Management of Medial Collateral Ligament Injuries in the Knee: An Update and Review

Patrick S. Duffy, MD; Ryan G. Miyamoto, MD

Abstract: The medial collateral ligament (MCL) is the most frequently injured ligament in the knee, with mild-to-moderate tears often going unreported to physicians. Medial collateral ligament injuries can result from both contact and noncontact sporting activities. The mainstay of treatment is nonoperative; however, operative management of symptomatic grade II and grade III injuries is considered when laxity and instability persist. The timing of surgical repair in the setting of a multiligament knee injury remains an area of controversy among surgeons, with proponents of early reconstruction of the anterior and posterior cruciate ligaments and nonoperative management of the MCL versus proponents of delayed reconstruction following nonoperative treatment of the MCL. Prophylactic bracing may continue to increase and evolve as bracing technology improves and athletic cultures change.

Keywords: medial collateral ligament; anterior cruciate ligament; knee bracing; tibial collateral ligament

Patrick S. Duffy, MD[1]
Ryan G. Miyamoto, MD[2]

[1]University Hospitals–Case Medical Center, Cleveland, OH; [2]Fair Oaks Orthopaedics, Fairfax, VA

Introduction

The medial collateral ligament (MCL) is the most frequently injured ligament in the knee, with low-grade sprains often going unreported.[1] These injuries frequently occur in active and athletic populations as a result of both contact and noncontact sporting activities. Clinically, they are graded based on the amount of joint space opening with valgus stress at 30° of knee flexion. The American Medical Association describes a classification system for the grading of the joint space opening (Table 1).[2] It is also crucial that the clinician evaluate damage to associated structures, including the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), posterior oblique ligament (POL), medial meniscus, and chondral injury, particularly with higher-energy injuries. Most MCL injuries are treated nonoperatively with stabilization and rehabilitation. In cases where instability exists after nonoperative treatment, or instances of persistent instability after ACL and/or PCL reconstruction, the MCL tear may be addressed through surgical repair or reconstruction. Some surgeons prefer to address bony avulsions with operative management when present.

Anatomy

The medial side of the knee has classically been described in 3 layers.[3] Layer 1 is the most superficial, and includes the fascia investing the sartorius muscle. Layer 2 is the middle layer, including the superficial MCL, the POL, structures of the posteromedial corner (including the musculotendinous attachments of the semimembranosus), and the medial patellofemoral ligament (MPFL). Layer 3 is the deep layer, including the true joint capsule and the deep component of the MCL. The MCL has both superficial and deep components, found in the second and third layers of the medial compartment of the knee, respectively, and are separated by a bursa. The superficial MCL originates from the medial femoral condyle and inserts on the medial tibial crest, about 4 cm below the tibial plateau, and posterior to the pes anserinus (Figure 1).[4,5] Recent anatomic studies of the medial knee anatomy have shown the superficial MCL to have 2 distinct attachments on the tibia.[6] The deep MCL can also be divided into 2 distinct portions—meniscofemoral and meniscotibial. The meniscofemoral portion originates from the femur distal to the origin of superficial component and inserts on the medial meniscus, and the meniscotibial portion inserts on the tibial plateau from the meniscus. The superficial and deep components of the MCL are separated by a bursa, allowing for translation of the structures with flexion and

Correspondence:
Patrick S. Duffy, MD,
University Hospitals,
Case Medical Center,
11100 Euclid Ave.,
Cleveland, OH 44106.
Tel: 719-660-4435
E-mail: patrick.duffy@case.edu

041509e

Table 1. American Medical Association Nomenclature for MCL Injury[2]

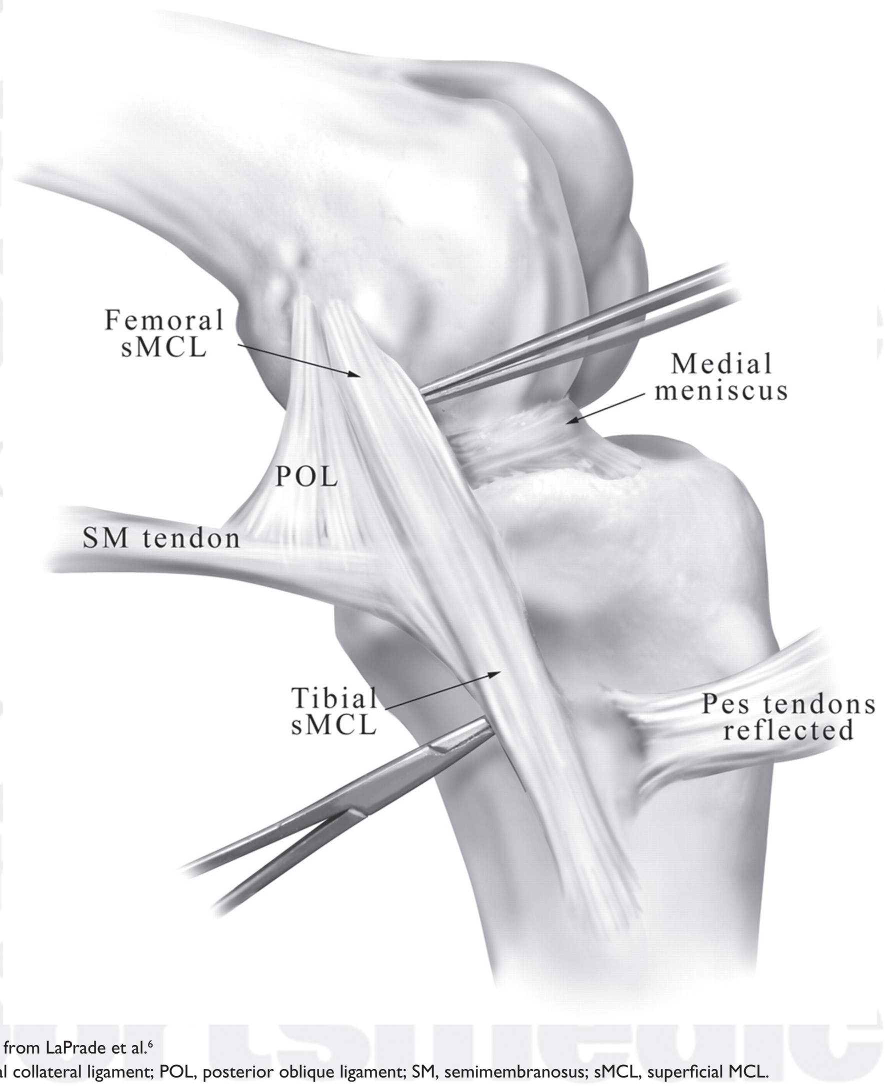
Grade of injury	Amount of medial joint line opening
Grade I	< 5 mm
Grade II	5–10 mm
Grade III	>10 mm

extension of the knee. The posterior fibers of the deep MCL blend with the fibers of the posteromedial capsule of the knee and the POL.[7]

The supporting structures of the medial side of the knee are important in understanding the evaluation, treatment, and rehabilitation of the patient with a knee injury. Muscular attachments on the medial aspect of the knee include the sartorius, gracilis, and semitendinosus, with a collective insertion point termed the pes anserinus that is located at the anterior medial border of the tibia below the tibial plateau. The semimembranosus and the medial head of the gastrocnemius also provide support and have attaching fibers on the medial and posteromedial corner of the knee. Ligamentous attachments on the medial side of the knee include the MPFL, POL, the oblique popliteal ligament, and the superficial and deep MCL, also known as the tibial collateral ligament (Figure 2).

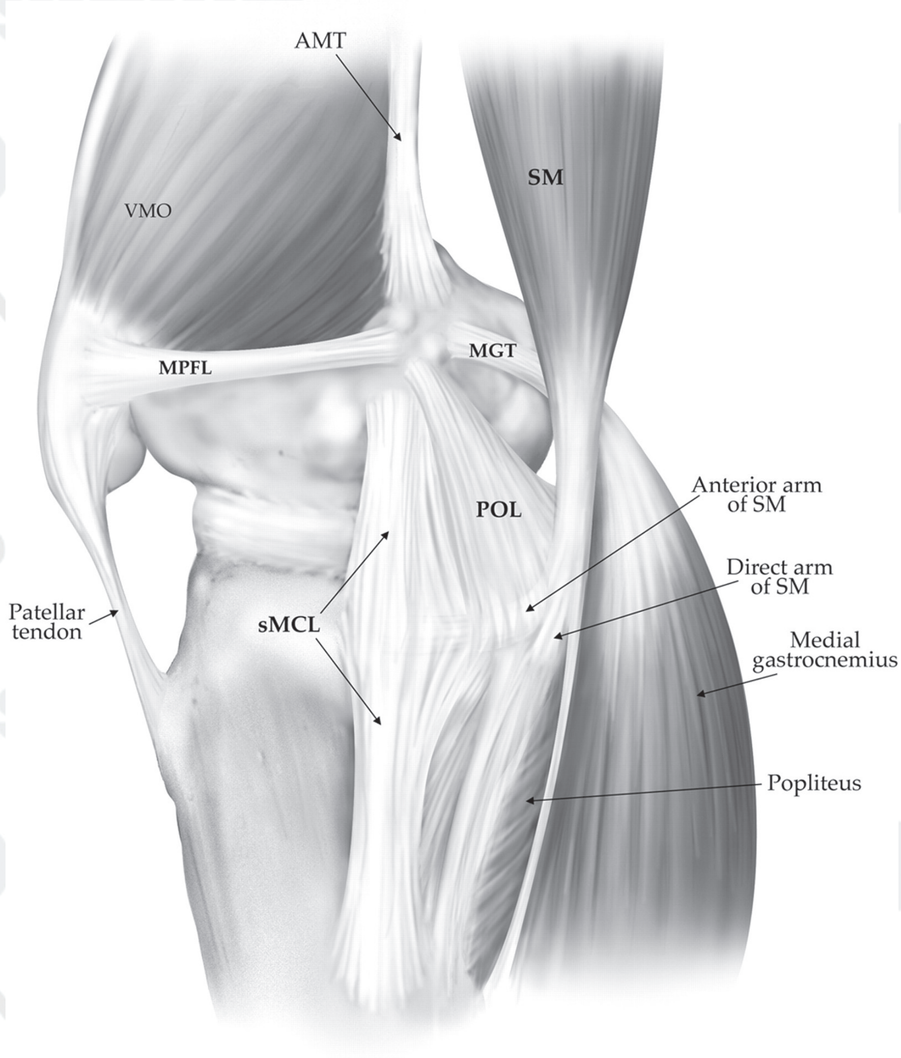
The biomechanical function of the medial knee structures is to provide stability against valgus stress, along with internal

Figure 1. This illustration shows the superficial MCL with its proximal femoral attachment and 2 distal tibial attachments. The tip of the hemostat sits between the 2 attachments.



Reproduced with permission from LaPrade et al.[6]
Abbreviations: MCL, medial collateral ligament; POL, posterior oblique ligament; SM, semimembranosus; sMCL, superficial MCL.

Figure 2. This illustration shows the main supporting structures of the medial knee.



Reproduced with permission from LaPrade et al.[6]
Abbreviations: AMT, adductor magnus tendon; MGT, medial gastrocnemius tendon; MPFL, medial patellofemoral ligament; SM, semimembranosus; sMCL, superficial medical collateral ligament; POL, posterior oblique ligament; VMO, vastus medialis obliquus.

and external rotation. A recent sectioning study investigated the role of each ligament in providing resistance to these motions.[8] The primary stabilizer to valgus stress at all angles of knee flexion is the superficial MCL, with the deep MCL acting as the secondary stabilizer. The ACL and PCL each provide some resistance to valgus stress. The primary stabilizer to external rotation was also determined to be the superficial MCL, with different portions of the ligament providing restraint at different degrees of flexion. Secondary stability to external rotation is provided by both the deep MCL and, at 30° of flexion, the POL. Finally, the POL, superficial MCL, and deep MCL share the primary stress of internal rotation, with different portions of the ligaments sharing the stress at different angles of knee flexion.

Etiology

Medial collateral injuries can result from both contact and noncontact sports. Classic examples include lateral blows to the knee resulting in a valgus stress, as seen in contact sports such as American football, ice hockey, and rugby. Additional mechanisms of injury include external rotation of the foot with a flexed knee, as seen in skiing injuries, and frank knee dislocations. The incidence of injuries to the medial knee structures is reported to be 0.24 per 1000 in the United States annually, affecting males twice as frequently as females.[9] Although most MCL injuries are isolated, the likelihood of injury to associated structures of the knee increases with increasing severity. With grade III sprains there is a 78% rate of associated injury.[10]

Clinical Presentation

The patient will typically present with a history of traumatic injury that resulted in pain on the medial side of the knee. The history may frequently include a tearing sensation; however, an auditory "pop" may suggest a higher-energy insult and involvement of additional structures. Individuals with lower-degree sprains may have attempted to continue to participate post-injury. In some instances, the injury may be more gradual in onset, resulting from repetitive use injury and microtears. The history should include the timing and onset of effusion, if any, suggesting a more significant injury or concomitant damage to the ACL, PCL, or meniscus. However, with multiligament knee injuries, capsular disruption may lead to swelling and ecchymosis down the leg, with minimal swelling in the knee itself. Because of the potential for swelling to enter the extremity, a good examination of the neurovascular status of the affected limb is warranted to avoid serious complications. The specific mechanism of injury should be elicited when possible, as a specific history of trauma by external force to the leg and rotational trauma have been shown to have an independent association with MCL injuries.[11] The use of palliative therapies in chronic injuries, and any history of previous knee pain, surgery, or prior injury should also be noted.[12] The differential diagnosis of medial knee pain includes MCL sprain, medial meniscus tear, pes anserine bursitis, medial plica syndrome, and chondral damage among others.[13]

Physical Examination

The key components of the physical examination include inspection, palpation, stress examination, and evaluation for concomitant injury. Inspection includes observation of the joint and lower extremity for swelling and ecchymosis, and observation of gait, both for initial evaluation and to follow clinical recovery after treatment. Palpation should include a good evaluation of the neurovascular status of the injured limb. Palpation along the joint line and length of the MCL should identify the point of maximal tenderness, as this may indicate injury to the origin, midsubstance, or insertion of the ligament. Pain with palpation along the medial joint line can also indicate a meniscal injury, chondral injury, or synovial inflammation.

Stress examination of the knee to evaluate the integrity of the MCL includes valgus stress testing and a dial or external rotation test. Valgus stress testing is performed with the patient supine, with one of the examiner's hands on the lateral thigh just above the knee and the other above the ankle, with gentle application of an outward force to ankle. The knee is assessed in this manner at both full extension and 30° of flexion. At full extension, the valgus stress test is assessing the integrity of the superficial and deep MCL, as well as the ACL and PCL. Valgus stress examination, with the knee at 30° of flexion, isolates the MCL. Because of the added stability from the ACL and PCL in extension, and the variable stress pattern on the MCL at different degrees of flexion, it is important to examine the patient in both full extension and at 30° of flexion to fully assess the integrity of the MCL. The injury is graded I, II, or III based on the amount of joint line opening compared with the uninjured knee (Table 1).[2] Experienced physicians can also describe the degree of the injury: first-degree sprains are mild sprains or strains with associated pain and inflammation without valgus instability; second-degree sprains are partially torn with valgus laxity but with a solid endpoint to widening stress and rebound to the resting position; third-degree sprains are complete tears of the ligament with instability of the knee to valgus stress and a soft or no endpoint to the valgus stress. The grading and degree of injury are often confused as terms and used interchangeably; however, grading should refer to the objective measurement of joint line opening, and the degree is a clinical description of the subjective quality of the instability. Pain and laxity at 30° of flexion have been shown to have high sensitivity (86%) and are predictive of MCL pathology.[11,14]

The dial test for stability with external rotation is performed with the knee flexed at 90° but externally rotating the patient's foot and tibia. Although this test is also used for assessment of the posterolateral corner and other knee pathology, it can be used to assess the medial knee stabilizers. Pain in the medial aspect of the knee with this test may add to the clinical suspicion of POL involvement of an MCL tear.

Evaluation for concomitant injury looks for additional injury in the knee. The examiner should assess the integrity of the ACL and PCL with the Lachman and drawer tests, as these structures can often be damaged with a high-grade injuries. Assessing patellar stability is also critical in evaluating the integrity of the MPFL. Meniscal damage may be present and can be assessed with the McMurray test or pain directly along the joint line. Chondral injury may also be present with MCL injury and may be addressed if surgical intervention is planned. The presence of a hemarthrosis may indicate damage to the cruciate ligaments or bony fracture. Additionally, the strength of the supporting musculature is assessed along with the neurovascular status of the limb.

Imaging Studies

Imaging of the knee is not always necessary to diagnose an MCL injury; however, radiographs and magnetic resonance imaging (MRI) can help guide treatment and therapy, particularly when planning surgical intervention. Lesions may even be detected with ultrasound in the hands of a trained ultrasonographer. Some have suggested the Ottawa knee rules should be used to guide the decision regarding the necessity of obtaining radiographs with suspected MCL injury. According to these rules, a radiographic knee series is only indicated if any of the 5 criteria are met (Table 2).[15] Radiographic imaging may include anteroposterior, lateral, oblique, and occasionally stress views of the knee joint. In children, stress radiographs are obtained to rule out physeal injury that, if missed, can lead to poor outcomes. In patients with chronic pain from a previous MCL injury, radiographs may demonstrate crescent-shaped calcification along the MCL, known as a Pellegrini-Stieda lesion. These lesions can occasionally be symptomatic, necessitating surgical excision.[16]

T2-weighted MRI is the gold standard for diagnosing MCL injury. Both partial- and full-thickness tears can be identified along with the site of injury (Figure 3). Magnetic resonance imaging has been studied in comparison with the evaluation by an orthopedic surgeon and shown to have an 87% accuracy in comparison with the clinical diagnosis.[9] Magnetic resonance imaging is warranted in second- and third-degree MCL injuries, when concomitant damage to the ACL, PCL,

Table 2. Ottawa Knee Rules

Imaging is only indicated if the patient meets any of the following 5 criteria
1. Patient aged ≥ 55 years
2. Isolated tenderness of the patella (no bony tenderness of the knee other than the patella)
3. Tenderness at the head of the fibula
4. Inability to flex knee to 90°
5. Inability to bear weight both immediately and in the emergency department for 4 steps

Figure 3. A coronal plane magnetic resonance image of a knee with an avulsion of the superficial medial collateral ligament (MCL) and meniscotibial portion of the deep MCL from their tibial origin. The white arrow demonstrates the distal end of the avulsed superficial MCL.

Reproduced with permission from Wijdicks et al.[9]

menisci, or chondral surfaces may also be present with a high sensitivity (90%) and specificity.

Prevention and Treatment

Hinged knee braces have been considered for injury prevent in at-risk populations (particularly those in contact sports). A study on commercial knee braces conducted on surrogate knee models has shown up to a 20% to 30% increase in MCL strain relief and knee stiffness.[17] Two large epidemiologic studies have investigated the injury rates and compliance of athletes wearing knee braces for injury prevention. One study was performed at West Point involving cadets playing intramural tackle football, and the other study evaluated football players in the Big Ten Conference universities. The West Point study was a prospective randomized trial that demonstrated that cadets not wearing prophylactic knee braces had more than a 2-fold increase in injury rate compared with those wearing braces.[18] The Big Ten Conference study did not show a statistically significant difference in injury rates; however, athletes playing positions considered at increased risk of MCL injury, such as tight ends and linebackers, did have a decreased injury rate.[1,19] Although there has been evidence to show that bracing can help prevent injury and mitigate MCL stress during valgus force, concerns of performance impairment by athletes prevents widespread use of prophylactic bracing. Functional studies on knee bracing vary, but suggest that there may be a detrimental effect on performance characteristics, including straight sprint speed, oxygen consumption, energy expenditure, heart rate, blood lactate levels, maximal torque, and muscle relaxation pressures.[20] As more studies are conducted on the performance characteristics of modern and custom-fit braces and their effect on athletic performance, it is possible that prophylactic bracing will become a standard preventative measure to help reduce MCL injuries.[1]

Nonsurgical intervention is the mainstay of treatment for first- and second-degree MCL sprains as well as isolated third-degree sprains. Healing occurs as an admixture of overlapping processes, including hemorrhage, inflammation, repair, and remodeling, resulting in scarring and reattaching of the ligament.[21] Rest, ice, compression, and elevation, along with bracing and crutches are used acutely. The patient is placed in a hinged knee brace and may bear full weight with follow-up examinations at 1- to 2-week intervals to ensure that appropriate healing of the ligament is occurring. Once valgus laxity is no longer present and the patient is pain-free, return to sport is encouraged.

In a study performed in football players, the combined time for return to play in first- and second-degree sprains was an average of 20 days.[22] In first-degree injuries, this may average 10 to 11 days post-injury and 20 days post-injury in second-degree sprains.[1] Healing times vary among individuals, but tend to follow an increasing period of recovery with high-grade MCL injuries.

Surgical intervention remains a controversial topic in the literature, with excellent results reported with both conservative and operative management. Surgery is generally reserved for patients with third-degree injuries who fail to recover stability appropriately from nonoperative treatment, resulting in chronic valgus instability.

Surgical options include primary repair of the ligament or autograft/allograft reconstruction. Primary repair can be performed with heavy braided suture, suture anchors, spiked washer fixation, or a combination thereof depending on the site of injury. Excellent results have been reported with all types of repair, and selection may depend on surgeon preference. There are a variety of options for reconstruction of the ligament, including the use of hamstrings, which can be used in a double-bundle fashion to help repair the integrity of the POL and provide additional stability throughout knee flexion.[1] Achilles allograft is another popular choice for reconstruction because the broad, fan-shaped nature of the graft can restore valgus stability through multiple angles of knee flexion as different parts of the graft are being tensioned.

Patients with bony avulsions at the origin or insertion of the MCL, and patients with combined MCL/ACL and/or PCL injury may be candidates for operative intervention.[22] When a bony avulsion is present, a cancellous screw may be used for fixation of the bony fragment, and may be sufficient to restore stability in the absence of additional ligamentous tearing. Recent studies have focused on early versus late reconstruction of combined ACL/MCL injuries, with more emphasis on surgical reconstruction of the ACL and nonoperative management of the MCL injury. Early repair has been shown in animal models to create a positive healing environment for the MCL, as stability and reapproximation of the ligament is achieved.[1] However, recent reviews of the literature still address controversy regarding early versus late operative treatment, and there are a lack of appropriate studies to make a final determination.[23]

Early return to play is the goal of both amateur and professional athletes, and multiple emerging therapies and modalities are being explored to hasten the healing process. These include modalities such as low-intensity pulsed ultrasound, prolotherapy, platelet-rich plasma injection, stem cells, porcine small intestine scaffolding, gene therapy, and growth factors. Of these, there is already some supportive evidence for low-intensity ultrasound in rabbit models.[24] Prolotherapy is the practice of injecting dextrose or other sclerotic irritants into the injured tendon to encourage inflammation and tissue proliferation. Platelet-rich plasma injections involve an autologous blood donation that is fractionated and concentrated to obtain platelet-rich plasma fractions that are then co-injected with platelet activators into the damaged tissue. Although many of these therapies are gaining popularity, there are a lack of data and large-scale studies to support their evidence-based clinical use. Some emerging concepts in tissue engineering may become clinical practice in the future, with bio-scaffolding being studied in animal models.[25] These frontiers of medicine may affect the future of ligamentous injury management.

Summary

The MCL is the most frequently injured ligament in the knee, and remains an area of emerging clinical, surgical, and rehabilitative science. A clinical diagnosis of MCL injury can be made by combining knowledge of medial knee anatomy with the most common mechanisms of injury, a thorough history and physical examination, and appropriate imaging. With excellent outcomes reported from both conservative and surgical management, the mainstay of treatment remains non-operative for most MCL injuries. Many surgical options exist, with ongoing studies on the benefits of early versus late reconstruction of the ACL in the setting of an MCL injury. With the increasing demand for early return to play at both the amateur and professional athletic level, emerging therapies may prove beneficial in future clinical practice but are still investigational.

Conflict of Interest Statement

Patrick S. Duffy, MD and Ryan G. Miyamoto, MD disclose no conflicts of interest.

References

1. Miyamoto RG, Bosco JA, Sherman OH. Treatment of medial collateral ligament injuries. *J Am Acad Orthop Surg*. 2009;17(3):152–161.
2. American Medical Association. Committee on the Medical Aspects of Sports. Subcommittee on Classification of Sports Injuries. Standard nomenclature of athletic injuries. Chicago, IL; 1966:157.
3. Warren LF, Marshall JL. The supporting structures and layers on the medial side of the knee: an anatomical analysis. *J Bone Joint Surg Am*. 1979;61(1):56–62.
4. Robinson JR, Sanchez-Ballester J, Bull AM, Thomas Rde W, Amis AA. The posteromedial corner revisited. An anatomical description of the passive restraining structures of the medial aspect of the human knee. *J Bone Joint Surg Br*. 2004;86(5):674–681.
5. Wymenga AB, Kats JJ, Kooloos J, Hillen B. Surgical anatomy of the medial collateral ligament and the posteromedial capsule of the knee. *Knee Surg Sports Traumatol Arthrosc*. 2006;14(3):229–234.
6. LaPrade RF, Engebretsen AH, Ly TV, Johansen S, Wentorf FA, Engebretsen L. The anatomy of the medial part of the knee. *J Bone Joint Surg Am*. 2007;89(9):2000–2010.
7. Sims WF, Jacobson KE. The posteromedial corner of the knee: medial-sided injury patterns revisited. *Am J Sports Med*. 2004;32(2):337–345.
8. Griffith CJ, LaPrade RF, Johansen S, Armitage B, Wijdicks C, Engebretsen L. Medial knee injury: part 1, static function of the individual components of the main medial knee structures. *Am J Sports Med*. 2009;37(9):1762–1770.
9. Wijdicks CA, Griffith CJ, Johansen S, Engebretsen L, LaPrade RF. Injuries to the medial collateral ligament and associated medial structures of the knee. *J Bone Joint Surg Am*. 2010;92(5):1266–1280.
10. Fetto JF, Marshall JL. Medial collateral ligament injuries of the knee: a rationale for treatment. *Clin Orthop Relat Res*. 1978;132:206–218.
11. Kastelein M, Wagemakers HP, Luijsterburg PA, Verhaar JA, Koes BW, Bierma-Zeinstra SM. Assessing medial collateral ligament knee lesions in general practice. *Am J Med*. 2008;121(11):982–988.
12. Calmbach WL, Hutchens M. Evaluation of patients presenting with knee pain: part I. History, physical examination, radiographs, and laboratory tests. *Am Fam Physician*. 2003;68(5):907–912.
13. Calmbach WL, Hutchens M. Evaluation of patients presenting with knee pain: part II. Differential diagnosis. *Am Fam Physician*. 2003;68(5):917–922.
14. Scotney B. Sports knee injuries—assessment and management. *Aust Fam Physician*. 2010;39(1–2):30–34.
15. Stiell IG, Greenberg GH, Wells GA, et al. Prospective validation of a decision rule for the use of radiography in acute knee injuries. *JAMA*. 1996;275(8):611–615.
16. Theivendran K, Lever CJ, Hart WJ. Good result after surgical treatment of Pellegrini-Stieda syndrome. *Knee Surg Sports Traumatol Arthrosc*. 2009;17(10):1231–1233.
17. Brown TD, Van Hoeck JE, Brand RA. Laboratory evaluation of prophylactic knee brace performance under dynamic valgus loading using a surrogate leg model. *Clin Sports Med*. 1990;9(4):751–762.
18. Sitler M, Ryan J, Hopkinson W, et al. The efficacy of a prophylactic knee brace to reduce knee injuries in football. A prospective, randomized study at West Point. *Am J Sports Med*. 1990;18(3):310–315.
19. Albright JP, Powell JW, Smith W, et al. Medial collateral ligament knee sprains in college football. Brace wear preferences and injury risk. *Am J Sports Med*. 1994;22(1):2–11.
20. Najibi S, Albright JP. The use of knee braces, part 1: prophylactic knee braces in contact sports. *Am J Sports Med*. 2005;33(4):602–611.
21. Woo SL, Vogrin TM, Abramowitch SD. Healing and repair of ligament injuries in the knee. *J Am Acad Orthop Surg*. 2000;8(6):364–372.
22. Chen L, Kim PD, Ahmad CS, Levine WN. Medial collateral ligament injuries of the knee: current treatment concepts. *Curr Rev Musculoskelet Med*. 2008;1(2):108–113.
23. Papalia R, Osti L, Del Buono A, Denaro V, Maffulli N. Management of combined ACL-MCL tears: a systematic review. *Br Med Bull*. 2010;93:201–215.
24. Sparrow KJ, Finucane SD, Owen JR, Wayne JS. The effects of low-intensity ultrasound on medial collateral ligament healing in the rabbit model. *Am J Sports Med*. 2005;33(7):1048–1056.
25. Woo SL, Takakura Y, Liang R, Jia F, Moon DK. Treatment with bioscaffold enhances the the fibril morphology and the collagen composition of healing medial collateral ligament in rabbits. *Tissue Eng*. 2006;12(1):159–166.