**Summary:** Proximal tibia and plateau fractures are challenging cases with a high rate of soft-tissue complications. Although precontoured locking plates provide excellent results, they are not always ideally suited for fixation of additional or small fragments, and their prominence can lead to irritation and wound problems. Fragment-specific fixation for complex fractures has been used extensively in the upper extremity, but the literature on the lower extremity is sparse. The purpose of this article is to illustrate the use of small-fragment plates in the fixation of a complex proximal tibia fracture.

**Key Words:** proximal tibia fracture, plateau fracture, fragment-specific fixation, small-fragment plating

**INTRODUCTION**

The aims of periarticular fracture fixation include restoration of articular congruity, joint stability, and metaphyseal alignment. Locked plating has become more popular in the care of tibial plateau fractures. Their variable-angle screw options, and ability to compress and bridge, have greatly enhanced the surgeon’s armamentarium in approaching these difficult injuries. However, these plates, especially when placed under thin or damaged soft tissue, may compromise wound healing. Plate irritation occurs with a bone–plate distance of as little as 5 mm. Even with staged external fixation and careful soft-tissue handling, complication rates of high-energy proximal tibia fractures range from 10% to 30%. One study cited an infection rate of 21%, with 8% being deep infections. Ten percent of patients experienced hardware-related complications, including pain and mechanical symptoms associated with prominent screws and lateral plates. These complications were independent of factors such as age and diabetes. Additionally, locking plates are precontoured to fit the bone in a specific place, and thus may not be in an ideal position over the fracture spikes, and are not reliable in stabilizing posteromedial fragments.

In contradistinction to precontoured plating, fragment-specific fixation involves using thinner, more malleable small or mini plates in the most biomechanically optimal position to support fracture fragments. These plates can be used in 3 ways: as provisional fixation, as supplementary fixation in addition to large plates, and as the sole fixation in smaller joints, such as the ankle. In subcutaneous bones like the clavicle, these low-profile plates enjoy a lower implant removal rate, a significant advantage particularly in traumatized soft tissue. Further advantages include ease of contouring, multiple points of fixation, and the ability to capture smaller fragments using smaller and more clustered screw options.

Fragment-specific fixation has been successfully used in the upper extremity, including the distal humerus, Monteggia elbow fracture–dislocations, and the distal radius. Lower extremity literature, on the other hand, is limited. One study used small 3.5 T-plates and atraumatic soft-tissue handling to fix tibial plateau fractures in 17 patients. In unicondylar fractures, the plate was used on its own; in bicondylar C-type fractures, it was supplemented with a medial external fixator. The authors cited their ability to place screws very proximally, allowing for better support of the fracture fragments. All fractures united without infection, and no patient experienced irritation during knee motion; however, 4 thin...
patients had the plate removed because of irritation when the knee hit a hard object, such as a table.\textsuperscript{11}

Given the sparse literature on fragment-specific fixation in the lower extremity, the purpose of this report is to illustrate the use of this technique in a complex proximal tibia case, with a specific focus on its biomechanical and soft-tissue advantages.

**PATIENT INFORMATION**

A 21-year-old healthy, nonsmoking man sustained a left closed bicondylar tibial plateau fracture after a dirt bike accident. He was transferred 2 days after injury from an outside facility to the Level 1 trauma center for definitive management. He received no treatment other than knee immobilizer placement before transfer. He had no neurologic or vascular compromise, and no other injuries were present on tertiary examination upon arrival at the trauma center. Because of his delayed presentation and swelling, compartment pressures were measured and were not indicative of compartment syndrome.

Imaging studies, including plain radiography (Fig. 1) and CT scan (Fig. 2), showed a multifragmentary tibial plateau fracture, with a posterior shear pattern, separate posteromedial, posterolateral, and anterolateral fragments, and comminution.

Initial management included observation of swelling and compartment checks in a long leg cast with the top half cut off for examination. Definitive fixation was performed on day 4 after injury once the skin was amenable to surgery.

**SURGICAL TECHNIQUE**

The presence of bicondylar involvement, particularly the separate posteromedial and posterolateral fragment (Figs. 2A, C), necessitated extensive surgical planning. Because of the relatively small size of the fragments, we believed that a large locking plate in this young patient with excellent bone would not be positioned properly to support the fragments. Given his traumatized soft tissues and high-energy injury, smaller ideally located plates would provide more mechanical stability with a lower risk. Additional concerns included limiting the amount of incisions about the knee and being mindful of soft-tissue stripping and skin bridges. Two strategies were considered. The first was a prone posteromedial approach to stabilize the posterior shearing injury with posterior plates followed by an anterolateral approach to reduce and fix the anterolateral fragment and meniscus. Alternately, we chose to do the entire procedure supine with a plan to reduce and fix the posteromedial fragment through a posteromedial approach, then reduce and fix the posterolateral fragment using lag screw fixation from anteriorly using the lateral most portion of the interior portion of the fracture, a direct view through the anterolateral fracture, and

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**FIGURE 1.** Preoperative anteroposterior (A) and lateral (B) knee radiographs.

**FIGURE 2.** Preoperative axial (A), coronal (B), sagittal lateral (C), and sagittal medial (D) CT images.
FIGURE 3. Fluoroscopic lateral image showing the posteromedial 2.7 plate with the associated lag screw.

FIGURE 4. Fluoroscopic anteroposterior image showing the posteromedial 2.7 plate and a K-wire holding the posterolateral fragment.

FIGURE 5. Fluoroscopic lateral image showing the independent lag screws placed anteromedial to posterolateral.

FIGURE 6. Fluoroscopic anteroposterior image showing the lateral-to-medial independent lag screw holding the anterolateral fragment and reducing the articular surface to the reconstructed medial side.
fluoroscopy to judge the reduction, followed by more standard lateral fixation of the anterolateral fragment.

The patient was taken to the operating room and positioned supine on a standard radiolucent table without a bump because of the need to externally rotate the limb for access to the medial side. Reduction and stabilization of the posteromedial fragment were performed first to provide a stable platform to work from. A posteromedial approach to the proximal tibia, going through the pes tendons and periosteum as one layer, allowed access to the fracture. Dissection was extended proximally, with an arthrotomy and submeniscal release to view the medial joint line. The posteromedial fragment was then reduced both at the cortex distally and the joint proximally and stabilized with an underbent 2.7 plate (EVOS; Smith and Nephew, Memphis, TN) directly over the spike with a lag screw in the excellent cortical bone (Fig. 3). The lag screw was positioned to avoid the lateral fragments so it would not impede their reduction. The posterolateral fragment was palpable through the posteromedial approach but was externally rotated and irreducible through this incision.

Attention was turned to the lateral side, where a curvilinear S-shaped incision was performed over the proximal tibia to allow access to the lateral plateau and proximal shaft. After incision of the iliotibial band in line with its fibers, the anterior compartment musculature was released from the intact tibia and most of the anterolateral fragment. This fragment was then externally rotated to view the joint further posteriorly. The posterolateral component was then visible and was manually reduced into proper position using a direct read laterally and a palpable read posteriorly with a finger through the medial incision. Once reduced, this fragment was held reduced with a clamp and a K-wire (Fig. 4), and reduction was confirmed using fluoroscopy. Lag screws placed from the intact anteromedial bone into the posterolateral plateau stabilized this fragment (Fig. 5). The anterolateral fragment was then placed back into its bed and held with a separate lag screw aimed into the medial plateau (Fig. 6). It was then supported at its spike by a thin

**FIGURE 7.** Final fluoroscopic anteroposterior (A) and lateral (B) images showing the lateral 3.5 plate supporting the anterolateral fragment and the additional anterolateral-to-posterolateral lag screw.

**FIGURE 8.** Final anteroposterior (A) and lateral (B) radiographs of the reconstructed plateau.
3.5 small-fragment lateral plateau plate (Smith and Nephew), with lag screws proximally and shaft fixation. No locked screws were used. Independent lag screws were then aimed from anterolateral to posterolateral for additional posterolateral fragment support. Appropriate joint reduction and meta-diaphyseal alignment were confirmed on direct vision and imaging (Fig. 7). An associated lateral meniscal tear was repaired using an inside-out technique through the iliotibial band. Wounds were thoroughly irrigated and closed in a standard fashion after applying vancomycin putty. The patient was immobilized in extension to take stress off the posterior fragments and avoid flexion contracture. The ankle joint was kept free.

Anticoagulation was achieved using low-molecular weight heparin for 4 weeks until the patient mobilized well and then switched to 81 mg aspirin. The patient was kept in extension for 2 weeks doing only straight leg raising exercises and then active, active-assisted, and passive motion was started when the wounds healed. Motion was performed out of the brace, but the brace was on at all other times for 6 weeks. The patient was kept non-weight bearing for a total of 12 weeks from surgery and then progressive weight bearing was allowed. His reduction was maintained through healing and at final follow-up, he had 0–135 degrees of motion, minimal pain, and was back at work (Fig. 8).

DISCUSSION

Fragment-specific fixation provides an alternative, soft-tissue friendly option in open reduction internal fixation of proximal tibia fractures. These plates can be used with less concern for implant prominence and can be contoured to fit the bone much more closely than locking plates. Modern small plates also keep the advantages of larger locking plates by providing locking and nonlocking options, screw clusters, and variable-angle directions.

In the illustrated case, the goals of treatment included limiting additional trauma to the soft tissues and visualization and fixation of multiple small fragments that would provide optimal support and joint congruence. The ability of small plates to sit directly where they are needed, as opposed to larger locking plates that are precontoured to a specific position on the tibia, made these plates an attractive option in this complicated case. Their low profile also allowed them to be placed on the relatively subcutaneous lateral proximal tibia without compromising the surgical wound. Screws were placed from multiple directions to support the posterolateral fragment, some of which were through the anterolateral plate. Stabilization of multiple fragments from different directions underscores the importance of carefully planned surgery that not only limits soft-tissue dissection but also provides adequate stabilization to the important fracture components.

In large joints and/or osteopenic bone, small-fragment fixation should be used with caution. When used in type C articular fractures of the knee, small plates will provide excellent support when bicolumn plating is performed and have lower rates of hardware irritation. The senior author (P.T.) has moved almost entirely away from larger lateral locked plating unless the entire medial condyle is intact. All other fractures are treated with thinner medial or posteromedial and lateral plating through 2 small approaches. The case presented in this article demonstrates the concepts of carefully planned and specific limited fixation in the appropriate biomechanical position to provide adequate support.

CONCLUSIONS

The presented case illustrates the successful use of fragment-specific fixation to address a displaced proximal tibia fracture. These plates continue to address the goals of surgery by providing stable fixation, articular reduction, and limb alignment, while minimizing the complications of hardware prominence. They also optimize fixation by allowing the surgeon to aim the screws in the best direction for separate fragment support and to position the plate exactly on the fracture spike, thus providing optimal biomechanical placement.

REFERENCES


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