Distal Tibia Pilon Fracture Operatively Treated With Variable Angle Locking Small Fragment Fixation: A Case Report

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Summary: Intraarticular distal tibia (pilon) fractures occur with limited frequency, but can present substantial morbidity to patients and clinical challenges to the treating orthopaedic surgeon. With the advent of modern surgical techniques and implants, open reduction and internal fixation is now the standard of care. Staged protocols were developed to allow soft tissue swelling to improve before definitive internal fixation, reducing complications. Below, we present a case of an OTA/AO 43C pilon injury treated with a staged protocol. Fixation included low profile small fragment distal tibial and fibular plates with variable angle locking screws, accommodating trajectories to fix the key articular fragments. This construct limited the dissection necessary to achieve the goals of anatomical joint reconstruction and rigid fixation, allowing for early motion.

Key Words: distal tibia, pilon, small fragment, variable angle, locking

INTRODUCTION
Intraarticular distal tibia fractures (pilon fractures) constitute approximately 1% of all lower extremity fractures. They present with a wide range of severity that correlates with the mechanism of injury, level of energy, and quality of bone.1,2 Evaluation of these injuries includes a complete neurovascular examination of the injured extremity in addition to ruling out associated injuries of the ipsilateral extremity, pelvis, and spine. Radiographs and typically computed tomography (CT) provide fracture visualization and allow for preoperative templating. Treatment of these injuries remains a challenge even to the experienced orthopaedic trauma surgeon. If severe medical comorbidities preclude safe general anesthesia, nonoperative treatment can be chosen. However, the functional results after nonoperative management are poor and its use is limited to the most infirm patients.3 In the 1960s and 1970s, surgical techniques advanced and better implants were developed, thus operative treatment gained popularity as outcomes improved.3,4 However, even at high volume centers with experienced orthopaedic surgeons, open reduction and internal fixation (ORIF) has high risks of complications, infection, malunion, non-union, and posttraumatic arthritis.1,5–7 Operative timing, surgical approach, and fixation construct depend on host comorbidities, fracture pattern, and soft tissue status.5 A commonly practiced algorithm follows a staged protocol with initial external fixation, followed by a period of soft tissue rest to reduce swelling, CT scanning, and later definitive fixation. Numerous studies report improved outcomes with a staged protocol, resulting in more predictable wound healing and fewer infections.8,9 More recently, multiple studies report good outcomes in selected pilon fractures fixed acutely by experienced surgeons at high volume trauma centers.10,11

CASE REPORT
A 20-year-old woman fell with a twisting injury to the right ankle, resulting in immediate pain and mild deformity. She presented to the emergency department with a closed right
intraarticular distal tibia pilon fracture with an associated fibular fracture. Her right lower extremity showed no gross neurovascular deficits and no evidence of compartment syndrome. She was placed into a short leg splint with cotton padding. Given the amount of soft tissue swelling, but limited amount of deformity without shortening, the patient’s leg was elevated in the splint. Nine days later, definitive ORIF was performed, as there was resolution of the edema and a positive wrinkle sign.

The patient was brought to the operating room and placed supine with a bump under the ipsilateral hip, a nonsterile tourniquet, and bone foam. General endotracheal anesthesia was obtained to facilitate full muscle paralysis. After prepping, direct medial and posterolateral approaches were made to the ankle with care to avoid damage to neurovascular structures. These approaches were selected based on preoperative CT scan imaging that showed the key fragments that necessitated direct visualization, and the availability of variable angle locking small fragment implants that would allow for fixation of these key fragments (Figs. 1 and 2). The metadiaphyseal dissociation necessitated long fixation to span well above the injury in the diaphysis.

The distal fibula was reduced anatomically with small standard and pointed reduction clamps to help restore length and alignment of the metaphysis. An interfragmentary positional screw and neutralization plate were applied. The distal tibial articular block and metaphysis were then reduced with a combination of small and large Weber clamps and provisionally held with Kirschner wires. A precontoured small fragment distal tibial plate was secured to the distal segment with multiple nonlocking and variable angle locking screws into the key articular fragments. The plate was then secured to the shaft with multiple nonlocking screws. The alignment of the limb, the reduction of the joint, and the position of the implants were verified with direct visualization and fluoroscopy (Figs. 3 and 4). The incisions were irrigated, closed in layers with 0-vicryl deep, 2-0 vicryl subcutaneous, and 3-0 nylon mattress sutures. A sterile dressing was applied along with a bulky Jones–padded plaster splint.

She was instructed to remain non–weight-bearing on the right lower extremity for 12 weeks. After 3 weeks, her wound healed uneventfully. Her splint and sutures were removed, and she began range of motion exercises in a removable fracture brace. She advanced to weight-bearing as tolerated after follow-up radiographs confirmed fracture union at 12 weeks. At 6 months, she had returned to all activities without any limitations and with no pain (Fig. 5).
DISCUSSION

Although pilon fractures represent a small proportion of lower extremity injuries, they present major challenges to both the patient and treating orthopaedic surgeon. Patients can experience persistent pain, posttraumatic arthritis, infection, amputation, and even 43% may never return to work. These injuries significantly reduce the quality of life, physical, and mental health scores of patients. At 6 months, 1 and 2 years after injury and surgery, most patients fail to reach their preinjury pain and quality of life as measured by pain Visual Analog Score and EQ-5d, respectively.

Outcome studies show patient factors and fracture patterns correlate with functional and radiographic results. A recent article reported on 102 complete articular type C pilon fractures. They found that 28% were unsatisfied. This article also cited a high rate of infections occurring in 17.6%, correlating with comorbidities and open fractures. Another series of 46 patients found fracture severity correlated closely at 5 years postinjury with worse Short Form-36 scores. They reported SF-36 averages of 65.3 and 41.9 for B- and C-type fractures, respectively, compared with 90.3 national standard for those of age-matched healthy controls. Another report of 76 B- and C-type fractures found that type C3 fractures also exhibited higher complications and greatest impairment up to 8 years later. Older patients tend to develop more posttraumatic arthritis and recovery to a lower functional status. Patients older than 55 years scored worse (higher) on a Musculoskeletal Function Assessment of 33.5, compared with 24.1 in patients younger than 55 years. Comorbidities, especially diabetes mellitus, dramatically increase the rate of complications for operatively treated pilon fractures. In a retrospective cohort of diabetics compared with non-diabetics, infection occurred in 71% versus 35% ($P = 0.011$), 43% deep versus 9% ($P < 0.001$). Nonunion occurred more frequently in diabetics, 43% versus 16% ($P = 0.015$). One publication tested the theory that obesity may provide a better soft tissue envelope for healing around the ankle. In 31 obese pilon fractures, 4 experienced major wound-healing complications (13%), compared with 4/86 in the nonobese group (5%).

Although patient and injury characteristics affect outcome, a surgeon can improve and enhance outcome with a carefully planned and executed procedure. Early treatment techniques varied widely, with simple immobilization the treatment of choice centuries and even decades ago. With technical and implant advances, the current standard of care is operative fixation in some form. The pioneers of internal fixation recommended applying a medial tibial plate. However, the medial tibia is subcutaneous, and plating with traditional thicker implants has shown high rates of skin necrosis. Modern accepted techniques focus on patient and fracture-specific constructs, using a variety of approaches and plate positions. Staged external fixation, followed by delayed anatomical ORIF can minimize complications. One series describe staged ORIF of the posterior fracture fragments first, followed by later supine anterior approach to complete the construct. Others describe combining simultaneous limited internal with external fixation as definitive treatment.

In addition to judicious soft tissue management and operative timing, a critical evaluation of the fracture pattern to plan an anatomical articular surface, restoration of length, alignment, and
rotation will give the best results. Multiple series report statistically better functional and radiographic outcomes with better articular reductions. The surgical approach selected confers direct visualization of the fracture fragments, and windows to facilitate reduction and fixation. Once the surgeon obtains an anatomical reduction, rigid fixation facilitates healing with maintenance of reduction while allowing for early motion. Internal fixation implants are typically mini or small fragment plates and screws. Newer implants that are low profile and offer the advantage of variable angle locked screws facilitate plate positioning to minimize soft tissue irritation and screw positioning to secure key articular fragments rigidly. Single or even double plate small fragment osteosynthesis is a commonly practiced technique and reported in the literature. Kirschner wires and bioabsorbable nails/pins can supplement larger internal or external fixation constructs.

In the aforementioned case report, the surgeon selected low profile precontoured small fragment plates with variable angle locked screws. This construct allowed for limited soft tissue dissection and minimal irritation, while offering rigid fixation of the anatomically reduced fragments. The distal articular fragment was provisionally reduced with clamps and K-wires, and then stabilized using variable angle locking screws to maintain alignment. Polyaxial locking screws have been tested and shown to hold fragments comparably to fixed angle screws in biomechanical studies.

CONCLUSION

Pilon fractures present substantial clinical challenges for both the patient and surgeon. The surgeon-controlled treatment options fortunately allow, in part, for improving short- and long-term patient subjective and objective outcomes. Once the soft tissues allow for an open approach, the keys to a successful result include anatomical reduction of the articular surface, restoration of the metadiaphyseal alignment, and rigid fixation to allow for early motion. Low profile, precontoured small fragment implants with variable angle locked screws can facilitate these treatment goals.

REFERENCES


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