Calcaneal Plate Fixation of Distal Femoral Fractures

Donald W. Hohman, MD, Jesse Affonso, MD, Jacob Budny, DO, and Mark J. Anders, MD

Abstract

Open reduction and internal fixation constitute the standard of care for management of displaced distal femoral condylar fractures. The techniques most commonly used include conventional and locked plating with the primary goal of articular surface congruency. However, a specific implant for the isolated medial femoral condyle fracture is lacking. We report the use of a calcaneal plate as a novel technique for managing medial and lateral femoral condylar fractures.

Unicondylar fractures of the femur are often characterized by avulsion of one femoral condyle with the other intact condyle remaining in continuity with the femoral metaphysis.[1] Making up less than 1% of all femoral fractures,[2,3] these injuries have not received extensive attention in the orthopedic literature. They have almost always been included in the generic group of distal-third femoral fractures.[3,4] Unicondylar femoral fractures represent a diagnostic challenge, as they are often overlooked. These injuries are often found in association with other injuries of the same limb. The inherent anatomical variability accounts for unique fracture characteristics (Table), resulting in difficult radiologic evaluation and no clear consensus on specific operative intervention. Open reduction and internal screw fixation of unicondylar femur fractures provide overall excellent long-term results.[5]

Multiple fixation techniques have been developed to manage distal femur fractures with articular involvement. When the articular surface is involved, anatomical reduction of the articular component is required. Isolated medial condyle fractures of the femur represent a unique problem. Percutaneous screw fixation,[2] dynamic condylar screws, and conventional and locking plates have all been used successfully.[4] All condylar plates currently available are contoured to fit the lateral femoral condyle. These devices are primarily introduced from the lateral femur; medial-side fracture fragments are addressed with indirect reduction.

With no specific implant design representing the standard fixation method for the isolated medial condylar fracture, we have applied a calcaneal plate to medial, as well as lateral, condylar fractures of the distal femur (AO [Arbeitsgemeinschaft für Osteosynthesefragen] classification 33-B1/B2). The patients provided written informed consent for print and electronic publication of these case reports.

Case Reports

Case 1

A 53-year-old woman with a previous history of trauma requir-

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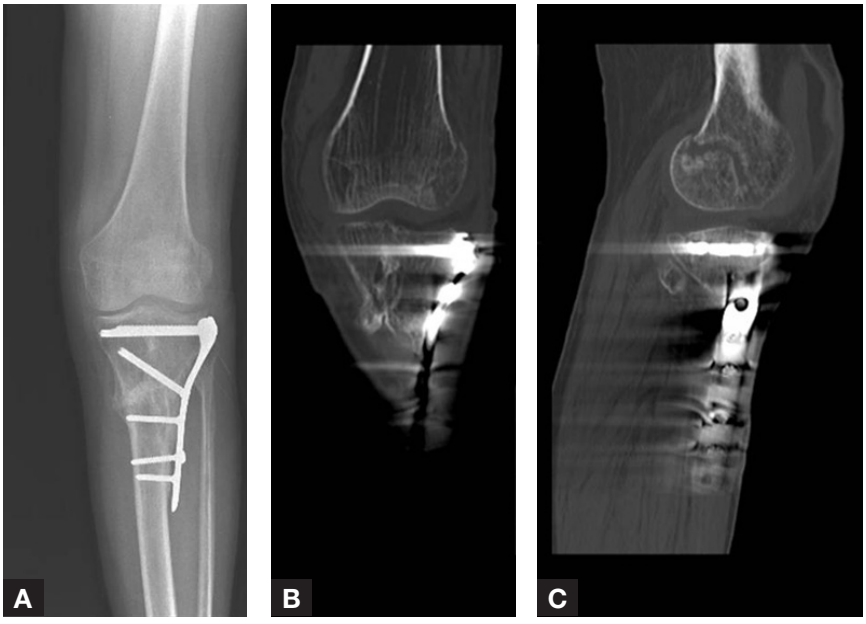

Figure 1. Radiographic (A) and computed tomography (B,C) evaluations of 53-year-old woman, with previous history of trauma requiring surgical fixation to left proximal tibia, who sustained minimally displaced intra-articular left lateral femoral condylar fracture.

Table. Müller AO Classification

33	Femur distal
33-A	Extra-articular fracture
33-A1	Simple
33-A2	Metaphyseal wedge
33-A3	Metaphyseal complex
33-B	Partial articular (unicondylar)
33-B1	Lateral condyle, sagittal
33-B2	Medial condyle
33-B3	Frontal—"Hoffa fracture"
33-C	Complete articular (bicondylar)
33-C1	Articular simple, metaphyseal simple
33-C2	Articular simple, metaphyseal complex
33-C3	Articular complex

Abbreviation: AO, Arbeitsgemeinschaft für Osteosynthesefragen.

ing surgical fixation to the left proximal tibia, fell, and could not weight-bear. She sustained a minimally displaced intra-articular left lateral femoral condylar fracture. Radiographic and computed tomography evaluations are shown in Figure 1.

A standard lateral approach to the femur was used to gain adequate exposure. Provisional pin fixation was used for fracture fragment reduction. A titanium alloy calcaneal plate (ACE Ti6-4V; DePuy Orthopaedics, Warsaw, Indiana) was used as a washer with 4 distal cancellous screws and 2 cortical screws placed proximally for fragment fixation. In addition, a cortical screw and a partially threaded cancellous anterior-to-posterior buried lag screw were placed to capture the lateral condylar shear fragments. These screws were countersunk at the articular margin (Figure 2).

Case 2

A 28-year-old man sustained a gunshot wound to the anteromedial distal femur and fractures of the medial femoral condyle with associated comminution (Figure 3).

The fracture was exposed by anteromedial incision with a subvastus-type approach and arthrotomy. Alignment was achieved and reduction performed and held provisionally with Kirschner wires. Titanium small fragment screws (ACE, DePuy) were used in an anterior-to-posterior lag fashion to capture the posterior fracture fragment. The distal femur was then supported by a large titanium calcaneal plate used as a washer and fixed in a lag fashion with 3 screws placed through the medial condyle and 1 screw placed above the fracture into the femoral shaft (Figure 4).

Discussion

Continual improvements in implants and surgical techniques have made fixation the treatment of choice for most distal femoral fractures.[4] The primary goals of open reduction are attaining and maintaining length, alignment, rotation, and an anatomical articular surface. Early knee motion requires sufficiently stable fixation of the articular segment to the intact femur. The main disadvantage of operative intervention includes the potential for damage to the local blood supply. Detrimental effects of such damage include nonunion, malunion, and infection. As changes have been made to implants and strategies in an attempt to mitigate these complications, the isolated condylar fracture has not received extensive attention. With no specific implant design representing the standard fixation method for the isolated medial condylar fracture, we have applied a calcaneal plate to medial, as well as lateral, condylar fractures of the distal femur (AO classification 33-B1/B2).

We believe that several inherent design features make the calcaneal plate appropriate for fixation of isolated femoral condyle fractures. In the senior author's experience (MJA), this alternative fracture fixation method has been implemented with a calcaneal plate made of titanium alloy (ACE, DePuy). On the basis of individual experience and implant availability, it seems plausible that these fixation advantages would be shared across similar implant designs of similar materials.

Conventional calcaneal and periarticular plate designs are usually

Figure 2. Radiographic evaluation 6 months after surgery.

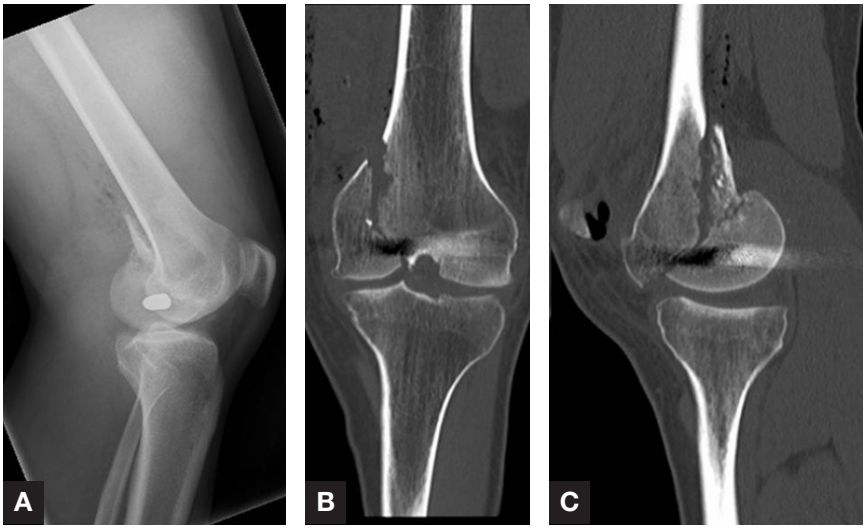

Figure 3. Radiographic (A) and computed tomography (B, C) evaluations of 28-year-old man with fractures of medial femoral condyle and associated comminution.

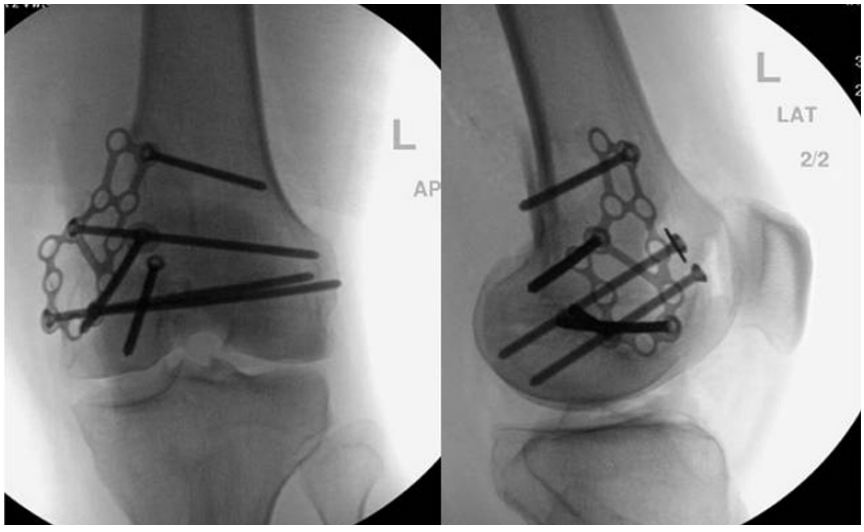

Figure 4. Radiographic evaluation after open reduction and internal fixation.

high-strength and low-profile. One calcaneal plate feature that we believe combines the strength and durability needed for this expanded indication is the transverse strut, which extends to the perimeter of the construct, potentially increasing overall fixation stability. We believe that the strut helps mitigate the rotational forces at the implant–bone interface. The contained plate design lends itself to alternative fixation applications based on the absence of the cantilever arms commonly found in other calcaneal plate designs. This plate provides a wide area of bone coverage, increasing the surface area of fixation while the spanning structural design of the construct offers regions of intermittent fixation, which likely promotes periosteal preservation, and ultimately, fracture healing. In the appropriate setting, the plate may be used essentially as a large washer, representing a unique management option for fracture comminution, osteopenic or osteoporotic bone. These plate designs include as many as 12 screw holes, which may be strategically placed to augment fracture reduction or fixation based on anatomical variation or injury pattern. The low-profile design (plate thickness, 1 mm) reduces the risk for irritation of the surrounding soft tissues, specifically the iliotibial band in the lateral application. The screw holes allow low-profile interaction with the heads of 3.5-mm cortical screws and 4.0-mm cancellous screws.

Contouring the plates for specific fracture patterns may be necessary. Although implemented with relative ease, the plate continues to provide adequate fatigue strength and sufficient durability to reduce the risk for secondary displacement of the fracture associated with plate failure or loss of fixation. The intrinsic design features of the calcaneal plate allow for potential reconstruction of the articular surface with absolute stability, thereby enhancing articulate cartilage viability and primary bone healing.

The calcaneal plates are made in 3 sizes to optimize anatomical use based on individual management requirements. With countersinks on both sides, the plate design can be used on either femora (medial or lateral condylar fixation). Numerous holes allow a variety of screw fixation possibilities based on fracture pattern and comminution level, which also is a deciding factor in sizing the plate for application. The "character" of the fracture pattern helps dictate plate sizing/templating. In our experience, proximal cortical extension has been successfully negotiated with application of a larger plate, whereas minimal cortical involvement or a "pure" condylar fracture can be managed with a smaller plate. The case reports presented here suggest that 2 cortical screws placed proximal to the fracture itself provide adequate fixation in the femoral shaft. Distal fixation must be applied at the discretion of the operating surgeon on the basis of preoperative evaluation, intraoperative findings, and associated fracture lines.

Titanium screw fixation options are available in locked and variable-angle trajectories, offering further versatility. Many of the conventional locked implants used in distal femoral fixation have manufacturer-preset uniaxial screw paths, and therefore, are at a potential

disadvantage in unique injury patterns. The screw path options that accompany the calcaneal plate construct represent potential solutions to various fracture patterns and provide anatomical variation about the distal femur. Conventional plates with only predetermined screw trajectories and precontoured designs cannot address the variation in femoral anatomy, fracture patterns, or alterations in plate positioning.

Innovative polyaxial screw plate designs allow more variation in fixation constructs and the ability to perform targeted percutaneous fracture fixation. These devices represent a significant advance in fixation of complicated supracondylar injuries to the distal femur, but their increased surgical morbidity and higher cost make it seem difficult to justify their use in isolated condylar fractures, both high- and low-energy in nature.

Schatzker and Tile[6] noted that nonoperative management of isolated condylar fractures leads to less than satisfactory outcomes, but they did not describe any specific recommendations as to a management approach. Our experience in operatively managing isolated condylar fractures has been successful. Our indications essentially are fracture fragments amenable to fixation and displacement of 2 mm or more. These indications serve as general guidelines, as all injuries are unique. We use the surgical approach that the fracture requires, and achieve rigid fixation with lag screw and calcaneal plate fixation with the goal of perfect anatomical reduction. The stability conferred allows for unrestricted immediate range of motion of the joint, lessening the risk for postoperative joint ankylosis. We emphasize that this technique is appropriate only for partial articular injuries, those with intact contralateral condyle and cortex. This type of fixation is clearly inadequate when there is bicondylar involvement or a lack of metaphyseal stability. Such patterns require implants that impart adequate angular stability.

We have described our surgical technique and reviewed the conditions under which open reduction and internal fixation of a distal femoral condylar fracture with a calcaneal plate may be appropriate. Other orthopedic surgeons, particularly those managing cases of complex orthopedic trauma, may be able to apply this technique.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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This paper will be judged for the Resident Writer's Award