Multiligamentous Knee Injury in Siblings with Associated Peroneal Nerve Deficits: A Case Report

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Introduction

Multiligamentous knee injuries (MKI) are a relatively rare orthopedic injury that most commonly occur in the polytraumatized patient or in the setting of occult knee dislocation.[1,2] These injuries require careful management due to potential joint instability and/or associated neurovascular injury.[3] Multiligamentous knee injuries can be classified by the number and location of the ligaments injured, as well as by the energy of the injury mechanism (ie. high or low velocity).[4,5]

Because the literature is limited regarding treatment of MKI in children and adolescents, particularly those with neurovascular compromise, classifications and treatment algorithms from the adult literature are often used.[6] While this is necessary in order to guide safe and appropriate decision-making, it is important to consider that younger patients may have biologic and mechanical differences from adults that can lead to different injury patterns, treatment considerations, and outcomes. We present siblings who sustained MKI with associated peroneal nerve deficits as a result of low velocity, non-contact athletic injuries. The patients and their parents consented to publishing their unique cases.

Case Information

Case 1

A 17 year-old male with a history of medial meniscus bucket handle tear repaired two years prior presented with right knee pain and swelling one day after a hyperextension injury sustained while playing soccer. Examination revealed an effusion and initial ligamentous testing was limited by pain. He had strong distal pulses but was unable to dorsiflex the ankle or great toe. He had minimal firing of the peroneal muscles and decreased sensation over the dorsum of the foot. Ankle-brachial indices (ABIs) were normal and MRI demonstrated a complex medial meniscus tear, partial thickness anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) tears, and a Grade 2 lateral collateral ligament (LCL) sprain. He was initially treated with a hinged-knee brace, an ankle-foot orthosis (AFO), and physical therapy.

Six weeks later his nerve function had failed to improve and electromyography (EMG) confirmed the common peroneal nerve injury, without definitive evidence of nerve continuity. He was evaluated by a pediatric neurosurgeon and underwent peroneal exploration and neurolysis; the nerve was in continuity and did not require neuroma excision or repair. Four months after the injury he had regained full knee motion and had returned to daily activities without feelings of knee instability. He underwent arthroscopic partial medial meniscectomy for his complex meniscus tear. Continued non-operative management was chosen for his ligamentous injuries because his knee was clinically stable and MRI revealed healing ACL, PCL, and LCL tears.

At 6 months he began a slow return to sports while wearing an AFO. However, his peroneal nerve lacked clinical and EMG improvement, so internal neurolysis was performed without identification of a neuroma. He had minimal subsequent improvement in nerve function, so the option of a posterior tibial tendon transfer was discussed but the patient was eager to continue his return to sports. At 2 years after the injury, he had minimal recovery of nerve function but was satisfied with his level of activity, and played baseball and soccer with the assistance of his AFO.

Case 2

A 16-year-old female presented with right knee pain and inability to dorsiflex her right foot two days following a non-contact pivoting injury while playing soccer. On examination she had a knee effusion, instability with varus stress testing, and a 2B lachman's test. Neurologic testing revealed inability to dorsiflex or evert the foot, and diminished sensation in the peroneal distribution. MRI demonstrated a complete ACL tear, high-grade partial PCL injury, and a distal avulsion of the LCL with edema at the posterolateral corner (Figure 1). Standing lower extremity radiographs did not show mechanical malalignment.

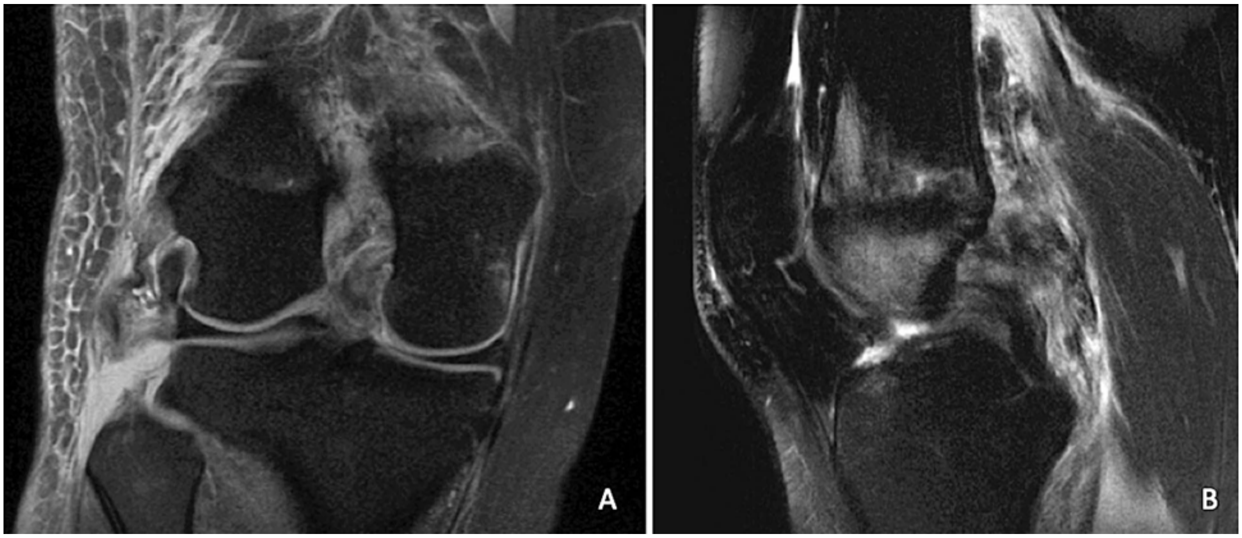

Figure 1. Selected coronal PD FS **(A)** and sagittal T2 FS **(B)** MRI images demonstrating a distal avulsion of the LCL from the fibular head, a complete ACL tear, and an incomplete PCL injury

Given her injury pattern and peroneal dysfunction, she underwent staged surgical intervention, starting with LCL stabilization and peroneal neurolysis at two weeks post-injury. Ligamentous testing under anesthesia revealed a positive dial test at 30 degrees but not 90 degrees and a negative posterior drawer test, so the PCL was treated non-operatively. The avulsed LCL was repaired to the fibular head by pulling it through a bone tunnel in the proximal fibula and securing it with a biotenodesis screw. Neurosurgery then performed a neurolysis and confirmed that the nerve was in continuity. Because the patient's brother had a similar injury, the patient underwent evaluation by genetics, which did not result in significant findings or diagnosis of underlying connective tissue disorder.

At 3 months post-injury, she did not have clinical or EMG improvement of her nerve injury. She therefore underwent repeat neurolysis and exploration, which revealed dense scar tissue around the fibular head and a small neuroma. The neuroma was resected and the nerve was primarily repaired without residual tension. Six months post-injury, the patient underwent ACL reconstruction with quadriceps autograft and had an uneventful recovery. Nine months after ACL reconstruction, her EMG showed signs of continued improvement and clinically she had improving strength and sensation in the peroneal distribution. She also passed her functional ACL testing and was cleared to progressively return to sports while wearing her ACL brace and AFO.

Discussion

MKI is far less common than isolated ACL injury in young patients, but it can be challenging to manage as there is wide variability in injury patterns, presentation, and associated pathology.[2,7-9] Recent studies found that older teens are more likely to sustain MKI, and incomplete injury patterns are more common than complete patterns.[10-11] Incomplete MKI are also more likely to go undiagnosed, and indications for reconstruction in young patients with incomplete injuries have not been established.[11] Our cases highlight the potential for neurovascular injury even in the setting of low-energy or incomplete MKI, and underscore the importance of a careful neurovascular exam in all patients with potential MKI.

Initial evaluation should include a peripheral vascular exam, with ABIs or advanced vascular imaging if asymmetry is detected, and a neurologic exam should be documented with particular attention to the peroneal nerve. Ligamentous testing should be performed with caution in the setting of a potentially self-reduced dislocation or otherwise highly unstable knee.[3] Associated fractures around the knee are common and radiographs should always be obtained.[12] This is especially important in young patients, as the physis is weaker than surrounding structures and a physeal fracture around the knee may be misinterpreted as ligamentous laxity. In the case of neurologic injury, any asymmetry or deficit should be followed with repeat examinations and EMG should be done at 6 weeks after injury if no improvement is seen. However, patients who undergo earlier reconstruction of lateral ligamentous injuries may also undergo peroneal neurolysis at that time.[13]

While principles for initial knee stabilization, ligament reconstruction, and management of neurovascular injury in pediatric MKI are typically extrapolated from the adult literature, additional factors in pediatric patients should be considered.[8] First, undiagnosed connective tissue or endocrine disorders may cause changes in tissue biology that place children at higher risk for ligamentous injury. Family history, thorough physical exam, including beighton score, and additional medical or genetic work-up should be pursued if abnormalities are suspected. Secondly, mechanical differences such as open physes, a growing skeleton, and lower extremity malalignment may lead to different injury patterns from adults. Rotational, coronal, and sagittal lower extremity alignment should be assessed on physical exam and with standing lower extremity radiographs if needed. Mechanical malalignment may be addressed at the time of ligamentous reconstruction or in a staged fashion in order to decrease the risk of recurrent injury. Finally, the psychosocial effects of MKI in children and adolescents may be under-appreciated after a low-velocity sports injury. Recent literature has demonstrated that children and adolescents often have signs and symptoms of post-traumatic stress disorder or depression even after an isolated ACL injury, particularly those with a strong association between sports and self-identity.[14-15] Because MKI treatment can be prolonged and involve multiple surgeries, surgeons should be sensitive to the potential effects of the injury and continually re-evaluate and address the patient's psychosocial needs in a multi-disciplinary fashion.[8]

Outcome data after treatment of pediatric and adolescent MKI is mostly limited to small case series, although they have generally shown favorable function and rates of return to sport.[8,9,16,17] Multiple studies in the adult literature have shown an increased complication rate and less predictable outcomes after treatment of MKI compared to isolated ligamentous injury, but larger studies are needed to evaluate this trend in young patients.[18-24] Growth arrest, limb length discrepancy, and limb deformity are potential complications of ligament reconstruction around the knee in skeletally immature patients, but they have not yet been reported in the setting of MKI.[25] Regarding neurologic injuries, younger age is typically considered to be a favorable factor for recovery of long term nerve function, although our patients had unpredictable nerve recovery even with appropriate neurosurgical treatment.[13,26,27]

Conclusions

In this case report, we present siblings with MKI and peroneal nerve dysfunction after sports injuries. We advocate for careful neurovascular evaluation in the setting of all MKI, regardless of mechanism, as well as additional radiographic and clinical evaluation in the setting of significant family history or benign injury mechanism. Further studies are needed to evaluate the incidence, injury patterns, and patient characteristics of pediatric MKI, as well as the outcomes after treatment of pediatric MKI and associated nerve deficits, in order to better guide patient counseling and management.

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