bone grafting of osseous voids left after reduction and disimpaction; and stable
fixation to maintain reduction and to allow early joint motion. Mini fragment plates provide a versatile system to achieve these goals and may be used as an alternative or adjunct to conventional plates and external fixators. They are low profile, can be contoured, and offer a wide array of options for fragment-specific fixation because of variable angle locking screws and multiple plate configurations. Fragment-specific fixation using mini fragment plates has already been adopted for other articular fractures particularly of the upper extremities and may also help to accommodate the specific needs arising during fixation of individual pilon fracture patterns.

It is important to point out that mini fragment fixation should not be used for all pilon fractures. In cases of complete C-type injuries and cases of metaphyseal comminution, larger plates should be used to avoid plate fatigue and failure. It is also important to note that in most cases, the external fixator should be removed at the time of definitive ORIF to allow for early range of motion. The senior author’s indication for leaving the external fixator on after ORIF is in cases of significant anterior joint comminution and/or impaction. In these selected cases, the tendency is for the talus to displace anteriorly through the zone of comminution and impaction leading to a loss of reduction. Furthermore, if this does occur, then arthrodesis can be more challenging to the sagittal plane relationship/ deformity of the talus and the axis of the tibia. In fact, to correct this deformity during arthrodesis, one can use an external fixator as described by Firoozabadi et al.

Following the aforementioned principles, we decided for a 3-stage procedure to minimize additional iatrogenic soft tissue compromise in the early phase of treatment. A staged procedure with initial ankle-spanning external fixation (with or without fibular fixation) and delayed definitive ORIF after allowing for soft tissue recovery has been reported to reduce the historically high rate of infection and wound complications after early definitive ORIF. Staged ORIF is therefore generally considered advisable for most cases. Nevertheless, early single-stage definitive ORIF may be considered if there is no doubt that soft tissues allow and if an experienced surgeon is available. Furthermore, in this case, the external fixator remained in place to protect the comminuted medial gutter reduction for a period of 4 weeks and was removed in the clinic.

Initial fibula stabilization was performed by percutaneous intramedullary screw fixation to minimize soft tissue trauma and was deemed reasonable because of simple fracture configuration and only minimal displacement. Intramedullary screw fixation similar to fibular nailing requires less extensive soft tissue dissection than plate and screw fixation. Both procedures have been reported to provide reliable fixation and to result in a lower rate of wound complications. In contrast to fibula plating, the minimal incisions required for percutaneous fixation do not interfere with future approaches for delayed definitive ORIF.

CONCLUSIONS

The presented case demonstrates that mini fragment plates may be successfully used for fragment-specific pilon fracture fixation. Mini fragment plates may be a useful alternative or adjunct to conventional plates or external fixation. They are less prominent, more amenable to being contoured, and offer numerous options for fixation of a broad range of fracture patterns because of the variety of plate configurations, distal screw cluster, and variable angle locking screws.

REFERENCES