Beware of Ultra-Low-Velocity Knee Dislocation

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The epidemic of obesity in the United States has had undeniable effects on the practice of musculoskeletal medicine.[1] The estimated cost of obesity-related health care was $147 billion in 2008 and is expected to continue to rise.[2,3] Treatment of such patients is often fraught with costlier care, higher complication rates, longer surgeries, worse outcomes, and negative prognosticators in both adult and pediatric orthopedic care.[4-6] Regardless of the results of national efforts to improve nutrition and combat the obesity epidemic, the orthopedic surgeon needs to remain vigilant in recognizing new presentations of classic musculoskeletal injuries. Seemingly innocuous trauma in an obese patient can be deferred or overlooked entirely, with devastating consequences. One such injury is the recently reported "ultra-low-velocity (ULV) knee dislocation (KD)." This is a clinical entity whose presentation, treatment, and complications have been described at a few major centers and that seems associated exclusively with obesity.[7-10]

Knee dislocation is defined by loss of the tibiofemoral articulation. Traditionally, high-velocity dislocations result from vehicular trauma and are associated with the highest rates of nerve and vascular injury, while low-velocity dislocations are characterized as sports injuries.[11,12] There have been recent reports of complete KDs in patients with high body mass index (BMI), sustained merely during falls from standing, falls from a single step, and noncontact injuries. The first descriptions of ULV KD included 2 morbidly obese female patients who had falls while walking.[13] These patients' courses were characterized by complete tibiofemoral dislocation, popliteal artery occlusion, open revascularization procedures, and early transfemoral amputation in 1. This was the first series to describe the delay to presentation in such patients, intraoperative difficulty, postoperative complications, and difficult prosthetic fitting.

In the laboratory, 650 psi of force is required to overcome soft tissue restraints and dislocate a knee anteriorly.[14] During the gait cycle, as much as 2000 lb of force can be transferred across the tibiofemoral joint in a patient weighing 400 to 500 lb. A majority of the reported ULV dislocations are anterior, likely a result of supraphysiologic loads and failure of the ligamentous and capsular restraints about the knee. There is also a large body of evidence suggesting that obese patients have displaced centers of mass and altered gait kinematics and are at increased risk of falls.[15,16] In a morbidly obese patient with a generous soft tissue envelope, deformity of the femur and tibia at the knee can be difficult to assess clinically. This can result in dulled suspicion at the time of index evaluation and a delay to radiography. A recent patient at the authors' facility with a BMI of 69 kg/m^2 sustained a low-velocity slip and fall and resulting left knee pain, and was triaged to a low-acuity bed in the emergency department. Radiographs were first obtained 5 hours after injury (**Figure**)**.** The patient had a pulseless and insensate distal extremity at the time of orthopedic consultation. This patient underwent a long index revascularization procedure, fasciotomies, revision revascularization for early graft occlusion, and a prolonged hospital stay with multiple complications. This caliber of disaster is inexcusably common.

A thorough neurovascular examination and ankle brachial indices (ABIs) should precede and follow emergent closed reduction of KD. Patients with acute ischemia should be heparinized. If the ABI is greater than 0.9, the patient can be observed. If the ABI is less than 0.9, further arterial imaging is necessary. For

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significant changes (ABI, <0.8), the authors recommend angiography or computed tomography-angiography. If intimal arterial injury involves less than 30% of vessel circumference, patients can be safely observed with serial ABIs and administered pharmacologic anticoagulation. If pulses do not return after closed reduction, the patient should be taken immediately to the operating room for intraoperative angiography or immediate exploration.

Regardless of the anticipated procedure, the patient should be placed supine on a radiolucent table and both extremities prepped into the surgical field. Often 2 tables placed side by side are necessary. The orthopedic team should assess ligamentous stability to anterior/posterior translation and varus/valgus stress. The knee will invariably prove unstable. Placement of an external fixator is often necessary, but this delays revascularization and prevents knee flexion, which is critical for medial popliteal exposure by the vascular surgery team. The authors have found that, once reduced, the patient's soft tissue envelope provides sufficient knee stability while flexed, and knee spanning external fixation is placed after vascular exploration or repair. The authors often use 3 or more uniplanar femoral and tibial half-pins and multiple bars for maximal stability. At the authors' institution, a minority of these patients are good candidates for ligamentous reconstruction, and the external fixator is maintained for a minimum of 6 weeks. If warm ischemia exceeds 5 to 6 hours, 2-incision 4-compartment fasciotomies are performed and precede all other procedures.

Since the initial cases reported by Marin et al,[13] several small series have reported high complication rates in patients with ULV KD. Rates of operative vascular injury range from 15% to 100%,[7,9,17,18] with similarly high rates of tibial and peroneal neurapraxia; these rates may exceed those of high-energy KD. After ligamentous reconstruction, patients with ULV KD have experienced more reoperations, thromboembolism, vascular claudication, and wound infections than patients who have sustained KD by another mechanism.[10] Most importantly, a patient evaluated by an evidence-based protocol to rule out vascular injury is less likely to experience delayed diagnosis and more likely to have been treated at a Level I trauma center.[19]

Multiligamentous knee injury (MLI) has often been equated with KD, a conflation of terminology that the authors find to be a source of confusion. Multiligamentous knee injury can certainly represent a KD that has undergone spontaneous reduction. However, the authors only consider a knee to have been objectively dislocated if there has been clinical or radiographic evidence of complete loss of the tibiofemoral articulation. Knee dislocation can occur without ligamentous injury, and MLI can occur without KD.[20] This distinction is relevant as the authors' experience with ULV KD and neurovascular injury has been entirely in the setting of true dislocation, in which complete tibiofemoral incongruity has been overlooked in the emergency department evaluation.

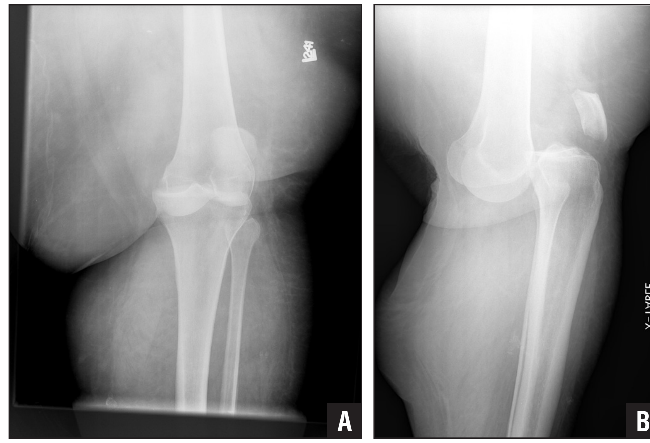

Figure: Anteroposterior (A) and lateral (B) knee radiographs of a morbidly obese female with a body mass index of 69 kg/m^2 presenting to the emergency department after a slip and fall. No gross deformity was appreciated. Radiographs were performed 5 hours after presentation. A complete anterior knee dislocation and significant soft tissue envelope are shown.

"Low velocity" does not connote "low energy"—quite the opposite, in fact. Ultra-low-velocity dislocations are decidedly high-energy injuries with terrific consequences, and low energy represents a misnomer that the authors had employed until recently.

There is every reason to suspect that the diagnosis of ULV KD will increase in frequency. Obesity rates continue to rise in the United States. The first evaluators in most cases of KD are actually the least equipped to evaluate these patients.[21] At the time of orthopedic or vascular surgical consultation, the patient's fate may be sealed. It is orthopedic surgeons' responsibility to educate their residents and their general surgery, vascular surgery, and emergency medicine colleagues about this clinical entity. In the seemingly innocuous instance of an obese patient with knee pain after a fall, the consequences of delayed evaluation can be devastating.

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