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Recent trends in treatment of medial collateral ligament of knee reconstruction - review literature

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Abstract:

The medial collateral ligament (MCL) is a key stabilizer of the knee, responsible for resisting valgus stress and maintaining medial joint stability, which makes it highly vulnerable to injuries during twisting movements, abrupt directional changes, or direct lateral impacts. These injuries are particularly common in high-velocity and pivot-intensive sports such as skiing, where the MCL accounts for a significant proportion of knee trauma. MCL injuries typically result from rotational forces or valgus overload and may occur in isolation or as part of complex patterns such as the "unhappy triad," involving additional damage to the ACL and medial meniscus.

Epidemiologically, MCL injuries represent the most frequent ligamentous knee injury, reflecting the ligament's essential biomechanical role. Diagnostic evaluation begins with radiographs to identify fractures or Pellegrini-Stieda lesions, but MRI remains the gold standard for assessing ligament integrity and associated soft-tissue damage, while ultrasound offers a dynamic and cost-effective alternative with high diagnostic accuracy. Management is largely conservative for grade I–II injuries, focusing on NSAIDs, bracing, early mobilization, and structured rehabilitation to restore strength and function, with most athletes recovering successfully.

Grade III injuries or those associated with multi-ligament trauma may require surgical repair or reconstruction, followed by staged rehabilitation. Differential diagnoses include *inflammatory arthropathies, infections, osteoarthritis, overuse syndromes, patellar instability, tendonitis, Baker's cysts, and pediatric hip disorders. Complications are rare but may include heterotopic ossification, such as Pellegrini-Stieda lesions, especially when rehabilitation is inadequate. Overall, early diagnosis, appropriate imaging, and a coordinated interprofessional approach result in excellent outcomes, with most patients returning to pre-injury activity levels and maintaining long-term knee stability.*

***Keywords**: Medial collateral ligament, MCL injury, valgus stress, knee instability, sports trauma, ligament reconstruction, MRI evaluation, ultrasound assessment, conservative management, surgical repair, rehabilitation, Pellegrini-Stieda lesion, unhappy triad, knee ligament injuries*

Introduction

The medial collateral ligament (MCL) is a broad, flat, and strong band of connective tissue extending from the medial epicondyle of the femur to the medial aspect of the proximal tibia. It plays a crucial role in maintaining valgus stability of the knee by resisting forces that push the joint inward. Because it functions as a primary stabilizer against medial stress, it is highly vulnerable to injury during activities that involve sudden twisting, abrupt directional changes, or direct blows to the outer side of the knee. Such mechanisms are common in various sports, with skiing being notably associated with a high incidence of MCL trauma. Studies have reported that approximately 60% of all knee reconstruction in skiing involve the MCL, underscoring its susceptibility in high-velocity, pivot-based, and fall-prone environments.[1-3]

Anatomy

The medial knee stabilising complex is composed primarily of three ligamentous structures: the superficial medial collateral ligament (sMCL), the deep medial collateral ligament (dMCL), and the posterior oblique ligament (POL).

The sMCL is the largest medial ligament — broad, flat and triangular — with a femoral attachment near (but not exactly at) the medial epicondyle and two tibial attachments (proximal and distal).

The dMCL lies deep within the joint capsule and has meniscofemoral and meniscotibial portions that connect the medial meniscus and tibia/femur, providing restraint to valgus and rotation.

The POL is a thickening of the posteromedial capsule arising from the distal semimembranosus tendon expansions; it attaches on the femur somewhat distal and posterior to the adductor tubercle and contributes to valgus and posteromedial stability.

Important bony landmarks on the medial femur include the medial epicondyle, adductor tubercle, and gastrocnemius tubercle; precise knowledge of these is critical for anatomic repair or reconstruction of medial-side injuries.

Beyond these primary ligaments, additional medial structures (e.g., medial patellofemoral ligament, hamstring tendon insertions, adductor magnus tendon) also contribute to medial knee stability and should be recognised in assessment and treatment. [14]

Quantitative Anatomical Measurements

The femoral attachment of the superficial medial collateral ligament (sMCL) was found to be approximately 1-2 mm proximal to the medial epicondyle.

In one cadaveric study cited: the sMCL femoral attachment measured about 7 mm wide anteroposteriorly (≈11% of condyle dimension) and 9 mm wide proximodistally (≈13%) centered ~1–2 mm proximal to the epicondyle.

The proximal tibial insertion of the sMCL lies approximately 12.2 mm distal to the joint line.

The distal tibial insertion of the sMCL is around 61.2 mm distal to the joint line.

The femoral origin of the deep medial collateral ligament (dMCL) is about 6 mm distal and 5 mm posterior to the medial epicondyle.[14]

Medial Side Biomechanics :

The medial collateral ligament (MCL) is the primary stabilizer of the knee against valgus forces and a secondary stabilizer against excessive external tibial rotation. Its femoral attachment is positioned so that the ligament maintains nearly constant tension throughout knee motion. In contrast, the posterior oblique ligament (POL) contributes mainly to valgus stability in full extension, becoming slack in knee flexion and lying beneath the posterior MCL; this anatomical relationship is important surgically because inappropriate suturing may cause postoperative flexion contracture. The posteromedial corner, including the POL, semimembranosus expansions, meniscotibial ligaments, oblique popliteal ligament, and posterior horn of the medial meniscus, provides both static and dynamic restraint to anteromedial rotatory instability. Strain patterns vary across the MCL: the posterior and central fibers experience decreasing strain with flexion, while the anterior fibers maintain more constant tension. The greatest strain occurs at the femoral origin of the posterior fibers in full extension, explaining why this is the most common injury site.[15]

Etiology :

The medial collateral ligament (MCL) is commonly injured when the knee experiences sudden rotational forces such as abrupt turning, cutting, or twisting movements. Another frequent mechanism is a direct impact to the outer (lateral) side of the knee, which forces the joint into excessive valgus stress and overstretches the ligament. Although an MCL tear can occur as an isolated injury, it often appears in combination with damage to other stabilizing structures of the knee. A classic example is the “unhappy triad,” a well-recognized pattern in which the MCL injury is accompanied by simultaneous tears of the anterior cruciate ligament (ACL) and the medial meniscus, reflecting the significant rotational and valgus forces involved in such trauma.[4-6]

Epidemiology :

Ligament reconstruction of the knee represent a significant proportion of knee-related trauma, comprising nearly 40% of all documented knee reconstruction, and within this group, damage to the medial collateral ligament (MCL) occurs most frequently.[7,8]

These reconstruction arise because the MCL plays a major stabilizing role on the medial side of the knee, making it particularly susceptible to stresses such as valgus force, rotational strain, or direct impact. As a result, MCL tears are consistently reported as the most common ligamentous injury in epidemiological studies. The high incidence underscores the functional importance of this ligament in maintaining joint stability during daily activities and sports, thereby highlighting the need for timely diagnosis and appropriate management to prevent long-term complications.[7,8]

Evaluation:

Imaging for medial collateral ligament (MCL) reconstruction typically begins with plain radiographs, which help detect subtle or occult fractures, including small avulsion fragments that may not be clinically obvious. The presence of a Pellegrini-Stieda lesion—characterized by calcification or ossification at the MCL’s femoral attachment—usually indicates a previous avulsion-type injury involving the ligament. Stress radiographs can also be useful, particularly in skeletally immature individuals, as they help assess medial joint line opening and ligament integrity.

Despite the usefulness of these initial modalities, magnetic resonance imaging (MRI) without contrast remains the preferred investigation because it provides detailed visualization of the MCL and surrounding soft tissues. MRI is highly effective in detecting associated reconstruction such as meniscal tears, capsular disruptions, or damage to other stabilizing structures of the knee. In situations where subtle meniscal or capsular pathology is suspected and MRI findings are inconclusive, MR arthrography may be undertaken for improved diagnostic clarity.

Ultrasound serves as an alternative imaging tool, offering advantages such as rapid availability, portability, dynamic assessment capability, and reduced cost compared to MRI. High-resolution sonography has demonstrated the ability to accurately localize MCL reconstruction and determine their severity in up to 94% of patients, and it also permits real-time performance of the dynamic valgus stress test to evaluate medial joint stability.[9-11]

Conservative Treatment/ Management :

Treatment for most medial collateral ligament (MCL) reconstruction is primarily conservative, especially for grade I and II tears, unless a more serious associated injury necessitates surgical intervention. Pain and inflammation are generally managed with non-steroidal anti-inflammatory drugs (NSAIDs), while a knee immobilizer and temporary use of crutches help stabilize the joint during the early healing phase. As symptoms lessen, patients gradually discontinue supportive devices and begin structured physical therapy. Rehabilitation emphasizes quadriceps strengthening, cycling, and progressive resistance training to restore stability and function. A stepwise return-to-play protocol is recommended, focusing on increasing exercise intensity and sport-specific activities. Athletes with grade I reconstruction typically resume sports within 10–14 days, whereas grade II reconstruction may require a longer, individualized recovery period. Return to play is advised only when both limbs demonstrate equal strength and valgus stress produces no discomfort. Conservative treatment in grade I–II reconstruction is highly effective, with successful recovery reported in approximately 98% of athletes.[12][13]

Cryotherapy is a key non-surgical treatment for MCL injuries, helping reduce pain, inflammation, and secondary tissue damage, with evidence showing significant decreases in blood flow, metabolic activity, and injury size. Ultrasound therapy has also shown benefits, improving pain, range of motion, and tissue healing through its thermal and mechanical effects, with several studies supporting enhanced functional outcomes and collagen alignment. Laser therapy (LLLT) is increasingly recognised for reducing pain, inflammation, and promoting tissue repair, supported by systematic reviews demonstrating improved collagen synthesis and healing responses. Shockwave therapy has additionally emerged as a promising modality, stimulating tissue regeneration and improving pain and functional recovery. Overall, these modalities offer valuable adjuncts in non-surgical MCL rehabilitation, though further research is needed to refine protocols and optimise clinical effectiveness.

Management of grade III reconstruction may involve either conservative therapy or surgery, although operative intervention is frequently preferred for athletes due to the risk of persistent rotational instability. These high-grade tears commonly occur alongside other ligamentous reconstruction, such as anterior cruciate ligament (ACL) tears, which often necessitate surgical repair. Acute MCL tears are generally repairable, while chronic lesions may require reconstruction using autografts or allografts. Postoperative care includes the use of a hinged brace locked at 30° of flexion, with toe-touch weight-bearing for the first three weeks. During this period, range-of-motion exercises are permitted up to 90°, and strengthening exercises are initiated while maintaining brace support. After three weeks, patients progress to full weight-bearing, and the brace is unlocked to allow complete range of motion. Rehabilitation then advances to closed kinetic chain exercises and gradually increasing resistance training to restore functional stability.

Indications For Operative/Surgical Management :

Operative Management Of Mcl Injuries Is Indicated In Situations Such As Open Injuries, Significant Valgus Laxity In Full Extension, Anteromedial Rotatory Instability, Multiligament Knee Injuries, Or Persistent Symptoms After Adequate Non-Operative Treatment. Imaging-Based Indications Include Valgus Malalignment, Tibial-Plateau Fractures, Large Mcl Avulsion Fragments, Stener-Type Lesions Where The Pes Anserinus Interposes Between Torn Ligament Ends, And Cases Where The Mcl Becomes Entrapped Under The Medial Meniscus. In Combined Acl–Mcl Injuries, Several Strategies Exist: Acl Reconstruction With Non-Operative Mcl Treatment Is Chosen When The Mcl Has Good Healing Potential; Acl Reconstruction With Mcl Repair Is Preferred In Acute Avulsion Or Clear Anatomical Disruption; And Acl Reconstruction With Mcl Reconstruction Is Recommended When Chronic Instability, Poor Tissue Quality, Or Persistent Valgus Laxity Remains After Rehabilitation[16].

Surgical Principles:

First, thorough preoperative planning is critical to determine all required procedures, instruments, and backup strategies; surgery should be performed in a hospital setting with imaging support and vascular backup available. Second, adequate exposure is required for direct visualization of all structures being repaired or reconstructed; this is achieved through appropriately chosen incisions such as straight medial, curved medial utility, or midline incisions, ensuring proper skin flap thickness and healing. Third, appropriate graft selection is vital, with recommended allografts including Achilles or patellar tendon for PCL reconstruction and hamstring or tibialis grafts for the medial/posteromedial corner; autograft options include patellar tendon, hamstrings, or quadriceps tendon. Fourth, the sequence of surgery must follow a specific order—starting with examination under anesthesia, followed by limited arthroscopy, cruciate reconstruction tunnel placement, graft fixation timing, and finally medial-side repair—to ensure correct tunnel positioning and tensioning. Fifth, careful handling of posteromedial structures, especially avoiding excessive advancement of the posterior oblique ligament (POL), is crucial to prevent postoperative flexion contracture. Sixth, MCL repairs must maintain the ligament's broad, flat configuration, using the appropriate suturing method or anchors depending on tear location, with accurate restoration of isometry using the medial epicondyle as a guide. Together, these principles provide a structured framework for addressing complex medial-side and multiligament knee injuries.[15]

Surgical/Operative Techniques:

Modified "Danish technique" for reconstructing the superficial medial collateral ligament (sMCL), intended for high-grade or combined medial-side injuries where non-operative treatment is insufficient. The technique uses the patient's semitendinosus tendon with its tibial attachment preserved, which is then routed through anatomically positioned tibial and femoral tunnels to recreate the native sMCL. Fixation is achieved using dual adjustable-loop suspensory buttons on both sides, allowing precise intra-operative and postoperative graft tensioning to optimise valgus stability. The authors emphasise the importance of anatomic tunnel placement to restore normal medial knee biomechanics rather than simply tightening lax tissue. Advantages of this approach include preservation of the native tibial insertion, improved proprioceptive potential, controlled tensioning, and reduced donor-site morbidity by avoiding additional graft harvest.[17]

The Hughston technique is a traditional surgical method used to treat chronic medial knee instability, particularly longstanding valgus laxity caused by stretching of the superficial and deep MCL rather than complete rupture. It involves tightening and reinforcing the medial ligament complex by imbricating (reefing) and advancing the lax fibres of the sMCL, deep MLC, posterior oblique ligament, and medial capsule. Through a medial incision, redundant or elongated fibres are overlapped and sutured to restore appropriate tension, and in more severe cases the ligament attachments may be advanced on the femur or tibia. This technique re-establishes valgus and anteromedial rotational stability while preserving native tissue and avoiding graft harvest. Its advantages include shorter surgical time, no donor-site morbidity, and maintenance of proprioceptive function, though it is less suitable for complete tears, avulsions, or multiligament knee injuries. While modern anatomic reconstruction techniques are often preferred, the Hughston technique remains useful for selected cases where the medial structures are intact but overly lax.[18]

A modified medial collateral ligament reconstruction technique designed for chronic grade-III MCL injuries, often associated with ACL tears and significant valgus laxity. The procedure uses a single semitendinosus autograft with its tibial insertion preserved, fashioned into two functional bundles to anatomically reconstruct both the superficial and deep MCL. Femoral and tibial fixation points are chosen to replicate native ligament anatomy, with suspensory fixation on the femoral side and screw or anchor fixation on the tibia. The technique can be performed either alone or in combination with ACL reconstruction, depending on the pattern of instability. Early outcomes in high-BMI patients with chronic injuries showed excellent functional recovery and restoration of valgus, rotational, and anterior stability. Anatomical reconstruction of both the superficial and deep components is essential in combined ACL–MCL injuries to restore full medial-side stability and protect the ACL graft from excessive medial stress.[19]

Pearls and Other Issues

Complications associated with medial collateral ligament (MCL) reconstruction are uncommon, particularly when the condition is diagnosed promptly and managed appropriately. Early treatment and proper rehabilitation significantly reduce the likelihood of long-term problems, and the chances of a recurrent ligament rupture remain minimal. However, when an MCL injury is neglected or when patients do not follow a structured rehabilitation protocol, abnormal tissue healing may occur. One such consequence is the development of calcification or ossification at the site of injury, a condition classically referred to as the Pellegrini-Stieda lesion. This lesion represents heterotopic bone formation along the medial femoral condyle and typically arises due to chronic inflammation or repetitive stress at the injured ligament attachment. Although rare, such complications highlight the importance of timely diagnosis, adherence to physiotherapy, and appropriate follow-up to ensure optimal healing and prevent functional impairment.

Medial collateral ligament (MCL) injuries of the knee are described consistently across the referenced articles as a spectrum in which most isolated grade I and II injuries, and even many isolated grade III injuries, can be managed successfully with conservative treatment. The reviews emphasize that nonoperative care remains the standard for the majority of patients because the MCL has good intrinsic healing potential. Conservative management typically includes a short period of protection with a hinged knee brace, early but controlled range-of-motion exercises, and structured, progressively loaded rehabilitation focused on quadriceps/hamstring strengthening, proprioception, and neuromuscular control. Recent rehabilitation-oriented reviews underline that prolonged immobilization is no longer recommended; instead, early functional rehabilitation improves outcomes, speeds return to activity, and minimizes stiffness. Most patients treated nonoperatively regain medial stability with high satisfaction rates, and return to sport is generally achievable within weeks to a few months depending on injury grade.

Despite the strong success rates of nonoperative care, the literature consistently outlines clear indications for surgical intervention. Surgery becomes appropriate when there is persistent valgus instability following an adequate trial of conservative management, when the MCL injury is part of a multiligament knee injury—particularly in association with ACL, PCL, or posteromedial corner injuries—or when specific anatomic patterns are present such as femoral or tibial avulsions, entrapment of the MCL, intra-articular interposition, or open injuries. In these situations, restoring the medial stabilizers surgically is necessary both for functional stability and to protect concurrent ligament reconstructions.

The surgical options described in the articles include acute primary repair and anatomic reconstruction. Acute repair is reserved for cases where the tissue is repairable—such as bony avulsions or identifiable femoral/tibial detachments—using sutures or anchors, sometimes augmented with internal bracing. For chronic injuries, poor-quality tissue, or failed conservative management, anatomic reconstruction is recommended. Modern trends emphasize reconstructing both the superficial MCL (sMCL) and the deep MCL (dMCL)/posteromedial corner, often through dual-bundle or two-ligament techniques using semitendinosus autograft or allograft. These anatomic reconstructions better restore both valgus and rotational stability and have shown biomechanical superiority compared with older, nonanatomic or single-band techniques. Surgical technique papers highlight improving graft isometry, tensioning, and tunnel positioning to restore the native medial knee architecture.

Rehabilitation is essential regardless of treatment pathway. Conservative rehabilitation focuses on controlled early motion, progressive strengthening, and structured return-to-sport testing. Postoperative rehabilitation follows similar principles but proceeds more cautiously depending on the repair/reconstruction construct and any concurrent procedures. Early ROM is usually allowed within a controlled arc, with gradual progression of weight-bearing. Strengthening and neuromuscular training follow, but return to sport is typically slower after reconstruction than after isolated nonoperative recovery.

Conclusion:

Nonoperative treatment is the preferred first-line management for isolated MCL injuries, including most grade III lesions without valgus instability. Surgery is reserved for instability, multiligament injuries, acute avulsions, entrapment, or chronic symptomatic laxity, where it provides superior stability and protects associated ligamentous reconstructions. When surgery is indicated, anatomic dual-structure reconstruction offers the most reliable restoration of valgus and rotational stability. Ultimately, the best outcomes—whether operative or nonoperative—depend heavily on a criterion-based, progressive rehabilitation program.

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