Evolution of the Management of the Dislocated Knee: A Trauma Perspective

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Tom, Dan, and I (RCS) thought it would be interesting, historically to look at the differing perspectives on the evaluation and treatment of the dislocated knee, especially with the perspective of a trauma surgeon. We all believe there are many ways to treat knee dislocations, and often the perspective of the sports medicine orthopaedic surgeon will result in a totally different approach to treatment than what is seen from the perspective of the orthopaedic traumatologist. Using my (TAD) 35 years from residency to recent retirement at the University of New Mexico (UNM) gives a great insight to the changes in management of what was once thought a rare event. On a side note, I am happy to announce that although retired, I will continue on at UNM on a part-time basis.

Phase 0 (training 1976-1985)

In the 1980s, knee dislocations were considered a rare event. Most of the literature emanated from trauma centers and military experience.[1] It was said that the average orthopaedist could expect to see 1 case of knee dislocation in his or her entire career. It was known that knee dislocations were associated with popliteal artery injuries and that under-recognition, delay, and under-treatment of knee dislocations were common and associated with poor outcomes, including amputation of dysvascular limbs. The anterior knee dislocation was felt to have the highest incidence of arterial injury.[2]

Phase I (1985-1995)

In my second year of practice in 1987, I treated 3 cases of knee dislocations. They ran the gamut of high energy, open injury with obvious nerve and artery injuries to lower energy, closed injury with gross instability but more subtle associated injuries. Diagnosis at that time was universally based on plain radiographs demonstrating no contact between the articular surfaces of the distal femur and proximal tibia. Arteriography was considered essential because of the known association with arterial injury. Closed reduction was usually readily accomplished by realigning the limb with gentle axial traction and knee extension. Early popliteal artery repair or bypass was typically performed and external fixation spanning the knee was developed to maintain reduction. However, many surgeons stabilized such a knee temporarily with large Steinman pins crossing the knee through the femoral notch/tibial eminence. A good outcome was considered limb salvage with a reduced knee joint. Rehabilitation and long term results of range of motion and stability were not the focus of the literature.

My small series of knee dislocations in a short period of time suggested that the literature description of this problem did not entirely match our experience. The first observation was that knee dislocations were much more common (3 in 1 year) than suggested by the literature (1 in a career of 35 years). The second was that knee dislocations were not all high energy injuries but a wider spectrum of mechanism of injury. However, our attempts at publication of this experience were not well received by editors at that time. We did publish the more general topic of knee ligament injuries ipsilateral to femur shaft fractures in 1989.[3] At that time, we recommended a good ligament exam of the knee following nailing of femur shaft fractures with particular attention to vascular status if bicruciate ligament injury was diagnosed.

The late 1980s was also when effective procedures of knee ligament reconstruction and arthroscopic techniques were being developed by sports medicine. Anterior cruciate ligament (ACL) reconstruction had moved from extra-articular tenodesis and fascia lata intra-articular grafts to more substantial bone-patellar tendon-bone grafts with arthroscopic technique, and results were improving dramatically.

In the early 1990s, treatment of knee dislocations began to include more aggressive repair of torn structures and early reconstruction of the anterior cruciate ligament and later, the posterior cruciate ligament (PCL). Dr. Wascher and others at UNM Hospital, Dr. Schenck at the University of Texas San Antonio, and other orthopaedists elsewhere began to apply these ligament reconstruction techniques to patients with knee dislocations. The goal was to improve the long term stability without causing excessive stiffness. We attempted to report the results in sports and trauma literature but, again, editorial resistance was encountered.

Phase II (1995-2000)

Finally, in 1997, we combined forces and were successful at first publishing in *Journal of Orthopaedic Trauma* the results of the UNM experience.[4] Our main conclusions were: 1) knee dislocations were much more frequent than previous literature suggested, and 2) there was a range of energy mechanism from low (stepping off a curb) to medium (twisting injury to the knee in sports) to high (motor vehicle wreck).

Many knee dislocations actually presented with the joint reduced. We showed that bicruciate ligament tears (anterior and posterior cruciate ligaments both torn at the same time) were equivalent to knee dislocations. We postulated that in order to tear both the ACL and PCL simultaneously, the knee must have been dislocated at some point during the injury displacement. Evidence to support this theory was the fact that the knee could always be dislocated in the operating room under anesthesia when treating bicruciate ligament tears and further, that the rate of popliteal artery injury was the same in the bicruciate ligament tear population and the knee dislocation (by radiograph) population. This broadened definition partially accounted for the increase in frequency of knee dislocations.

Arteriography was not always essential. To be fair, I freely admit that I feel stronger about this than Drs. Wascher or Schenck. When an obvious arterial insufficiency accompanied a knee dislocation, it was not necessary to obtain an arteriogram because the key to successful outcome was timely vascular reconstruction. An arteriogram only delayed surgery and did not add useful information. Also, when a reliable vascular physical exam was repeatably normal, the incidence of clinically significant arterial injury was zero, thus angiogram was not necessary. Those recommendations initially were not palatable to reviewers but, with subsequent orthopaedic and vascular literature reporting the same conclusions, have made their way into treatment recommendations.[5,6] As Dr. Schenck stated, if there is any doubt as to the arterial status of the limb, then an arteriogram is recommended, or if unavailable, arterial exploration and reconstruction. Clearly, delay for obtaining an arteriogram in the presence of an avascular limb is best avoided by performing a surgical exploration and arterial repair/reconstruction.

It was my observation that the pattern of injury for knee dislocations was different from what had been described in earlier literature and in the developing literature on multiple ligamentous injuries of the knee. The differences are the frequency of associated injuries, the nature of the patients sustaining these injuries (mechanism, level of sports activity, and rehabilitation reliability), and the problems they encounter. Knee dislocations commonly have associated injuries involving tendon avulsions, the patella, nerves, capsule, tissue loss, and other extremity injuries.

Open knee dislocations often involve tissue loss, not merely tearing. One particular patient from southern Colorado had the medial side of his knee skived off in a garbage truck injury. He lost not only the medial skin but all the soft tissue and 2 centimeters of his proximal tibia, as well as tearing both cruciate ligaments and injuring his popliteal artery. Initial treatment was debridement, popliteal artery bypass, and external fixation. This was followed by a musculocutaneous free flap and then an osteochondral-ligamentous patella with quad tendon allograft to restore the proximal tibia, including joint surface (patella), with attachment of the quad tendon to the femur to reconstruct a medial collateral ligament. This resulted in a successful salvage with reasonable function and a decade of referrals from south central Colorado.

Tendon avulsions are the rule rather than exception in knee dislocations. These may involve the quadriceps off the patella, the patella tendon off the tibia tubercle, the iliotibial band off Gerdy's tubercle, and biceps off the proximal fibula. Soft tissue disruption of tendon attachments of the popliteus and hamstrings have also commonly been seen.

Although knee dislocation specifically refers to the tibia-femur articulation, knee dislocations commonly involve patella injury. Quadriceps and patella tendon injuries can be bony avulsions or soft tissue disruptions. Articular cartilage injuries with loose bodies occur. Patello-femoral ligament disruptions occur and often are seen in a spectrum with KDIIIM ligamentous injuries (both medial collateral ligament (MCL) and medial patellofemoral ligaments torn resulting in a dislocation of both tibio-femoral and patella-femoral joints). Buttonholing of the distal femur through the capsule and patello femoral ligament may prevent closed reduction. Even open reduction can be difficult, as the structures preventing reduction may be hard to identify and correct. Delay in such open reduction of the posterolateral knee dislocation with medial furrowing of the skin routinely results in soft tissue necrosis.

Although nerve injuries can be associated with any ligament injury to the knee, they are much more frequent in knee dislocations and may involve the peroneal or tibial nerve. Nerve injuries associated with knee dislocations are commonly stretch injuries with an

extensive zone of injury. Peroneal nerve injuries may be treated with decompression but results of nerve repairs and grafts are generally poor. Tibial nerve injuries cause even greater dysfunction. Lacerations of the tibial nerve do respond somewhat better to nerve repair, although the recovery is prolonged and incomplete.

The capsule of the knee is always torn with knee dislocations. Although capsular injury has not received much attention in knee ligament reconstruction, there may be a role for acute repair in the knee dislocation setting. There is typically a tissue sleeve avulsion around the proximal tibia and the tissue itself. Its correct anatomic location can be identified surgically in the acute setting. Repair allows some restoration of alignment of the articular surfaces and some stability to the joint, although this technique has not gained widespread popularity. The specific anatomic location of the capsule attachment to the proximal tibia was reported in the *Journal of Orthopaedic Trauma* in 1999[7] and was re-published as a classic article of clinical significance in 2004.[8] The specific capsular anatomy was noted to be significant clinically in the 1995 report of knee sepsis resulting from a pin track in the proximal tibia.[9] Repairs of soft tissue avulsions around the knee may be possible and effective in acute knee dislocations, whereas they are not generally possible or effective in more chronic treatment of knee ligament injury patients.

Phase III (2000- 2010)

The early descriptions of knee dislocations lacked anatomic specificity of injured structures. The direction the tibia was displaced relative to the femur was used to classify knee dislocations. This was similar to other joint dislocations. However, the torn ligaments were not named and no particular patterns were reported. This is where Dr. Schenck's knee dislocation classification scheme was very helpful, as it required an initial description of the status of the 4 main ligaments of the knee: ACL, PCL, LCL, MCL.[10] The advent of readily available MRI in the late 1990s to supplement the specific ligament injury diagnosed on clinical exam was crucial to providing reliability and specificity to this anatomic ligament injury as the basis for classification of knee dislocations. It has been a great pleasure observing the routine use of the "KD#" classification in daily rounds by the residents at UNM Hospital. It has reinforced just how common this injury is, as hardly a week goes by without at least 1 patient on the inpatient list with this injury. It is also gratifying to see the improved clinical assessment, designation, and treatment of the specific anatomic injury.

Rehabilitation after serious knee injury is important to restore motion and avoid stiffness. The degree of compliance in trauma patients with knee dislocations is often not as great as an injured football player or other sports injury patient. The trauma patients may not even come back to clinic, much less participate in physical therapy sessions several times a week for months. It is clear that a stiff knee is worse than an unstable knee. A stiff knee is more disabling to the patient and is harder for the orthopedic surgeon to treat. Trauma patients often have injuries to other extremities which further limit their ability to focus on rehabilitation of the knee and tend to increase the incidence of stiffness, especially after operative stabilization of the injured knee ligaments. The daily activity of trauma patients and the amount of time spent doing activities involving running and twisting may be much less than the average sports patient.

There may be some patients with knee dislocations who are best treated with reduction and stabilization in a reduced position with a spanning external fixator. They recover from their overall injuries for 6 weeks and then have the fixator removed in the operating room with a gentle closed manipulation of the knee followed by bracing and rehabilitation. If they have subsequent difficulty with instability, then a delayed reconstruction of the unstable ligaments can be performed.

As Dr. Schenck has mentioned, Dr. Mercer reported what we consider to be the optimal pin and frame configuration for knee spanning external fixation in the *Journal of Orthopaedic Trauma.*[11] There is a tendency for the tibia to sag posteriorly that may go unrecognized, thus it is important to confirm a good joint reduction radiographically at the end of the case when applying an external fixator for knee dislocation.

There have been numerous other publications from UNM, including "The Ten Commandments of Knee Dislocation" in 2001,[12] "Multiple Ligamentous Injuries of the Knee in the Athlete" by the American Academy of Orthopaedic Surgery in 2002,[13] Orthopedic Knowledge Online topic on Knee Dislocation in 2004[14] and the update in 2011,[15] and the Orthopedic Trauma Association Fracture and Dislocation Classification in 2007.[16] All of these provide a current perspective on the evaluation and management of knee dislocations.

Current

The definitive treatment of knee dislocation is now firmly in the realm of sports medicine. Initial treatment still often occurs with general orthopaedists and trauma orthopaedists. Recognition that bicruciate ligament tears are the equivalent of knee dislocations has become accepted. A high index of suspicion for popliteal artery injury and appropriate use of angiography in the initial evaluation is standard. Early bicruciate ligament is the usual treatment, although there is an accepted role for staged treatment with external fixation in some patients. The goal of restoring full function to the knee with normal stability and motion remains a quest, but overall outcomes have improved over the past 3 decades.

As Dr. Schenck pointed out, there are trials and tribulations in an academic career and pursuing scholarly activity in orthopaedics. Current dogmas have a tendency to fade and popularity of techniques and concepts are cyclical. Perseverance and continued clinical correlation and modification of your opinion based on observed patterns, outcomes, and other published literature and podium presentations will result in overcoming the trials and celebrating the tribulations.

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