A Review Paper

Plating of Tibial Pilon Fractures

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Abstract

Successful treatment of pilon fractures requires a thorough understanding of the injury, proper timing of treatment, and use of the proper implant placed in the correct location. This article describes the factors involved in treatment decisions.

Treatment of fractures of the distal end of the tibia can be very challenging for orthopedic surgeons. These fractures make up 1% to 10% of all lower extremity fractures. As the energy of injuries increases, so does the number of these complex fractures. Avoiding the numerous soft-tissue complications that may be encountered during treatment is critical to a good result. Wound problems, osteomyelitis, malunion, nonunion, pin-tract infections, and hardware failure are typical obstacles that must be avoided to obtain a satisfactory outcome. Treatment goals include anatomical reconstruction of the joint surface and maintenance of mechanical alignment. Proper length and rotation are critical, as are preserving and maximizing ankle and subtalar motion. Even when these goals are met, there is no guarantee that patients will have an acceptable result.

Surgeons face several complex treatment decisions, including these. What kind of incision should be made, medial or lateral? Which implant will maintain the reduction the best? Should an external fixator be used? Should it be placed temporarily or used for definitive treatment? Should treatment be staged or done all at once?

Radiographic Evaluation

Plain films are mandatory in evaluating the distal tibia fracture. It is essential to have plain films centered on the ankle as well as films of the entire tibia. Ankle films are used to delineate articular incongruity and fragmentation. Lateral plain films should be used to look for any joint impaction and to further delineate articular involvement. Tibial films are necessary to fully evaluate the metaphyseal and diaphyseal extent. These plain films must be obtained to look for any proximal injuries that may easily be overlooked.

Computed tomography (CT) should be used as an adjunct to plain films. CT scans act as a guide to the articular injury for fracture orientation, fragment location, and amount of comminution or impaction. They aid in surgical decision making and help to determine which part of the reduction and fixation can be done by a closed percutaneous method and which part will require a more formal approach. They also aid in planning surgical approaches and in determining which incisions are best. This information is often not readily available on most plain films. Tornetta and Gorup[1] noted a 64% change in the operative plan when the additional information obtained from CT scans was used. They recommended routine use of CT scanning for all pilon fractures to help the surgeon understand the fracture pattern and to serve as a guide for operative intervention. Having a full understanding of these studies makes successful fixation of the tibia possible. Timing of the CT scan is typically done after leg alignment and length have been restored, usually after placement of an external fixator.

Surgical Timing

In addition to the skeletal injury, the associated soft tissues are typically injured as well. Proper timing of treatment is required to minimize the chance of soft-tissue complications. Interventions must respect the underlying tissue and the amount of surgery that the soft-tissue envelope can tolerate. Staged procedures are therefore often required to reduce complications and maximize functional results. Usually in a staged protocol, immediate or early intervention (within 12-18 hours of injury) is limited to stabilization of the fibula with a plate, using transarticular external fixation to keep the extremity out to length and to obtain a preliminary reduction by ligamentotaxis. Placement of the external fixator creates a more optimal environment for soft-tissue healing. Definitive reconstruction can be performed at a later date.

Definitive reconstruction through open approaches should be delayed until soft-tissue swelling has decreased, as the tissues are tenuous and cannot withstand surgical trauma. Surgery should be delayed for at least 10 days to allow wrinkles to return, blisters to re-epithelialize, and wounds to heal. Not until after 10 days do the soft tissues enter the reparative phase, at which point they can tolerate surgical intervention. Wagner and Jakob[2] showed that in tibial plateau fractures, the rate of soft-tissue problems was highest when surgery was performed within 7 days of injury. Wyrsch and colleagues[3] showed incidence of infection, 28%; wound problems, 33%; and amputation, 16%, when open stabilization was performed on the distal tibia within 3 to 5 days of initial injury. Other authors have also shown significant complications when operating on high-energy injuries.[4-6] Clearly, operating during this

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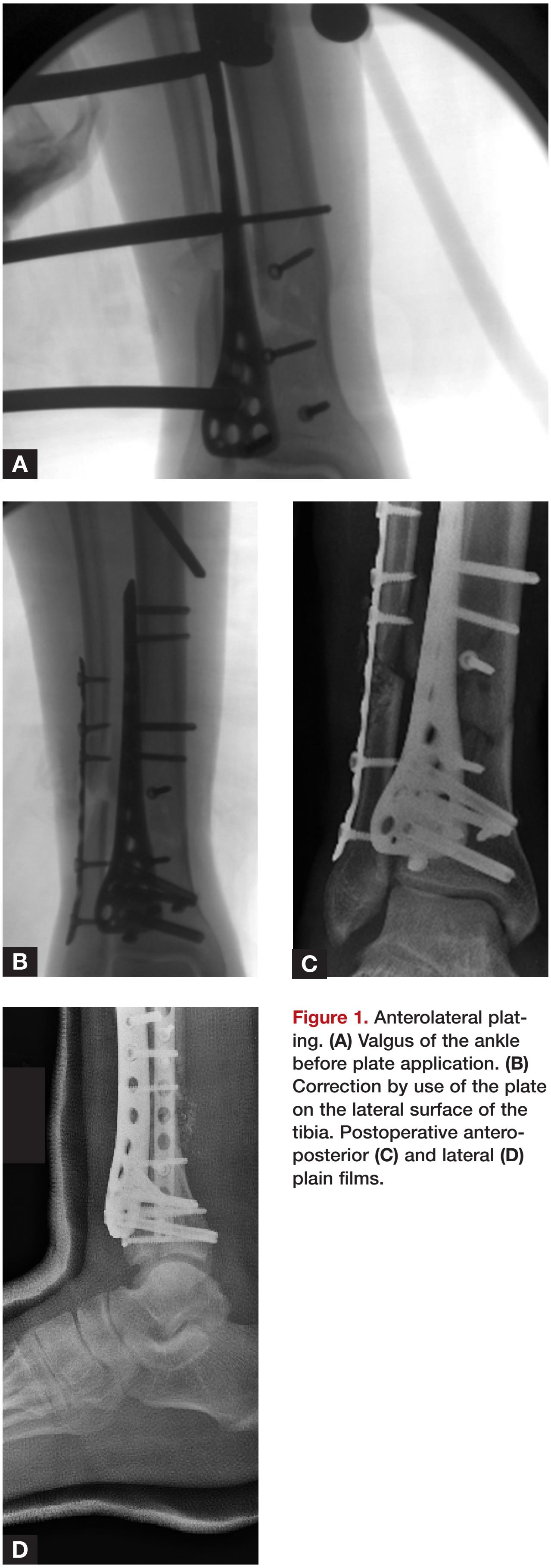

Figure 1. Anterolateral plating. **(A)** Valgus of the ankle before plate application. **(B)** Correction by use of the plate on the lateral surface of the tibia. Postoperative anteroposterior **(C)** and lateral **(D)** plain films.

period is unwise. When open reduction is contemplated, in some cases delaying the procedure for up to 4 weeks may be required to allow soft-tissue swelling to subside. Staged protocols have been shown to be effective in preventing complications related to soft tissue.[7-11]

Decision Making

In decisions regarding which plating technique to use for fractures of the distal tibia, several components must be understood for successful treatment. We must take into account the different fracture patterns that commonly are seen in these high-energy pilon fractures. These patterns include fracture patterns of the fibula as well as the distal tibia. We must also understand the common articular fragments and their relationships to the rest of the joint.

Three articular parts are typically found with pilon fractures—the posterolateral fragment or Volkmann fragment, the medial malleolus fragment, and the anterolateral or Chaput fragment. In addition, there are 3 typical areas of comminution or impaction.

Lateral comminution occurs between the anterolateral and posterolateral fragment, usually near the fibula. There is central involvement—either free fragments or an impacted part of the posterolateral fragment. The medial shoulder is a third common area, for part of the medial fragment or for impaction next to the medial malleolus or as separate pieces. By understanding the possible articular fracture patterns, knowing what to look for, and carefully reviewing the CT scan, a surgeon can now thoroughly understand the articular injury. Once it is understood, he or she can begin to develop a reduction of these fragments, as well as a surgical strategy.

Fixations of tibial plafond fractures most commonly use either a medial buttress or an anterolateral buttress. Deciding which fixation is biomechanically optimal is accomplished through careful analysis of the injury films and the characteristics of the fibula fracture. The fibula fracture will be a tension failure or a compression failure, or it will be intact. Each of these fibula fractures can usually be associated with a corresponding fracture pattern of the tibia.

Compression fractures of the fibula are associated with a valgus injury force. Typically, they are comminuted and more extensive. The tibia has a corresponding pattern of associated valgus. A laterally based implant is needed to resist this valgus pattern that the ankle has assumed and to prevent later displacement (Figure 1). There is typically some lateral tibial comminution, which makes stable fixation without lateral plate fixation difficult. Primary medial plating of this fracture will not resist the valgus force very well and is predisposed to failure and redisplacement (Figure 2). If a medial malleolus fracture has also occurred, small medial fixation may be required.

Tension failures of the fibula are typically associated with a varus injury force. The result is usually transverse and simple fracture patterns. The tibia typically is in varus as well. This fracture is best suited for a medially based implant, which will create a medial buttress and support the

Figure 2. Plain film shows implant poorly positioned to resist the valgus forces in a fracture. Courtesy of Sean Nork, MD.

Figure 3. **(A)** Medial buttress plate in fracture with tension failure of the fibula. An extra anterolateral plate is needed to buttress the anterolateral fragment **(B)** Postoperative lateral view.

tibia. Typically, there is medial comminution of the tibia, making stable fixation without a medial support almost impossible (Figure 3). With lateral involvement or impaction, smaller lateral fixation may be required.

When the fibula is intact, the tibia articular surface may experience 2 different injury patterns. Care must be taken during examination to look for the more complex, significantly impacted articular injury. In the axially impacted fracture, it may be very difficult to get stable fixation, as the articular surface may have almost no bony contact with the remaining tibia after fracture reduction secondary to metaphyseal impaction.

Surgical Approaches

After the fracture pattern has been fully delineated and the articular injury understood, the surgical approach can be determined. The plate is to be placed in the best biomechanical position to resist the forces originally seen at time of injury: Simple fibula fractures with varus position of the ankle require medial buttress plating; more comminuted fibula fractures and valgus ankle position require a more lateral plate. This strategy helps in identifying proper plate position and preventing late displacement; the result is that healing occurs in the anatomically aligned position obtained during surgery. Once the proper plate location has been determined, the correct surgical approach can be chosen. The 2 most commonly used approaches are anteromedial and anterolateral.

Medial plating is best accomplished through the anteromedial approach. The skin incision begins on the lateral side of the tibial crest. The incision is carried distally across the ankle joint, staying medial to the tendon of tibialis anterior. The extensor retinaculum is incised. The tendon and paratenon should be avoided. In the distal extent of the wound, the plane between the tibialis anterior and posterior is exploited. The incision is carried down to the periosteum, and full-thickness flaps are raised. Periosteal stripping and anterior compartment elevation are performed only where needed. This approach allows direct visualization of the anterior portion of the joint and can be carried laterally when more extensive visualization or fixation is needed.[9] Any medial malleolar involvement is easily addressed, and a medial plate is used to resist any varus. If the Chaput fragment needs reduction or there is significant lateral joint involvement, a small anterolateral approach can be used for reduction and fixation.

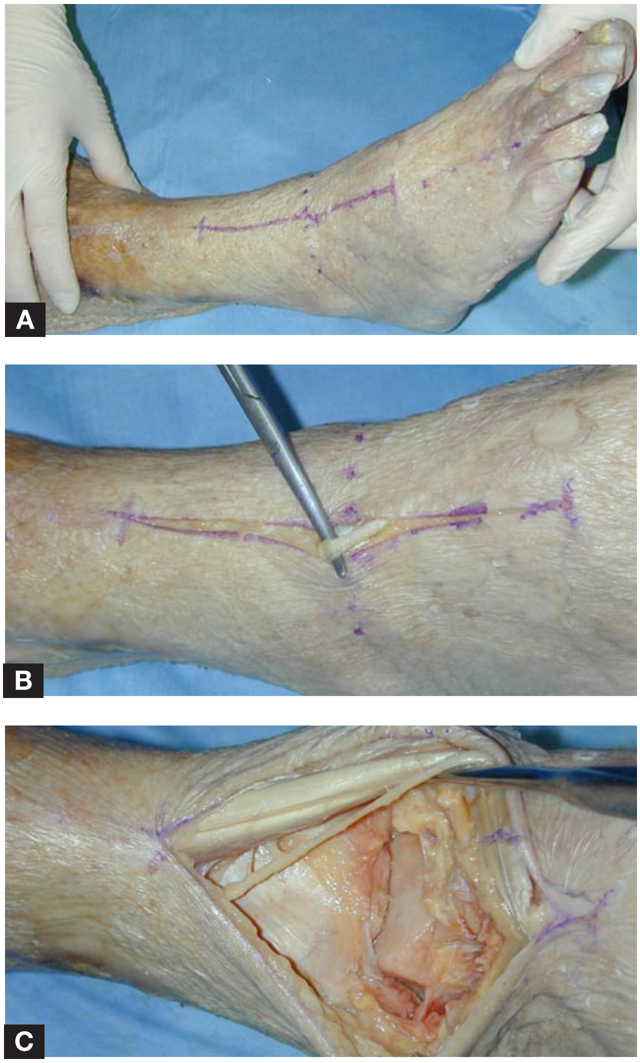

Figure 4. Anterolateral approach. (A) Skin incision drawn in line with the fourth metatarsal and proximal extension directly between the anterior and lateral compartments. (B) Position of the superficial peroneal nerve. (C) Joint exposure after transverse arthrotomy. Courtesy of Frank Liporace.

Anterolateral plates are placed through an anterior approach using the interval between the anterior and lateral compartments (Figure 4A). The superior extensor retinaculum is incised, and the superficial peroneal nerve is protected (Figure 4B). Carrying the dissection between the fibula and extensor digitorum longus then exposes the tibia. Joint exposure is facilitated by a transverse arthrotomy (Figure 4C), and care should be taken to try to preserve the anterior talofibular ligaments. This approach has the advantage of excellent soft-tissue coverage. As the dissection is carried more proximally, the anterior neurovascular bundle becomes vulnerable. For nerve protection, screws in the distal third of the tibia should not be placed percutaneously. In addition, the plane of dissection and plate placement should change from lateral to the anterior compartment to medial to the anterior compartment when going more proximal. This places the plate underneath the neurovascular bundle. Then, a plate of any length can be safely inserted and the lateral aspect of the tibia buttressed. Any medial involvement, such as a medial malleolus fracture, can be addressed with a small anteromedial incision.

Figure 5. Spanning external fixation.

Other approaches that might need to be performed include the straight anterior, posteromedial, or posterolateral. Posteromedial and posterolateral approaches are seldom used but may be of value with certain fracture patterns that require more direct exposure of these areas. The straight anterior approach is seldom needed but may be used when there is both extensive anteromedial and anterolateral involvement. It allows direct exposure of the entire joint but puts the neurovascular bundle at jeopardy, as it is directly visualized. Careful dissection and identification of this structure are paramount to prevent injury.

Locked or Nonlocked Implants

The role of locked implants is unclear. Most fractures have the fibula plated, and, once the tibia is plated, both medial and lateral columns become stable, making locked plating unnecessary in most cases. Locked plating does have its role in specific situations. For patients with significant osteoporosis, locked screws have been shown to improve fixation. When significant comminution exists on both sides of the tibia, and there is very little cortical contact between fragments, locked implants may provide the required axial and angular stability required to successfully treat the fracture.

Surgical Tactic and Protocol

After initial diagnostic testing and complete evaluation of the patient's injury, the limb should be splinted and a staged protocol followed. Stage 1 includes restoration of lateral column length by plating the fibula, if it is fractured, and restoration of limb length, alignment, and rotation. This alignment is maintained by application of a transarticular fixator across the ankle joint (Figure 5). The most crucial aspect of this stage is not to malreduce the fibula in the sagittal or coronal planes, or it will be impossible to anatomically reduce the tibial articular surface during stage 2. The fibula incision should be cheated posterior to try to maximize the skin bridge between this incision and the one to fix the tibia, especially when an anterolateral approach is being considered. It is also imperative to regain adequate length (even slight overlengthening is preferred) to allow the soft tissues to stabilize in their appropriate position. After initial skeletal stabilization, CT scanning is performed. CT scans are best obtained after external fixation and after preliminary reduction. The talus can then be disimpacted from the tibia for better understanding of the fracture pattern. This will allow for better evaluation of the articular injury and will help in determining which reduction maneuvers are required and how hard the reductions will be to obtain.

After external fixation and CT scanning, patients are instructed to keep their legs elevated and are taught to ambulate, non–weight-bearing, on crutches. Patients are discharged home when medically cleared and are instructed to keep their legs elevated as much as possible. They are then followed until they are ready for definitive reconstruction. When soft-tissue swelling has decreased, fracture blisters have re-epithelialized, the skin wrinkles, and the leg is ready for surgery.

After the most appropriate location for fixation is determined, the correct surgical approach is chosen. Fixation strategy can progress as follows. Typically, the central impacted area needs to be reduced. First, the posteromedial fragment is connected to the posterolateral fragment. Then the central impacted fragment can be reduced to this block and held with Kirschner wires. The anterolateral fragment can then be reduced and lag screws placed across the articular surface. Next, the articular surface is fixed to the diaphysis to complete the reconstruction.

After surgery, the leg is placed in a cast until sutures are discontinued. Early motion is encouraged, physical therapy for range of motion is begun, and a cam walker is used until the patient maintains neutral active dorsiflexion, at which time soft-tissue splinting is longer needed. Patients are typically kept non–weight-bearing for 3 months or until fracture healing.

Conclusions

Successful treatment of a complex intra-articular distal tibial fracture requires a full understanding of the fracture. This begins with correct identification of fracture components and areas of comminution and with an understanding of which type of implant is biomechanically sound to prevent displacement. If this information is appropriately used and surgical timing is appropriate, treatment can be optimized and complications minimized. Several authors have shown that no matter how well patients do or how many complications can be avoided, these injuries have lasting consequences with regard to functional activity. Many patients must modify their lifestyle, up to half cannot return to their job, and even more have significant difficulty when running. In addition, significant time (up to 30 months) is required before these patients can realize their maximal gain in activity and functionality.[12-14]

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