Posteromedial Supine Approach for Reduction and Fixation of Medial and Bicondylar Tibial Plateau Fractures

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Summary: Traditionally, both high- and low-energy tibial plateau fractures are classified on the basis of the anteroposterior (AP) plain radiograph. Several fracture types exist that are not included in currently used classification schemes, including posteromedial shear and coronal plane fractures. These fracture types can appear as isolated fracture lines or as a part of a bicondylar plateau fracture. The purpose of this study is to describe a posteromedial supine surgical approach and antiglide plating of the posteromedial fragment, either as a single approach for a unicondylar posteromedial fracture or in combination with a second lateral approach for bicondylar fractures. We have used this technique in 27 patients that had posteromedial shear fractures on preoperative computed tomography (CT) scans, in the setting of a Level I trauma center. Ten were isolated medial plateau fractures, and 17 had bicondylar fractures. Radiographic analysis was done for all patients, and clinical outcomes were available in 19 out of 27 patients through phone interviews and chart reviews. Mean follow-up was 3.5 years (range 1–12 years). Seventy-five percent of patients had anatomic or good reductions. The average Oxford knee score was 19.9 ± 5.4 (12–29). Average range of motion was 0 to 120 (0–90 to 0–130). The articular malreduction (>5-mm gap or step-off) rate was 4%, and there were no wound complications. Posteromedial shear fractures of the tibial plateau are not uncommon. This pattern is assessable using the preoperative CT scan. A supine posteromedial approach with antiglide plating provides a good clinical solution for these complex injuries.

Key Words: tibial plateau fractures, posteromedial approach, coronal shear fracture, antiglide plating

Accepted for publication January 14, 2008.
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INTRODUCTION

Tibial plateau fractures demonstrate different patterns mandating various treatment strategies. Several classification schemes have been proposed on the basis of fracture morphology, the most common of which is the Schatzker classification. This classification and others rely solely on the plain radiographs, mainly in the anteroposterior (AP) plane for designating the fracture type, and, thus, they may not account for fracture patterns perpendicular to the AP plane (sagittal plane). The advent of computed tomography (CT) has added invaluable information for further delineation of tibial plateau fracture patterns. Posteromedial shear or coronal fractures of the tibial plateau, appearing either as isolated fractures or as components of bicondylar fractures, have been previously described. The surgical approaches, as well as the reduction and fixation techniques, for treating these fracture types often require more than one incision and the use of a variety of implants. Several reports have dealt with similar fracture patterns, and these generally describe a true posterior approach for reduction and fixation of this fracture type, usually done in the prone position. A posteromedial approach in bicondylar fractures is believed to minimize surgical soft-tissue injury when a separate anterolateral approach is contemplated. The purpose of this study is to describe the surgical technique and clinical experience of a supine posteromedial approach with antiglide plating for unicondylar and bicondylar tibial plateau fractures associated with a posteromedial shear fragment.

SURGICAL TECHNIQUE

Bicondylar fractures are initially stabilized with a spanning external fixator for 1 to 3 weeks, to allow for soft-tissue injury and swelling to subside. In unicondylar fractures, an external fixator is used either in cases of fracture dislocations and/or significant subluxation of the joint relative to the femur and posteromedial fragment. Care with pin placement should be taken to avoid pin-site insertion in the area of planned incisions for future surgery. In a case of compartment syndrome, a two-incision fasciotomy is performed. A negative-pressure vacuum system can expedite the closure of fasciotomies, and these had been successfully used in our institution for the past few years as part of our protocol. Definitive surgery is done when there is adequate soft-tissue healing. Our preoperative planning includes adequate AP and lateral knee radiographs before and after the application of the external fixator, as well as a 2.5-mm cut axial CT scan with two-dimensional coronal and sagittal reconstructions. If a fixator is applied, the CT scan should be performed after its application. Three-dimensional CT reconstruction can be helpful in understanding fracture morphology, but, for most
cases, the two-dimensional data can provide sufficient information. An example of a typical posteromedial shear fracture, as seen on the lateral radiograph and the axial CT scan at the level of the joint line, is seen in Figure 1A and B.

The location of the posteromedial spike relative to the planned incision (apex of the fracture) has to be determined preoperatively. The described approach is for placing a buttress plate directly on this spike. If this spike is located elsewhere (more anterior or posterior), a different approach should be considered.

The patient is positioned supine on a radiolucent table. A femoral distractor can be applied in the case of shortening on the medial side, or the external fixator can be left in place for traction. Our preferred pin configuration for a distractor (in the case of one distractor) is at the femoral condyles proximally, parallel to the joint line on the medial side, and in the distal tibial shaft or metaphysis, far from the planned incisions, and also parallel to the ankle joint. Both pins should be inserted in the same rotational trajectory. In some cases of severe bicondylar fracture, a second, lateral distractor can be placed with the same pin configuration, inserted from lateral to medial. In many instances of bicondylar fractures, we prefer to start with the posteromedial approach, to provide a stable medial column to which the lateral plateau can be reduced and stabilized. The surgeon should stand on the opposite side of the operated limb. The landmarks for the incisions (Fig. 2) are at the medial femoral epicondyle proximally, the joint line, and the posterior tibial border at level of the metaphysial–diaphyseal junction distally. We recommend a slight knee flexion (about 30 degrees) and external rotation of the ipsilateral hip to allow an easier access to the posteromedial edge of the proximal tibia. Care is taken to provide an adequate skin bridge (usually greater than 7–8 cm) if an anterolateral incision is planned. Fluoroscopy in the lateral view can help determine the incision length according to the location of the distal spike of the fracture (the fracture apex). The incision is planned about 4 to 6 cm proximal and distal to the fracture’s apex (the overall incision length is around 8–12 cm). In cases where the joint line is to be exposed, the incision can be extended proximally. After the skin incision and dissection of the subcutaneous layer, the fascia is incised between the medial gastrocnemius (posterior border of the dissection) and the pes anserinus anteriorly (Fig. 3). The medial collateral ligament remains intact anteriorly and deep to the pes anserinus. To gain access more posteriorly, the semimembranosus insertion can be released off the bone using an elevator. In that case, it should be reattached after fracture fixation. The pes tendons are mobilized posteriorly and proximally, keeping their insertion intact. A Penrose drain can be used for their retraction. The apex of the fracture is then readily seen, and insertion of clamps and the plate can be facilitated (Fig. 4). From our experience, if the posteromedial fragment is large and not comminuted, as we fortunately found in the majority of cases, the articular surface does not need to be exposed, and the dissection is limited to the fracture apex. The joint is not opened in this case, because the technique uses indirect reduction of the joint line, provided by an accurate distal reduction of the fracture apex. However, in cases where comminution of the posteromedial edge is seen, a submeniscal arthrotomy can be done to visualize the joint directly (Fig. 3). In stubborn or very delayed cases, when the fracture does not reduce at the articular surface, as evidenced by intraoperative fluoroscopy, further dissection and debridement of the fracture site proximally should be considered.

Reduction of the fracture can be achieved using both direct and indirect reduction techniques. The femoral distractor placed medially assists in obtaining length and alignment through ligamentotaxis in some instances. The apex of the fracture line is exposed, and it is irrigated and debrided.
Because the forces created by the antiglide plating are large, even a relatively large gap or displacement is correctable in many instances with this relatively limited approach. To “key in” the fragment, a ball-spike pusher or pointed reduction clamp may be used, along with indirect reduction techniques such as an undercontoured buttress plate. An antiglide buttress plate (a one-third tubular or a 3.5-mm reconstruction plate) is used for reduction and fixation. A T- or an L-shaped plate can also be used. The principle and sequence of antiglide plating (antishearing) is depicted in Figure 5. In the instance of a posteromedial fragment that is large and intact, the most common displacement is distal and medial (Fig. 5A). Therefore, the required force for reduction would be to push the fragment proximally and laterally. An undercontoured plate is used to push the fragment laterally. The first screw (3.5-mm bicortical screw) is drilled 2 to 3 mm distal to the fracture line, directly below the apex. It can be drilled through the plate, or it can be drilled before plate placement (Fig. 5B). As the screw is tightened, the plate pushes on the shear fragment, translating it proximally and anterolaterally by virtue of the screw trajectory and the undercontoured nature of the plate. Thus, a properly placed “apical screw” with an undercontoured plate would provide antishearing stability and compression along the joint line (Fig. 5C). Additional screws, including lag screws through the plate proximally, will augment this fixation. As a general rule, two screws proximally and distally, with an adequate working length, are sufficient for fixation. Proximal palpation of the fracture lines, both anteriorly and posteriorly (gently done, taking care not to strip the bone), as well as fluoroscopic control, can be used to assess the quality of the reduction.

The interval between the gastrocnemius and the pretibial fascia is closed using an absorbable suture, and the wound is closed in a routine fashion over a suction drain. When there is an associated lateral plateau fracture, a separate, lateral approach can be used concomitantly in the same supine position. A bump added under the ipsilateral hip is optional, but this should be added after the medial fixation is complete. Again, from our experience, we prefer fixing the medial column first, to create a stable strut that will facilitate lateral fixation.

Postoperative care includes early mobilization with active assisted and passive range-of-motion exercises, including continuous passive motion starting on postoperative day 1. The goal of early mobilization is to achieve 90 degrees of flexion within the first postoperative days. The patients are discharged typically after 3 to 5 days, depending on the initial injury pattern, pain control, and attainable range of motion.
Patients were operated on using this approach between 1994 and 2005. IRB approval was obtained for a retrospective review of this patient series, as well as for an outcome score survey. The average patient age was 43 years (SD = 19, 18–65). Ten patients were females, and 17 were males. Mechanisms of injury were motor vehicle accidents (52%), falls (35%), and ski injuries (13%). One fracture was a Grade IIIa open fracture. Ten patients had isolated posteromedial fractures (corresponding to Shatzker IV), and 17 had bicondylar (Shatzker V and VI) fractures. In all bicondylar fractures, an anterolateral approach with submeniscal arthrotomy was used concomitantly with the posteromedial approach. Perioperative complications included one compartment syndrome (4%), one malreduction requiring reoperation (4%), and one deep vein thrombosis (4%). There were no wound complications observed in this series.

Reductions were classified as anatomic (0-mm step-off or depression), good (≤2 mm), or fair (2–5 mm), according to the methods of DeCoster et al.15 A malreduction was defined as >5-mm step-off or gap. The varus angle of the tibial plateau was measured as the angle between the medial proximal joint line and the tibial shaft on long-cassette knee films that included the proximal tibial shaft.16 Radiographs available for analyses on all 27 patients were the preoperative plain films and CT scans, as well as the latest postoperative films obtained at least 1 year after surgery. The radiographic evaluator did not know the clinical results. Functional outcome was assessed using the Oxford knee outcome score17,18 obtained via a telephone interview by a blinded evaluator. Range of motion was determined from the documented office visits in each patient’s chart during his or her last visit, at least a year after surgery by senior surgeons who did the clinical exam. The Oxford score consists of functional patient-reported items and is rated 12 (best) to 60 (worst). The score was administered via phone to 19 available patients at an average follow-up of 3.5 years (range 1–12) postoperatively. Normal patients without knee complaints were assumed to have maximal scores of 12.19 Eight patients were lost to follow-up and could not be located or contacted.

Multivariate linear regression analysis was used to identify patient and fracture variables that were predictive of outcomes, using commercial statistical software (SPSS v. 11.0, SPSS Inc., Chicago, IL). The Oxford knee score was set as the dependent variable, and age, gender, fracture pattern on CT scan, varus angle, posterior slope, and reduction grade were tested as independent variables. A two-tailed student t test was used for comparing the reduction quality and alignment between the early and late postoperative films. A P value < 0.05 was considered statistically significant.

Anatomic (11 patients, 41%) and good (9 patients, 33%) reduction was achieved in 20 (74%) of the patients, and fair reduction was achieved in seven patients (26%). Table 1 specifies the quality of reduction and varus angles of the last postoperative radiographs (a minimum of 1-year follow-up) as well as the maintenance of reduction. The mean loss of reduction between the immediate and late postoperative films was 0.72 mm (P = 0.20; see Table 1). There was also no significant change in tibial varus angle between the immediate and late follow-up radiographs. The average Oxford knee score was 19.9 ± 5.4 (12–29). The average knee flexion was 120 (90–130), and extension was zero (0–0). No fixed-flexion contracture was noted at the most recent follow-up. With the linear regression used for the study variables, no correlation was found between quality of reduction, fracture type, age, sex, or outcome score, using multiple linear regression analyses.

Discussion

Our series demonstrates that there are distinct fracture patterns that involve a posteromedial coronal shear fracture line that can be treated with a specific surgical approach. The posteromedial tibial plateau fracture has been described previously.7,10,12 The posteromedial approach was used principally for soft-tissue preservation in a case of severe bicondylar fracture.12 These authors recommend the posteromedial approach to the proximal tibia, to gain access to the apex of
the fracture line and to create an antiglide effect, thus buttressing the medial column. We present here our surgical technique using a supine posteromedial approach with antiglide plating that can be used either alone or with a concomitant lateral approach, with acceptable clinical results.

A supine position allows adequate exposure for the reduction of the posteromedial fragment without compromising access to the lateral plateau. Furthermore, the approach is sufficient for buttressing the posteromedial spike, and deep dissection and soft-tissue stripping are minimized. From our radiographic analysis, all the posteromedial fracture lines had components of obliquity rather than lying purely in the coronal plane. This makes the posteromedial edge of the proximal tibia an ideal region for a direct surgical approach, reduction, and antiglide plate placement, allowing the direction of screws perpendicular to the fracture line and avoiding dissection of the more anterior plateau. The latter is more superficial and has a more tenuous soft-tissue envelope that remains intact during our described approach. The antiglide effect has been used for the tibial plateau as well as for fractures in other anatomic regions. In our series, reduction and alignment were maintained overall in most of our cases, and we observed relatively low wound and soft-tissue-complication rates despite the high-energy mechanism in many of these fractures.

Some authors have suggested that with the advent of locking plates, stable fixation of the posteromedial fragment can be achieved solely from the lateral side. It seems, however, that this technique may be suboptimal when a posteromedial shear fragment is present, because the lateral screws are positioned in the coronal plane and are frequently parallel to the fracture lines seen in these patterns. In fact, recent computer modeling has demonstrated that the majority of screws placed in a lateral proximal tibia locking plate may fail to capture the posteromedial fragment. Also, recent biomechanical evidence implies that dual plating increases resistance to subsidence when compared with a unilateral locking plate in bicondylar fractures. Our results also suggest that the added morbidity of using a separate posteromedial approach in a case of a bicondylar fracture is acceptable, and the rate of complications in these fractures is comparable with that found in the literature.

Our data concerning articular reduction and overall alignment were comparable with those of previously published studies, which have used various treatment modalities. The assessment of reduction was similar and was based on the plain radiographs. We found no correlation between articular reduction or alignment and clinical outcome. Given our small data set and heterogeneity of fracture types, and the fact that most reductions were adequate (20/27, 74%), a definite conclusion could not be drawn regarding the latter issue. Still, the added morbidity of using a separate posteromedial approach in a case of a bicondylar fracture is acceptable, and the rate of complications in these fractures is comparable with that found in the literature.

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previous evidence demonstrates that better reduction and alignment offer the best chances for minimizing posttraumatic arthritis and ensuring good functional outcomes.\(^3,12\)

Limitations of our study are its retrospective nature, variable time to follow-up, mechanisms of injury, patient demographics, small sample size, and diversity of fracture patterns. In addition, the assessment of reduction was limited by the lack of long-standing films and by the known limitation of plain radiograph compared with CT scans for assessment of articular reduction. Another limitation is the lack of follow-up data on 30% of the patients who were treated during the study period. Similar response rates were found in other retrospective studies dealing with the same issue.\(^3,12\)

In conclusion, the posteromedial supine approach is effective and reproducible for reducing and stabilizing posteromedial tibial plateau shear fractures. Further large-scale series studies are required to determine the long-term prognostic value of this approach.

**REFERENCES**


