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Tibial Plateau Fracture Following Low Energy Fall in the Rocky Mountains

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INTRODUCTION

Tibial plateau fractures are debilitating injuries. They can occur in younger individuals who sustain a high energy trauma or, with increasing age, lesser degrees of trauma and underlying bone pathology such as osteoporosis, metabolic bone disease, and malignancy.[1] Outside these cases, tibial plateau fractures are relatively uncommon. However, these fractures can occur in healthy patients who have sustained direct trauma to the knee.

Fractures of the tibial plateau often are classified according to the Schatzker or AO classification systems.[2,3] These systems evaluate the involvement of both the medial and lateral plateaus, degree of comminution, extension into the joint, and displacement (both articular surfaces and the relationship of the diaphysis to the metaphysis). Most tibial plateau fractures occur in the lateral aspect of the tibial plateau.[1] The increased frequency of lateral fractures is due to the medial tibial plateau being able to resist higher weight-bearing load due to the presence of more cancellous bone. More importantly, the lateral plateau has more articular surface exposed during extension compared to the medial plateau, which increases likelihood of injury.[4]

The standard of care for most displaced tibial plateau fractures is surgical management with open reduction and internal fixation (ORIF).[5] Conservative management, such as leg bracing, is an option for fractures that are nondisplaced or in patients too fragile for surgical intervention. In the senior population, a total knee arthroplasty (TKA) is a less common option. Tibial plateau fractures, particularly medial tibial plateau fractures, caused by direct trauma in the elderly, non-osteoporotic population are uncommon.

We present the case of an active male without overt risk for severe fracture (10-year fracture risk of 10% via FRAX score) who was working to repair a trail in the Rocky Mountains. While other injuries were more likely given the mechanism of injury and patient risk, this case highlighted the importance of considering tibial plateau fracture, even in atypical settings without significant risk. Improved awareness of this mechanism of injury will lead to more accurate diagnosis and greater post-injury management.

CASE REPORT

A 61-year-old male (Body Mass Index = 25.7) was pushing a wheelbarrow loaded with supplies while working to maintain a hiking trail in the southern Rocky Mountains. As he removed his hand from the wheelbarrow to readjust his grip, he lost control of the wheelbarrow, whose weight pulled him causing him to slide approximately five feet off the trail, where he lost balance and landed on his right knee. The patient landed on a dirt surface. He did not recall hearing a popping sound, but immediately felt pain. There was no loss of consciousness and no other injuries were sustained.

The patient was unable to bear weight following the fall. Joint stability was unable to be assessed due to pain. Fellow workers tried to assist the patient to a vehicle, but the pain was too great to flex his knee even 10 degrees while supported by crutches. A medical team was sent to evaluate the patient in the field. At that time, the patient had developed a large right knee effusion. Joint laxity was unable to be assessed due to joint swelling and discomfort. However, given the potential stress on the knee while holding a wheelbarrow and falling, a ligamentous injury was suspected. The knee was diffusely tender. He was evacuated by stretcher to an emergency vehicle and transported, with leg braced, to an emergency department at a local community hospital.

Physical exam at the emergency department showed intact and symmetric dorsalis pedis and posterior tibial pulses, intact lower leg sensation, and appropriate motor skills of ankles and toes. A plain film radiograph revealed an acute traumatic fracture involving the right knee (Figure 1). There was an oblique fracture just lateral to the tibial spines extending down to the medial metaphysis with a depressed and displaced medial plateau. The medial tibial plateau and lateral femoral condyle were displaced inferiorly through the margins of the fracture. There was lateral displacement of the tibia and fibula relative to the femur. There was a fat fluid level present within the joint space. The patella, distal femur, and proximal fibula appeared intact. The patient was diagnosed with an acute displaced tibial plateau fracture with subluxation (Schatzker type AO B1.3).

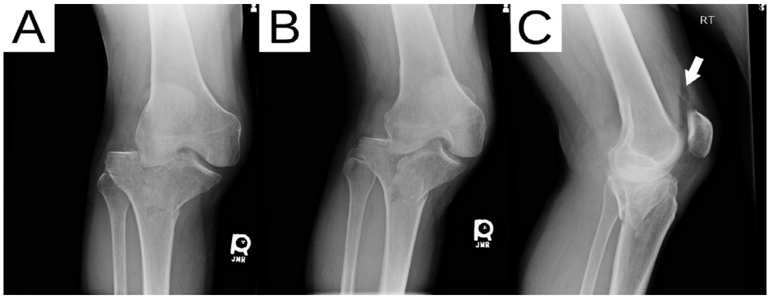

Figure 1. Initial radiographs of the patient's right knee obtained at the emergency department. (A) anteroposterior view; (B) oblique view; (C) horizontal beam lateral view, depicting lipo-hemarthrosis within the joint space (arrow).

Given the unanticipated fracture and corresponding severity of injury, risk factors for osteoporosis were assessed in the patient. The patient was a current smoker with a 10-pack year smoking history and had sustained an ankle fracture requiring rod placement while playing golf several years prior. However, at that time, there was no concern from physicians for osteoporosis or osteopenia. The patient did not have a significant family history of osteoporosis or preexisting degenerative diseases. He consumed two standard servings of alcohol per night. The patient was physically active, with at least one hour of activity four to six days per week, and had no history of prolonged glucocorticoid use, rheumatoid arthritis, type 1 diabetes, thyroid disease, or liver disease.

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The patient was transported to a level IV trauma center. The clinicians confirmed pain, deformity, edema, and limited range of motion in the right knee. Compartment syndrome was assessed through clinical evaluation, and the patient did not have pain out of proportion, paresthesia, muscle weakness, diminished sensation, or compartment tension. The patient's right lower extremity was braced. Due to the comminution and articular displacement, computed tomography of the knee without intravenous contrast was performed, which showed a large joint effusion indicating lipo-hemarthrosis and lateral displacement of the tibia (Figure 2). A comminuted split fracture was identified through the tibial eminence with marked distraction and rotation of the medial tibial plateau. The fracture extended longitudinally into the metaphyseal-diaphyseal junction. There was displacement of the tibial articular surface. The femoral condyles and proximal fibula were intact.

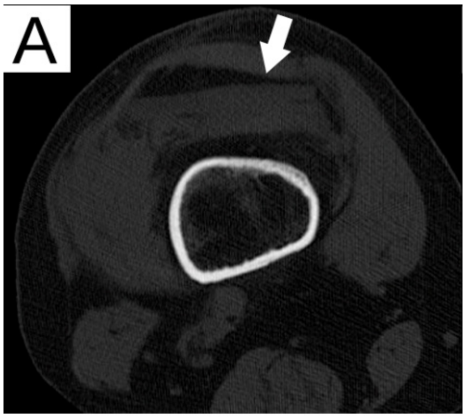

Figure 2. Computed tomography image of the patient's right knee. Lipo-hemarthrosis is evident in the anterior right knee (arrow).

Orthopedic evaluation recommended an ORIF. The surgery was delayed for 24 hours until the swelling was stable and the skin was appropriate for ORIF. A distraction external fixator connecting rod was placed on both sides followed by application of traction to distract and reduce the subluxation of the joint. One transverse incision was made over the lateral tibial condyle below the joint line and extended to the deep fascia, at which point compartment syndrome was evaluated due to higher risk. The fascia lata also was incised to visualize the small posterolateral articular surface fragment to be removed. An arthroscopic exam was performed and the anterior cruciate ligament was observed to be intact.

Reconstruction of the articular surface involved elevation of the depressed articular surfaces and debridement of small pieces of bone. An anteromedial percutaneous hole was used to insert a Cobb elevator to elevate the fractured fragment and the tibial spine. Reduction and elevation of the tibial spine was confirmed through radiograph. Three guide pins for 6.5 mm cancellous screws were placed from a medial to lateral direction followed by the placement of three 6.5 mm partially-threaded cancellous screws.

A subcutaneous plane was created on the medial aspect for the medial buttress plate. Non-locking compression screws were placed for adequate compression on the buttress plate, and locking screws were placed proximally to create an angularly stable construct.[6] A buttress plate was utilized to neutralize the axial forces on the tibial plateau and protect from failure of the weakened medial cortex (Figure 3).[7] External fixators were removed, and the wound was closed in layers using 2-0 vicryl and 2-0 nylon. Postoperatively, the right leg was placed in a posterior splint. There were no post-surgical complications and the patient reported controlled pain.

The patient was released from the hospital with pain medication and instructions to be non-weight bearing for six weeks. He received follow-up care with a local orthopedist, who removed the stiches and partial cast and obtained a follow-up radiograph. The patient also received injectable subdermal enoxaparin sodium to reduce blood-clotting risk. The patient was placed in a lockable/non-lockable brace to allow limited active and passive range of motion. He reported no pain and was taking a morning nonsteroidal anti-inflammatory drug to reduce swelling. The rehabilitation plan consisted of progressive range of motion and weight bearing exercises. After six months of physical therapy, the patient was cleared to return to normal hiking activities.

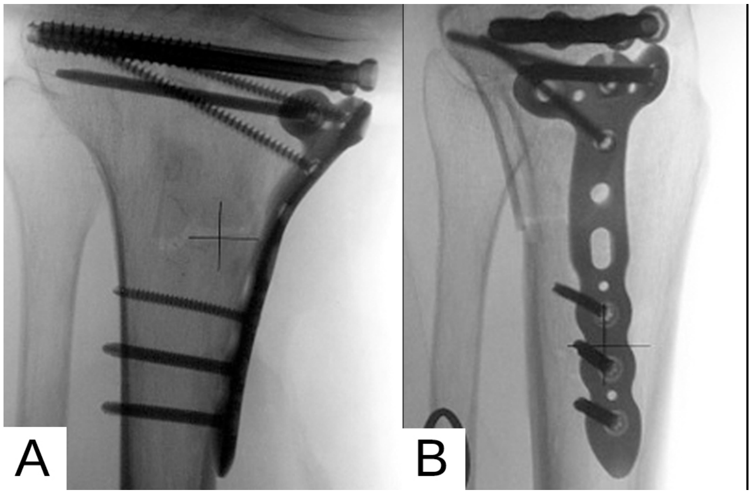

Figure 3. Post-operative radiographs of surgically-repaired right knee. (A) anteroposterior view; (B) medial oblique view, demonstrates hardware needed to correct fracture.

DISCUSSION

Tibial plateau fractures are typically compression fractures involving the articular surfaces between the proximal tibia and the femoral condyle. The compression typically occurs from an external valgus force, such as a car impact.[5] Low energy impact fractures may occur more frequently in elderly populations due to the effects of osteoporosis. Typical clinical findings include swelling, diminished range of motion, joint instability, ligamentous damage, meniscal injury, and inability to bear weight. Lipo-hemarthrosis may be visualized by imaging. Lipo-hemarthrosis commonly is caused by traumatic mechanisms that involve intra-articular injury of bone, cartilage, and/or ligament. Damage to these tissues leads to fat and blood seeping into the joint space and can be visualized by computed tomography or magnetic resonance imaging.[8] The energy of impact is an important determinant of concomitant soft tissue damage. Soft tissue damage is a risk factor for neurovascular deficit, infection, and a higher likelihood of compartment syndrome.[9]

The patient in this case presented with a severe acute tibial plateau fracture with lateral subluxation after a benign fall while working in a wilderness camp setting. The mechanism of this injury is atypical due to the knee not being extended and the minimal level of force upon impact. Furthermore, the sliding off the trail made ligamentous injury more concerning since the slide, as well as the angle of the slope at which the patient hit, decreased the axial force applied to the knee. Additionally, the degree of the fracture was abnormal, considering the patient's normal physical exam clearing him to work in mountainous terrain doing manual labor, and living an active lifestyle which included cycling and skiing. The patient's current smoking and alcohol history may be contributory to this injury.

The initial impression of the injury elicited a high suspicion of a knee sprain or ligamentous injury based on physical exam findings and the patient's personal account of no sound being heard upon impact. However, radiographic imaging indicated a more serious tibial fracture. The visualization of lipo-hemarthrosis on imaging further confirmed the injury. In circumstances where a fracture is not identifiable, the presence of lipo-hemarthrosis may be used as a proxy for an intra-articular fracture. Laboratory values were unremarkable and bone density of the tibia was non-osteoporotic, based on surgical evaluation during placement of cancellous screws.

This case represents that tibial plateau fractures cannot be excluded from the diagnosis in a healthy patient in the setting of wilderness medicine, even when other injuries are more likely. Preventing tibial plateau fractures in older, healthy adult populations is not clearly understood. The effect of improving proprioception has been proposed as a factor in preventing musculoskeletal injuries.[10] Knee proprioception has been increased in competitive sports settings using prophylactic joint stabilizers, such as compression garments, bandaging, taping, and using knee braces. Several mechanisms have been proposed to explain the increase in proprioception. The use of joint stabilizers has been related to an increase in afferent input by the cutaneous tactile receptors and mechanoreceptors within the tissue underneath the stabilizer, leading to an increase in proprioception.[11] Knee proprioception may be enhanced through the use of patellar taping.[12,13] Individuals traversing through environments with uneven terrain may prevent falls leading to fractures by improving proprioception through the use of knee stabilizers such as knee braces and taping. We recommend future research elucidate the effects of these stabilizers in outdoor settings.

CONCLUSION

Tibial plateau fractures are an important part of the differential diagnosis in trauma to the knee in wilderness medicine, even when other injuries might seem more plausible. In this case, a 61-year-old male working in a remote part of the Rocky Mountains sustained a tibial plateau fracture after sliding off a trail. While immediate care was sent to the patient and the patient was stabilized in the backcountry, the decision to image the patient immediately was important, given the complications that can develop from tibial plateau fractures. As such, providers in wilderness environments should consider skeletal damage beyond tissue injury and take immediate steps to determine diagnosis.

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