Mini-Fragment Fixation of Complex Pilon Fractures—A Case Report

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Summary: The purpose of this report is to demonstrate the use of a mini-fragment fixation construct in the treatment of a comminuted distal tibial plafond fracture. Internal fixation of displaced intra-articular distal tibia fractures remains the standard of care. Precontoured locking plates are the most commonly used fixation devices to achieve the goal of stabilizing the reduced articular block to the distal tibia shaft/metaphysis. In certain fracture patterns, some surgeons increasingly rely on mini-fragment fixation alone or in conjunction with precontoured plates in the treatment of pilon fractures. Mini-fragment plating allows for more screw trajectory options and the ability to achieve multiplanar fixation with less bulk than with precontoured plating.

Key Words: distal tibial plafond fractures, pilon fractures, mini-fragment plate

INTRODUCTION

The operative treatment of distal tibial plafond fractures is challenging and in some aspects remains controversial. What is not controversial are the goals of fixation: (1) anatomic reduction with rigid fixation of the articular segment, (2) restoration of the limb axis with reduction in length, alignment, and rotation of the distal tibia, (3) fixation of the metaphyseal block to the shaft, and (4) stable fixation that allows for early range of motion through healing.1

At present, most distal tibia fractures are treated with a staged approach. Early treatment is performed within hours of injury to realign and place a bridging external fixator to allow for soft-tissue recovery. Definitive fixation is delayed until the soft tissue has recovered enough to perform the necessary (at times multiple) surgical approaches.2

Many of the fixation constructs include a precontoured locking plate. These plates generally fit in 1 place per patient and do not always give adequate options for fixation of all fragments, articular and metaphyseal. Therefore, the use of mini-fragment plates as an adjunct has become popular in recent years. These plates allow more customized fixation options for the variety of fractures that are seen in the distal tibia.3,4

In addition, mini-fragment systems have recently evolved, offering multiple shapes and sizes of plates and longer (up to 80 mm) screw lengths. Other advances include having both flexible and rigid plates to enhance reduction and provide customized fixation. These plates are substantially less bulky, which aids in wound closure and theoretically may decrease wound complications. The ability to choose the location of fixation assists in the challenge of treating these injuries.

The author has used mini-fragment only fixation in certain pilon fractures over the past 2–3 years. Initially, only partial articular injuries were treated in this manner, but this has now been expanded to complete articular injuries with similar success. Scientific evaluation of this fixation strategy is ongoing. A single case-report using this technique is presented below.

Patient Information

A 20-year-old male patient presented to the emergency department after a motorcycle collision. He had an isolated right lower extremity injury with no other relevant past medical or surgical history. Radiographs obtained revealed a right distal tibia/fibula...
fracture with obvious articular involvement and metaphyseal displacement (Fig. 1). The distal tibial shaft was protruding medially and posteriorly. The patient had a medial transverse laceration, 10 cm in length at the metaphyseal level. There was an associated severe soft-tissue contusion involving the medial soft-tissue sleeve. No gross neurovascular injuries were noted.

Staged management of this injury was chosen. The first step was aggressive irrigation and debridement of the open fracture site with bridging external fixation placement.

Surgical Technique

After immediate antibiotics, the patient was taken to the operating room within 3 hours of admission to the emergency department.

The author performed a thorough debridement and irrigation of the open fracture site. There was no gross contamination or foreign material noted. One large corticocancellous fragment was removed because no soft-tissue attachment existed. This segment was the junction between the medial articular segment and the distal tibial shaft. After debridement, the wound was closed without undue tension. The surrounding tissue was severely contused and there was concern regarding its status and potential need for flap coverage.

Two tibial pins in the tibia shaft were placed well away from the zone of injury. A third pin in the calcaneus, centrally threaded, was placed to complete a delta frame. Traction via the calcaneal pin and manual manipulation allowed for correction in the coronal, sagittal, and rotational planes. Adequate stability for soft-tissue stabilization was achieved (Fig. 2).

Definitive surgery with internal fixation occurred 13 days after admission. Adequate recovery of most soft-tissue envelope occurred sooner; however, the medial tissue became problematic. A full-thickness eschar developed. It was believed that awaiting full recovery would take too long and surgery was scheduled with plans to avoid disrupting the secondary healing process in this area. The traumatic wound had sealed and no drainage or concerning signs of infection were present.

The patient was positioned supine with an ipsilateral hip bump and ramp cushion. A nonsterile tourniquet was applied. The external fixator was removed, except for the calcaneal pin that was used intraoperatively for traction and to aid in articular visualization.

Radiographs and CT showed a distal tibia fracture with comminuted articular surface (Fig. 3). The posterior plafond was a single major fragment and there was no posterior migration of it on the talus. The medial segment was also 1 large segment, with
Most comminution involving anterolateral and central segments. Free-floating articular fragments were noted on the imaging. An anterolateral approach was chosen, given the fracture characteristics and soft-tissue status. The fracture was exposed and an anterolateral arthrotomy was used for direct joint visualization. Rotation of the anterolateral and central segments exposed 2 free-floating fragments, as well as the posterior and medial segments.

Reduction started posteriorly, then medially, centrally, and finally anterolaterally. The posterior segment was controlled with a k-wire and positioned appropriately onto the talus. Traction via the calcaneal pin was needed to assist with reduction of the posterior segment. This segment was then pinned directly to the talus to give a stable base to work. Of note, this step is not always performed, but was performed in this situation because the preferred secondary posteromedial exposure of the metaphyseal cortical reads was not feasible.

Next, the medial articular segment was reduced via direct visualization through the window of the displaced anterolateral fragment supplemented with fluoroscopy. This segment was then affixed to the posterior segment via percutaneous k-wires (Fig. 4).

Now, the comminuted portion of the articular surface was addressed. Two articular segments were reduced on the back table and a 1.5-mm headless compression screw (DePuy Synthes, West Chester, PA) was placed to affix them. The remainder of the articular reduction was then completed and temporarily stabilized with more k-wires. Generally, 2 k-wires were placed per fragment to allow for removal of one if needed during definitive fixation. Satisfied with the articular reduction, restoration of the metaphyseal region and mechanical axis was tackled next.

There were not many good cortical reads to work from. The anterior metaphyseal block was the most promising. Lateral comminution and medial missing architecture left those regions less helpful. Bone quality, however, was very good. Reduction of the metaphyseal block was obtained using traction and manual manipulation and held tenuously with a k-wire and retractor.

Fixation was started with a direct anterior plate. The goal was to provide rigid fixation across the articular block and attach it to the distal tibia. A 2.7-mm mini-fragment Y-plate was chosen (EVOS, Smith and Nephew, Memphis, TN). Independent contouring of both Y-segments was performed, as well as a midplate contour.

Holding the metaphyseal reduction, the plate was positioned and screws inserted to hold the reduction. This plate, although designed to be flexible, was adequate to hold the reduction and contoured well to house the anterior metaphyseal comminuted segments. Four compression screws across the articular block were placed along with 2 screws (all non-locking) proximal to the fracture site.

At this point, fixation was near complete. There was a sizable gap in the medial metaphysis created by the previously removed segment during the first surgery. Fixation across this gap was desirable to assist in preventing collapse. Plating, as discussed, was not feasible, so screw fixation was chosen. A small stab wound was created near the tip of the medial malleolus, and a 2.0-mm drill bit was used to start a path with hopes of a bicortical screw. This drill bit flexed past other hardware and was unable to perforate the far cortex, instead flexing and bending up against it. Multiple attempts were made without success. Therefore, an 80-mm fully-threaded cancellous screw was placed in this path to aid fixation and assist in preventing medial metaphyseal collapse. This completed the distal tibia fixation.

The fibula fracture was proximal to the tibia fracture and comminuted. The anterior syndesmosis was visualized to be intact and it was radiographically stable to stress examination. Percutaneous fixation via a long cortical screw was chosen. Through a small stab wound near the tip of the lateral malleolus, a 2.5-mm drill bit was placed, starting just medial to the radiographic tip and just posterior to sagittal midline of the distal fibula. Drill was oscillated up to the fracture site. At this point, the talo-fibular joint was visualized with...
mild extension of the arthrotomy. The fibula was reduced to the talus under direct visualization and a k-wire placed from fibula into the talus. Minimal manual manipulation proximally was needed to assist in guiding the drill bit across and into the proximal segment. The distal fibula was opened minimally with a 3.5-mm drill to aid in screw insertion. A 150-mm pelvic cortical screw was placed across the fracture site holding it in adequate reduction. This completed the fixation (Fig. 4).

Closure proceeded uneventfully without significant tension on the wound edges. Once wounds were closed, the calcaneal pin was removed. A bulky splint was applied.

Postoperatively, the patient was told to remain non-weight-bearing for 12 weeks. Range of motion started at 2-week follow-up when the wound was stable and sutures were removed. By 12 weeks, the medial soft tissue had healed fully and radiographs showed enough healing to allow progressive weight-bearing (Fig. 5). At final follow-up, the patient reported no pain with normal daily activities including most exercise but an inability to run “long-distance” as previously. Final radiographs show adequate healing in combination with the clinical imaging. Mild traumatic arthrosis is visible (Fig. 6).

**DISCUSSION**

The ability to customize fixation options for fractures is desirable. This case illustrates the ability to use mini-fragment fixation for a complete articular distal tibial plafond injury. Recent improvements and innovation in mini-fragment options make this technique possible and advantageous in many regards.

The concern for plate fatigue during the healing process is valid but we believe that the new rigid “strength” plates have the ability to withstand stress for an adequate amount of time to allow most fractures to heal. Furthermore, plate fixation in multiple planes also contributes to the strength of the construct. Bone quality must be evaluated and patient selection is key. There is likely less ability for these plates to withstand early and unadvised weight-bearing, which is common among orthopaedic trauma patients.

The advantages include the ability to customize fixation in choosing where plates sit, as well as an improved ability to use the different types of plates to statically fix, compress, and buttress. Multiple plates can be used to individually stabilize fragments in multiple planes. The plates are smaller both in width and thickness, which also assist in wound closure. This has allowed for an increased use of medial plates when thicker plates might not be reliably covered by soft tissue.

The case presents the successful use of mini-fragment plates in the treatment of a complex distal tibia plafond fracture. This is an alternative technique in the treatment of these injuries and in no way replaces the use of the thicker precontoured distal tibia plates. As always, careful preoperative planning and patient characteristics is vital in choosing the most appropriate fixation constructs.

**REFERENCES**

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