Percutaneous Contoured Locking Plate Fixation of the Pilon Fracture: Surgical Technique

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Key Words: ankle fracture, distal tibial fracture, locking plate, percutaneous, Pilon fracture

Preservation of the soft tissue is of particular importance in the care of pilon fractures. Improper soft tissue management has been attributed to high rates of nonunion, nerve injury, and failures (1–12). Traditional open reduction internal fixation (ORIF) of pilon fractures allows for direct visualization of the fracture(s) but is criticized for the large exposure and periosteal stripping. As a result, this approach has been blamed for high nonunion rates as well as failure of the soft tissue to accommodate implants (1, 5, 8, 13). External fixation has also been used but has not demonstrated much advantage to internal fixation and requires significant postoperative care. Also, external fixation has a higher incidence of malunion (6, 14) and has inherent risks for pin-tract infections (14, 15). In an attempt to limit the iatrogenic soft tissue injury (5, 6, 7), some surgeons have used a limited ORIF concentrating on restoration of the articular surface combined with ring or hybrid external fixation. The "2-stage" technique combines the benefits of both external and internal fixation, and is thought to limit soft tissue related complications by allowing soft tissue recovery time before the introduction of internal fixation.

Initial temporary external fixation combined with limited exposures for internal fixation (2-stage technique) at a later date allows for less disruption of the soft tissue envelope, leading to a decrease in complications associated with traditional open approaches. This may be achieved through relatively "small incisions" extending from the pole of the malleolus to the metaphyseal fracture(s), although these incisions can still be quite long, especially when significant articular reconstruction and/or bone grafting is required. Other descriptions include "limited approach" or "minimally invasive"; and this differs from a true percutaneous approach.

With the advent of locking plate technology, surgeons have successfully managed a variety of fractures though smaller incisions to introduce the plate(s)—the percutaneous approach. Unlike traditional plating methods, locking plates do not rely on frictional forces between the plate/bone interface to achieve compression and stability. This allows for less damage to the periosteal blood supply, which may theoretically decrease the incidence of delayed or nonunion, soft tissue complications, and possibly secondary loss of fixation (16, 17). A recent study by Salton et al (18) demonstrated no major complications and only 4 minor soft tissue complications in a series of 19 patients treated with a limited incision and percutaneous medial plate fixation. More recently available contoured locking plates with multiple options for metaphyseal screw placement through the "percutaneous" incision allow for the surgeon to achieve stability through this access point. With percutaneous locking plates, the incision may be even smaller than used with the traditional 2-stage technique.

Technique

Initial operative management may involve a single-stage approach (Figure 1) or the 2-stage approach, depending of fracture pattern and degree of edema (Figures 2 to 4). The percutaneous locking plate approach is probably best suited for closed noncomminuted metadiaphyseal pilon fractures with minimal articular surface involvement and when bone grafting of the metaphysis is not necessary (Figure 1, A, Figure 2, and Figure 5). Injury computed tomography (CT) is often obtained to determine the extent of articular damage and intra-articular fractures (Figure 1, B, and 2, B, Figure 6). If a 2-stage approach is used, a medially based external fixator is preferred (allows lateral access to a concomitant fibular fracture, if

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Financial Disclosure: None reported.

Conflict of Interest: None reported.

1067-2516/08/4706-0020$34.00/0

doi:10.1053/j.jfas.2008.06.009

FIGURE 1 A 24-year-old male with isolated left pilon fracture, treated in a single stage. (*A*) Injury x-rays demonstrate single articular fracture traversing the metaphysis. (*B*) Injury CT further reveals obliquely oriented fracture line, almost parallel with the anteromedial tibial surface, making this fracture pattern amenable to medial plate fixation. Fracture involves approximately 50% of the tibial plafond with some minor comminution of the distal lateral tibia. (*C*) Fluoroscopic series demonstrating locking plate application. After the plate is positioned, a nonlocking screw proximal to the fracture is placed to buttress the plate against the distally based fracture to reduce the fracture. It is important to fluoroscopically evaluate the reduction in multiple planes before introducing fixation distally into the plate. Anatomic reduction is achieved.

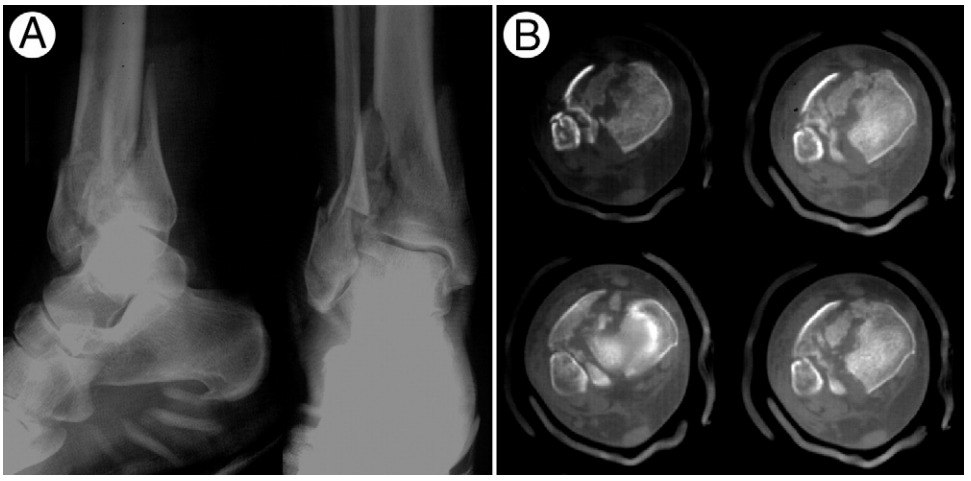

FIGURE 2 A 56-year-old female with comminuted pilon and fibula fracture, treated with the 2-stage approach. (*A*) Injury radiographs. A large butterfly fragment of the tibial plafond is present. (*B*) Injury CT. The plafond is comminuted with the major fracture line in the coronal plane. Note comminution of lateral plafond.

present) to stabilize the fractures as well as maintain length (Figure 3, A, and Figure 5, B). In some cases, the articular plafond may be percutaneously fixated and reduced with a percutaneous screw across the major fracture line, although definitive internal fixation should await soft tissue recovery (Figure 3, B). CT of the initial reduction allows the surgeon to assess the quality of the articular reduction before the second stage of percutaneously plating (Figure 3, C, and Figure 6).

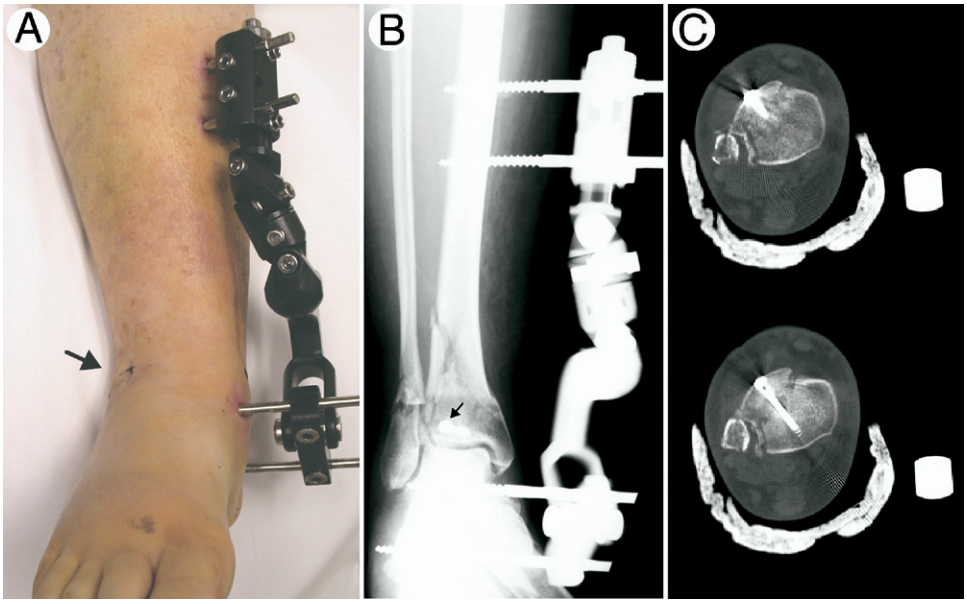

FIGURE 3 Same patient as Figure 2, demonstrating temporary stabilization with an external fixator. (*A*) Clinical photograph demonstrating temporary medial external fixator. (*B*) Radiographs with external fixation in place. The medial monorail used in this case was not ideal because half pin in the talar neck is located very close to the ankle joint capsule, and is at risk for development of a septic joint should this pin become infected. A delta configuration medial external fixator is a more appropriate choice. In this case, a periarticular percutaneous screw was placed anteriolaterally (*arrow*), though not necessary to be placed during the temporary external fixations setting. Ideally, definitive fixation is placed once the soft tissues have recovered and the external fixator is removed. (*C*) CT after external fixation allows for evaluation of the temporary reduction.

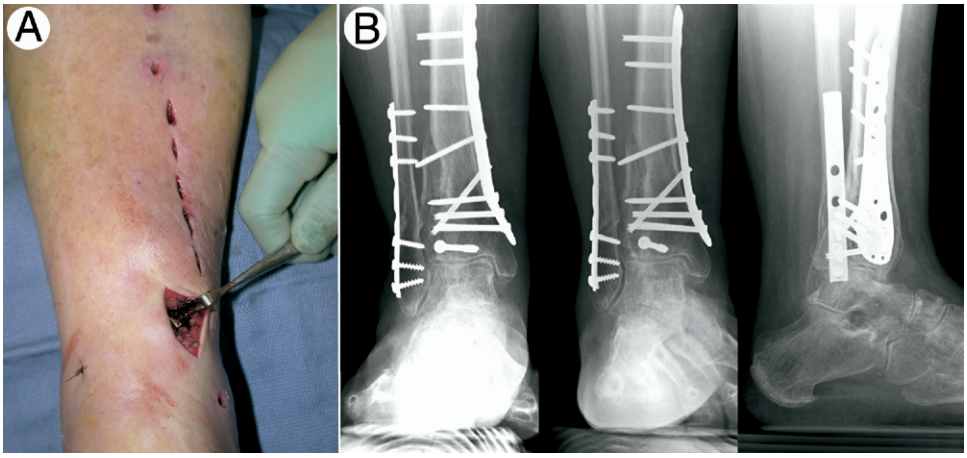

FIGURE 4 Same patient as Figures 2 and 3. (*A*) Intraoperative photograph after the external fixator is removed and ready for percutaneous locking plate fixation. Percutaneous incision for medial locking plate to is medial to the tibialis anterior tendon. The plate is inserted through this incision supraperiosteally along distal medial border of the tibia. Stab incisions are created for placement of proximal (locking or nonlocking) screws. (*B*) Weight-bearing radiographs approximately 12 months from injury. The articular component is completely consolidated in good alignment.

Plate fixation of the pilon component should be performed when soft tissue edema is decreased. The fibular fracture is fixated with standard plating techniques and not the focus of this techniques manuscript. The pilon component is percutaneously fixated with a contoured locking plate. The medial tibial plate is introduced through an approximately 3.5-cm anteromedial incision, or longer depending on surgeon skill level or comfort (Figure 4, A). The plate is then directed supraperiosteally across the metaphyseal fracture. Proximally the plate is fixated first with a single nonlocking screw (via a stab incision) to use the plate as a buttress to translate the distal periarticular fracture segment laterally into anatomic position, in line with the tibial shaft (Figure 1, C).

FIGURE 5 Open pilon and fibula fracture, treated with the 2-stage approach. (*A*) Injury radiographs. Displaced fracture, with corresponding skin laceration at medial aspect of metadiaphyseal spike. (*B*) Status post wash-out and delta frame external fixation. Acceptable alignment is achieved until definitive fixation is placed.

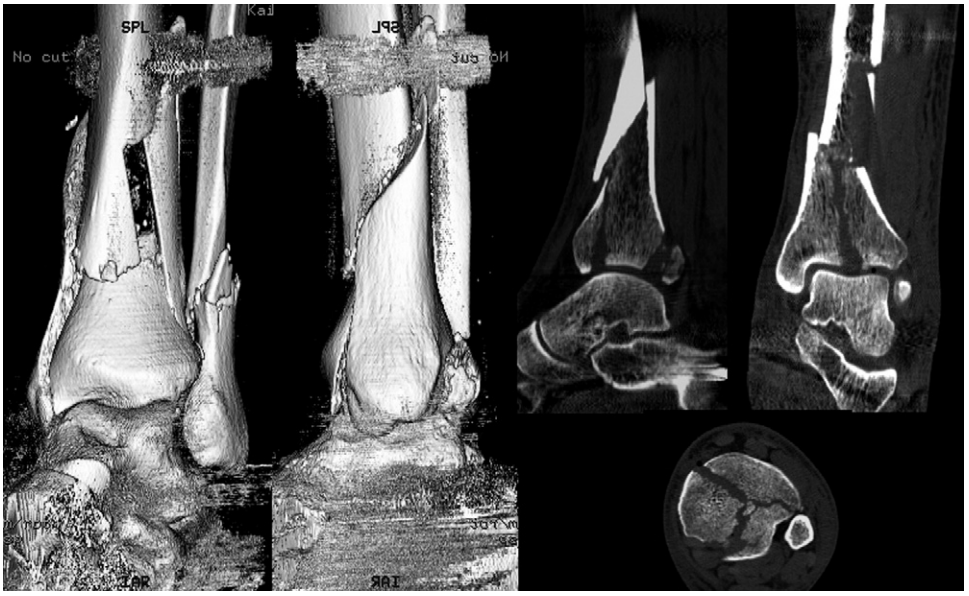

FIGURE 6 Same patient as Figure 5. CT (with 3D reconstruction) following temporary external fixation allows for planning of hardware placement. Tibial plafond has 3 major fragments.

Many countered locking distal tibial plates have multiple parallel options for screw placement at the distal end of the plate. Periarticular screws are then placed though the existing anteromedial percutaneous incision and stab incisions are created for percutaneous placement of diaphyseal locking screws.

Postoperative care includes keeping the patient non–weight bearing for 8 weeks or longer depending on the clinical situation. A removable cam walker may be placed to allow for early range of motion, all depending on the on the degree of comminution and stability of the construct. Figure 4, B, and Figure 7 demonstrate a healed pilon fracture treated with a medially contoured percutaneous locking plate. The ability to initiate weight bearing is determined by radiographic evidence of healing and should not be dictated by the method of reduction—percutaneous or open.

Summary

Using a "true" percutaneous approach combined with newer generation locking plates for the treatment of certain pilon fractures may decrease complications associated with disruption of the soft tissue envelope and associated osseous complications and allow for quicker return to function. This technique may prove to be advantageous when compared to more traditional open methods. The percutaneous locking plate approach is probably best suited for closed noncomminuted metadiaphyseal pilon fractures with minimal articular surface involvement and when bone grafting of the metaphysis is not necessary. This approach is not ideal for every pilon fracture and surgeons should have the significant experience with pilon fracture management before attempting this approach.

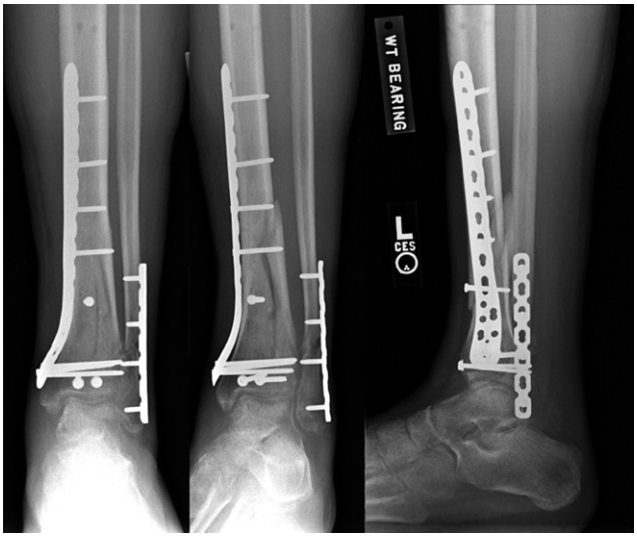

FIGURE 7 Same patient as Figures 5 and 6. Weight-bearing radiographs reveal anatomic alignment with percutaneously placed medial plate. Note that percutaneously periarticular screws were used to reduce the articular component. The plate is placed after the plafond is anatomically reduced. The fibula was concomitantly repaired with standard techniques.

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