

Medial collateral ligament injury

Anatomy & Pathophysiology

BONY ANATOMY & LIGAMENT STRUCTURE

- The medial collateral ligament (MCL) originates on the medial epicondyle and inserts 7 to 10 cm below the joint line on the posterior half of the medial surface of the tibial metaphysis deep to the pes anserinus tendons [6].
- The MCL is a long, rather narrow, well-delineated structure lying superficial to the medial capsule and capsular ligaments [6].
- The femoral insertion site of the superficial MCL is located a mean 1.6 mm posterior and 4.9 mm proximal to the intersection between a line paralleling the posterior femoral cortex and a line drawn perpendicular to the posterior femoral cortex, where it intersects the Blumensaat line [7].
- The medial side of the knee is described in layers: layer 1 is the deep fascia, layer 2 is the superficial MCL, and layer 3 is the joint capsule and deep MCL [2].
- The MCL receives its blood supply from the superior medial and inferior medial geniculate arteries [2].
- The perpendicular mean distance from the saphenous nerve to the adductor tubercle or the medial epicondyle is 5 cm or 6.1 cm, respectively [7].
- The perpendicular mean distance of the sartorial branch of the saphenous nerve to the anterior aspect of the superficial MCL is 4.8 cm at a point 2 cm distal to the joint line, 4.1 cm at 4 cm distal to the joint line, and 3.8 cm at 6 cm distal to the joint line [7].

STATIC & DYNAMIC STABILIZERS

- The superficial MCL is the primary restraint to valgus stress [2].
- The deep MCL and posterior oblique ligaments (POL) form the secondary restraints to valgus stress [2].
- The semimembranosus, vastus medialis, medial retinaculum, sartorius, semimembranosus, and gracilis act as dynamic stabilizers of the medial knee [2].
- The medial capsuloligamentous complex comprises a three-layered sleeve of static and dynamic stabilizers extending from the midline anteriorly to the midline posteriorly [3].

- Static stabilizers of the medial knee include the superficial MCL, the posterior oblique ligament, and the deep MCL (also called the deep medial ligament or middle capsular ligament) [3].
- Dynamic stabilizers providing abduction stability under dynamic conditions include the semimembranosus complex, the pes anserinus muscle group (sartorius, gracilis, and semitendinosus muscles), the vastus medialis, and the medial retinaculum [3].
- The superficial MCL with intact femoral and distal tibial attachments has the highest load to failure and stiffness among medial knee ligaments, followed by the POL and the deep MCL [7].

BIOMECHANICS & INJURY MECHANISM

- The main function of the medial capsuloligamentous complex is to resist valgus and external rotation loads [3].
- The superficial MCL is the primary restraint to valgus loads at 30° of flexion [3].
- The posterior oblique ligament, the deep MCL, and the cruciate ligaments are secondary restraints to valgus stress [3].
- The MCL is the most commonly injured ligament in the knee [2].
- The mechanism of MCL injury is a valgus and external rotation force to the lateral knee [2].
- The most common injury location for the MCL is the femoral insertion, which has great healing potential [2].
- Distal ruptures of the MCL are less common and more often lead to residual valgus laxity [2].
- In a healthy knee, the anterior bundles of both the superficial and deep MCL elongate during knee flexion, while the posterior bundles distend with knee flexion [7].
- The elongation of the posterior bundles of the MCL peaks at midstance and the terminal extension-preswing stance phase [7].
- Isolated grade III superficial MCL injury in a cadaver model resulted in a mean increase of 3.2 mm in medial joint line opening [7].
- In a cadaver model, medial joint line opening increased to 8.8 mm when the deep MCL and posterior oblique ligament were injured, and to 13.8 mm when ACL injury was added [7].
- A cutoff distance of 3.2 mm of medial joint line opening was established as the basis for suspecting an isolated grade III superficial MCL injury [7].
- The ultimate tensile strength of the MCL is twice that of the LCL, although there is no significant difference in stiffness between the two [7].
- The MCL was most commonly torn at the femoral insertion site in biomechanical studies [7].
- Only a few fibers of the MCL radiate to the medial meniscus, and meniscal displacement does not significantly differ between a healthy MCL and an MCL detached from the femoral insertion [7].

INJURY CLASSIFICATION & PATHOPHYSIOLOGY

- Grade I MCL injury involves minimal torn fibers with 1 to 4 mm opening on valgus stress at 30° [2].

- Grade II MCL injury involves partial tearing of the fibers with 5 to 10 mm laxity at 30° and a firm end point [2].
- Grade III MCL injury is a complete tear with >10 mm opening without an end point [2].
- Grade I MCL sprain is characterized by few torn fibers with no loss of ligamentous integrity [3].
- Grade II MCL sprain is characterized by incomplete ligament tearing with increased joint laxity, maintenance of an end point to valgus stress at 30° of flexion, and continued fiber apposition despite partial tearing [3].
- Grade III MCL sprain is characterized by complete ligamentous disruption resulting in gross laxity without a palpable end point to valgus stress [3].
- Concomitant ligamentous injuries occur in 20% of grade I, 52% of grade II, and 78% of grade III MCL injuries [3].
- Concurrent meniscal injuries have been noted in up to 5% of isolated MCL injuries [3].
- Chronic MCL injuries may present with calcification at the insertion of the MCL on the medial femoral condyle [1].
- A Pellegrini-Stieda lesion is a calcification at the medial femoral insertion site resulting from chronic MCL deficiency [2].
- High-grade medial instability or an MCL tear with an associated tear of the posterior horn of the medial meniscus should raise suspicion for posteromedial corner (PMC) instability [8].
- All patients with grade III laxity of the MCL had a complete tear of the POL and meniscotibial ligament in an MRI-based retrospective study [8].
- All patients with injury to the posterior horn of the medial meniscus had concomitant meniscotibial ligament injury, and 67% had a tear of the POL [8].
- 81% of patients with a confirmed knee dislocation or a knee dislocatable under anesthesia had an injury to the PMC, and 63% had a superficial MCL tear alone [8].

Clinical Presentation

MECHANISM OF INJURY

- MCL injuries occur after a valgus stress to the knee or a noncontact rotational injury [1].
- Lower-grade MCL injuries typically occur in a noncontact external rotational injury [1].
- Higher-grade MCL injuries generally involve lateral contact to the thigh or upper leg [1].

SYMPTOMS AND HISTORY

- The location and presence of pain, instability, timing of swelling, and sensation of a “pop” or tear are important pieces of historical information [1].
- Grade I and II MCL injuries are often more painful than complete MCL rupture [1].

CQ HAND + UPPER LIMB

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- Immediate swelling should make one suspicious for an associated cruciate ligament injury, fracture, and/or patellar dislocation [1].
- A prior history of knee injuries or instability should always be sought when evaluating a new knee injury [1].

PHYSICAL EXAMINATION

- Medial joint line tenderness along the course of the MCL is typical at the location of the tear [1].
- Laxity to valgus stresses is assessed by the amount of medial joint space opening that occurs at 30 degrees of flexion [1].
- The knee must be stressed at 30 degrees of flexion because with the knee in full extension the posterior capsule and PCL will stabilize the knee to valgus stress [1].
- Stability to valgus stress in full extension could mislead the examiner to believe that the MCL is intact [1].
- Zero opening is considered normal for medial joint space opening [1].
- 1–4 mm of medial joint space opening indicates a grade I injury [1].
- 5–9 mm of medial joint space opening indicates a grade II injury [1].
- 10–15 mm of medial joint space opening indicates a complete or grade III injury [1].
- Grade I and II injuries typically have a firm end point to valgus stress [1].
- A grade III injury tends to have a soft end point to valgus stress [1].
- Medial knee pain and instability at 30 degrees of flexion is diagnostic of MCL injury [1].
- If opening occurs at full extension with a valgus stress, ACL or PCL injuries should be considered in addition to MCL injury [1].
- Palpation of the patella and the medial parapatellar stabilizing ligaments should be performed in addition to patellar apprehension testing due to the frequency of coexisting patellar dislocations in MCL injuries [1].

IMAGING

- Chronic MCL injuries may have calcification at the insertion of the MCL on the medial femoral condyle [1].
- Radiographs should be inspected for acute fracture, lateral capsular avulsion (Segond fracture), loose bodies, Pellegrini-Stieda lesion (MCL calcification), and evidence of patellar dislocation [1].
- Stress radiographs should be obtained in patients prior to skeletal maturity to rule out an epiphyseal fracture [1].
- MRI can be helpful in confirming diagnosis and helping to rule out concomitant meniscal injury [1].
- MRI is useful for confirming MCL injury and identifying the site of injury [1].
- MRI is useful to detect the presence of meniscal and other injuries to the knee [1].
- Relative indications for an MRI include an uncertain ACL status despite multiple examinations, evaluation of a suspected meniscal tear, or preoperative evaluation for a planned MCL reconstruction or repair [1].

- An examination under anesthesia can be valuable when physical examination is unreliable because of the patient guarding the knee [1].
- Diagnostic arthroscopy can be used to evaluate for coexisting pathology [1].
- Examination under anesthesia and diagnostic arthroscopy have largely been replaced by MRI [1].

Investigations

PHYSICAL EXAMINATION

- Medial knee pain and instability at 30 degrees of flexion is diagnostic for MCL injury [1].
- Opening at full extension with a valgus stress suggests concomitant ACL or PCL injuries in addition to MCL injury [1].
- Laxity to valgus stress is assessed by the amount of medial joint space opening at 30 degrees of flexion [1].
- The knee is stressed at 30 degrees of flexion because the posterior capsule and PCL stabilize the knee to valgus stress in full extension, which could mislead the examiner into believing the MCL is intact [1].
- Zero opening to valgus stress is considered normal [1].
- Medial joint space opening of 1–4 mm indicates a grade I MCL injury [1].
- Medial joint space opening of 5–9 mm indicates a grade II MCL injury [1].
- Medial joint space opening of 10–15 mm indicates a complete or grade III MCL injury [1].
- Grade I and II MCL injuries typically have a firm end point to valgus stress [1].
- Grade III MCL injuries tend to have a soft end point to valgus stress [1].
- Valgus stress should be applied at both 0° and 30° of flexion [2].
- Opening at 0° of flexion indicates a posteromedial capsular or associated cruciate (ACL/PCL) injury [2].
- An effusion may indicate associated intra-articular pathology [2].
- Abduction stress testing should be performed with the knee at 0° and 30° of flexion [3].
- The superficial MCL is isolated with a valgus stress at 30° of flexion [3].
- Pathologic laxity is indicated by the amount of increased medial joint space separation compared with the opposite, normal knee [3].
- Grade I MCL injury is characterized by 1 to 4 mm of laxity [3].
- Grade II MCL injury is characterized by 5 to 9 mm of laxity [3].
- Grade III MCL injury is characterized by ≥ 10 mm of laxity [3].
- Valgus laxity with the knee at or near full extension implies concurrent injury to the posteromedial capsule and/or cruciate ligaments [3].
- Isolated laxity at 30° and stability in 0° of extension indicates either a grade I or II injury [3].
- Combined laxity at 0° and 30° indicates a grade III injury with concurrent injury to the posteromedial capsule, and ACL or PCL combined injury should be considered [3].

- The Lachman and anterior drawer tests should be performed to rule out an ACL injury [3].
- The pivot shift test often has false-negative results in the presence of a grade III MCL sprain [3].
- A PCL injury is assessed by palpation of the tibial-condylar step-off and by the posterior drawer test (both performed at 90° of flexion), the quadriceps-active test, and observation of posterior tibial sag [3].
- Patellar apprehension and tenderness over the patella and medial retinaculum indicate possible patellar dislocation or subluxation [3].
- Diagnosis of an isolated medial meniscal injury is suggested by medial joint line tenderness, the absence of pain to valgus stress, and increased pain on flexion-rotation testing (McMurray test) [3].

IMAGING

- Plain radiographs should be performed to rule out fracture [2].
- A Pellegrini-Stieda lesion can be seen on radiographs, which is a calcification at the medial femoral insertion site resulting from chronic MCL deficiency [2].
- MRI is not routinely necessary unless concomitant injuries are suspected [2].
- Plain radiographs are typically normal but should be inspected for fractures, lateral capsular avulsions (Segond fracture associated with an ACL tear), and Pellegrini-Stieda lesions (indicative of prior MCL injury) [3].
- Stress radiographs may be indicated in skeletally immature patients to rule out a physeal injury [3].
- MRI has become the imaging modality of choice to evaluate the injured MCL [3].
- MRI advantages include identifying the location and extent of injury and ruling out associated meniscal, chondral, and cruciate ligament injuries [3].
- MRI disadvantages include being expensive, reader-dependent, and potentially overestimating the degree of injury [3].

Treatment

NON-OPERATIVE MANAGEMENT

- Nonoperative treatment using a hinged knee brace is highly successful in alleviating isolated MCL injuries [4].
- Clinical work has shown the advantage of nonoperative treatment (bracing) for an associated MCL injury in patients undergoing an ACL reconstruction [4].
- Prophylactic bracing may be helpful for football players, especially interior linemen [4].
- Pellegrini-Stieda syndrome, which can occur with chronic MCL injury, usually responds to a brief period of immobilization followed by progressive motion [4].

OPERATIVE MANAGEMENT

- Advancement and reinforcement of the ligament are rarely necessary for chronic injuries that do not respond to conservative treatment [4].
- Distal (tibia-side) injuries have less healing potential than proximal (femur-side) injuries [4].
- The management algorithm for isolated grade III MCL injury or MCL with associated injuries includes MRI, rehabilitation, and physical therapy to regain motion [4].
- The management algorithm for femoral avulsion involves MCL repair or reconstruction [4].
- The management algorithm for tibial avulsion involves MCL repair or reconstruction [4].
- The management algorithm for ACL/MCL injuries involves ACL reconstruction and rehabilitation to regain full range of motion [4].

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