Medial collateral ligament of the knee: anatomy, management and surgical techniques for reconstruction

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Abstract

The medial collateral ligament (MCL) is the most commonly injured ligament in the knee. The incidence is reported to be 0.24 per 1000 per year, and twice as high in males. The majority of MCL injuries are isolated, occurring in young sportsmen and women. However, they can occur in association with other injuries of the knee, most commonly the anterior cruciate ligament. Most injuries to the medial supporting structures occur as a result of valgus forces; but in sports, these can be a result of skiing injuries or 'cutting' manoeuvres. The majority of MCL injuries heal well with non-operative management and rarely require surgery; but if acute injuries are insufficiently treated or missed, the result can be chronic laxity. This chapter reviews the existing literature on common history and examination findings in MCL injuries. There are a number of classification systems designed to grade the severity of injury, which are based on the amount of laxity and the ability of the assessor to feel an end-point. There has been significant advancement in the understanding of the anatomy and biomechanics of the different components of the MCL. The anatomical landmarks of the superficial and deep MCL as well as the posterior oblique ligament are discussed along with the function of these individual structures. Although most MCL injuries heal well with non-operative management, there are a number of indications for operative intervention. These include open and multi-ligament knee injuries, as well as chronic instability. Broadly these are divide into repair or reconstruction categories. Repair is best performed in acute cases, where surgery is indicated for other reasons such as a meniscal tear; whereas reconstruction is best reserved for chronic instability. The reconstruction techniques including the Lind and LaPrade are described.

Keywords knee ligament; LaPrade reconstruction; lind reconstruction; medial collateral ligament (MCL); posterior oblique ligament (POL)

Introduction

The medial collateral ligament (MCL), also known as the tibial collateral ligament, is the most commonly injured ligament in the knee.[1,2,3] Most injuries to the medial supporting structures occur as a result of valgus forces, applied as direct blows to the lateral aspect of the thigh or upper leg. Valgus forces can be applied with external rotation of the tibia on a fixed femur. In sports, these injuries can be a result of lateral tackles, skiing injuries or 'cutting' manoeuvres. These involve a sudden change of direction on a planted foot.

The incidence is reported to be 0.24 per 1000 per year,[4] and twice as high in males than females. The majority of MCL injuries are isolated, occurring in young sportsmen and women. However, they can occur in association with other injuries of the knee, most commonly the ACL. The likelihood of an associated ACL injury increases with the severity of the MCL injury, to the extent that up to 78% of Grade III MCL injuries have a concomitant ACL rupture.[5] If acute injuries are insufficiently treated or missed, the result can be chronic laxity of the MCL. However, most MCL injuries heal well with non-operative management and rarely require reconstruction.

History and examination

The history in an acute injury may be typical of a lateral blow, either in contact sports or during an awkward landing from a jump. A 'pop' may be heard or felt. Other causes of injury to the MCL include high-energy injuries such as road traffic accidents; although this is more likely to be in the context of a multi-ligament knee injury. In this context, complaints of instability are more frequent with ACL injuries.

Clinical examination will reveal medial knee tenderness in association with bruising or ecchymosis. It is important to determine whether the point of maximal tenderness is at the femoral or tibial insertion of the ligament. Although femoral detachment is more common, the ligament maintains its close proximity with its femoral attachment site, therefore retaining its healing potential. In the case of a tibial avulsion, the free edge of the ligament can lie superficial to the pes anserinus tendons. This creates a 'Stener' type lesion of the knee,[6] whereby the healing potential of the ligament is eliminated, mandating surgical intervention. Tenderness of the medial joint line in mid-substance tears can cause difficulty in differentiating between a meniscal injury.

The laxity of the joint to valgus stress should be assessed; which is more accurately palpated by placing a finger at the joint line during the stress test. Laxity should also be assessed in extension and 30° of flexion. Laxity at 30° but not 0° indicates an isolated superficial MCL injury, whereas laxity at both points indicates combined MCL and posterior oblique ligament (POL) injury. If the knee is stable in full extension, the POL is likely to be intact. The classification systems used to describe laxity are discussed below.

Increased clinical suspicion should be maintained to detect other intra-articular pathology. Therefore, a clinical examination should routinely include patellar apprehension tests, anterior and posterior cruciate ligament assessment, posterolateral corner integrity, meniscal provocation tests and neurovascular assessment of the limb.

The Dial Test is classically described as a test of posterolateral corner injuries. It involves comparing external rotation of the tibia on the femur at 30° and 90° of flexion. A positive result is considered to be an ***increase*** of 15° or more of external rotation.

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If this is at 30° only, the injury is likely to be isolated to the posterolateral corner, but a positive finding at both angles is suggestive of a possible combined PCL plus posterolateral corner injury. This highlights the excessive external rotation of the tibial about the fulcrum of the medial compartment. The Dial Test can, however, also be positive in a complete MCL injury. In this situation, there is increased external rotation of the tibial plateau about the fulcrum of the lateral compartment. This is due to a lack of external rotation restraint offered by the incompetent medial structures, and can be appreciated by observing the knee instead of the foot during the Dial Test.

In addition to the examination of the knee; the patient's lower limb alignment and habitus must be taken into account. A valgus knee will inherently place more demand on the injured MCL than would a knee in constitutional varus. Similarly, the force placed on the knee due to weight or body mass index will need to be considered when deciding management options.

Classification and investigations

A number of different classification systems have been described to assess MCL injuries.[7] The grading depends on the patient's apprehension, the surgeon's ability to feel an end-point during the application of a valgus force, and a judgement of the amount of laxity. Clearly, this can create a great deal of inter- and intra-observer variability.

The American Medical Association (AMA) Standard Nomenclature of Athletic Injuries established a widely used classification system to grade MCL injuries (Figure 1).[8] These are graded I to III:

I. Localized tenderness, no instability
II. Localized tenderness, partial tear of the MCL
III. Complete disruption with instability

Hughston further subdivided Grade III injuries according to the amount of subjective medial joint gapping on valgus stress[4,2]:

1+ <5 mm laxity
2 + 5 to 10 mm laxity
3+ >10 mm laxity

The Fetto and Marshall classification describes assessment of laxity at 0° and 30° of flexion.[7] They stressed the importance of testing the knee at 0° of flexion rather than full extension. In full extension, the cruciate fibres may be recruited as valgus stabilizers, which can mask the true extent of injury to the MCL. The grading is below:

1. No laxity at 30° or 0°
2. Laxity at 30°, but not at 0°
3. Laxity at both 30° and 0° of flexion

The inter- and intra-observer variability of these classification systems has not been published in the English literature. Therefore, it is recommended to use a combination of the above to include the severity of injury and the amount of laxity.

Radiographic classification has also been developed, using valgus stress radiographs in accordance with the amount of laxity observed at 30 degrees of flexion.[9–13] More commonly, magnetic resonance imaging (MRI) grading of the injury can be used to describe three groups[14]:

- Grade 1: (minor sprain) high signal is seen medial to the ligament, which looks normal

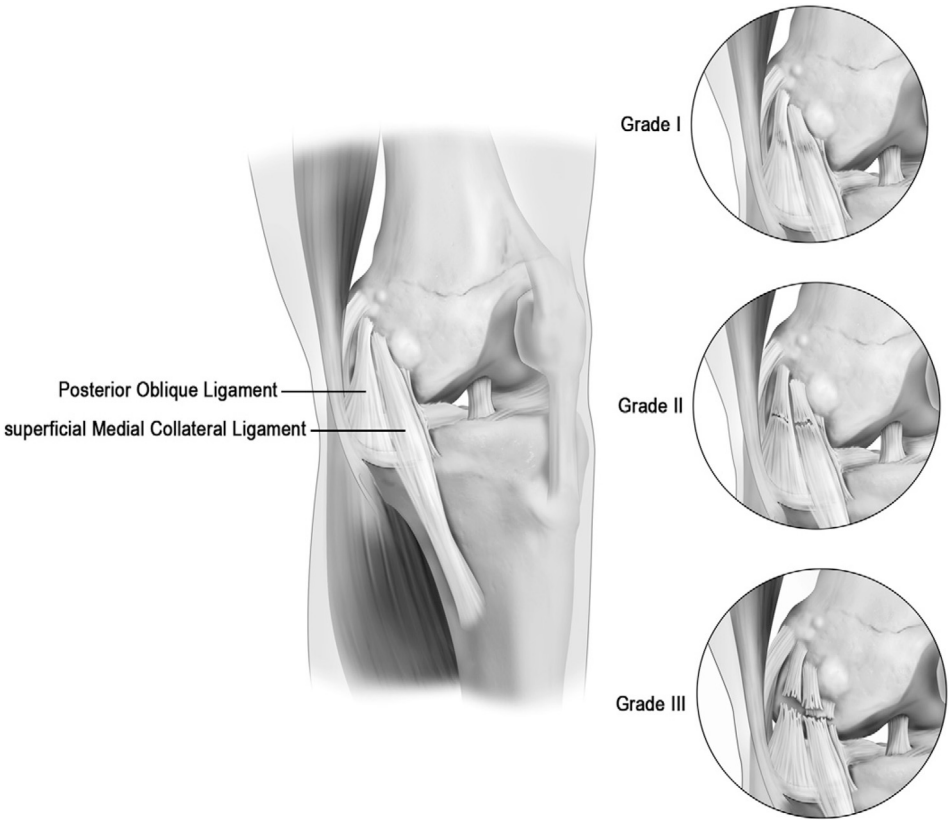

Figure 1 American Medical Association classification of medial collateral ligament injuries. Source: reproduced from reference 4 with permission from Wolters Kluwer Health.

- Grade 2: (severe sprain or partial tear) high signal is seen medial to the ligament, with high signal or partial disruption of the ligament
- Grade 3: complete disruption of the ligament.

After a few weeks, plain radiographs may reveal a Pellegrini-Stieda lesion. This is calcification at the medial femoral attachment of the MCL, and is a sign of chronic injury.[15,16] MRI is the gold standard investigation for soft tissue knee injuries. An acute scan will show increased signal in the injured part of the MCL and will help determine whether the injury is a femoral avulsion, a tibial avulsion or a mid-substance tear. In the case of a tibial avulsion, the fibres can lie against the tibial footprint or superficial to the pes anserinus (Figure 2). In addition, bone bruising in the lateral compartment may be visible as a result of the valgus force applied. Due to the profound healing potential of the MCL, a delayed MRI may not reveal a healed injury to the ligament. This is similar to injuries to the PCL, where a delayed scan may down-play the extent of the injury to the ligament.[17] Therefore, a high index of suspicion is required to diagnose an MCL injury on a delayed MRI scan. The advantage of an MRI scan, however, is that it also allows for characterization of the other intra-articular structures.

Anatomy

Warren and Marshall's classic paper in 1979 described the medial side of the knee in three layers.[18] Layer 1 consists of sartorius and the sartorial fascia; which also covers the gastrocnemius muscles and the popliteal neurovascular structures posteriorly. This layer blends with Layer 2 anteriorly, and within this plane are the tendons of gracilis and semitendinosus. Layer 2 consists of the superficial MCL, the POL and semimembranosus. This layer blends with Layer 3 posteriorly; which consists of the deep MCL and posteromedial capsule (Table 1).

Furthermore, Sims and Jacobson[5] divided the medial side of the knee into thirds. The anterior third consists of the patellar retinaculum; the middle third is the superficial and deep MCL; and the posteromedial corner includes the POL, the semimembranosus expansions, the oblique popliteal ligament and the posteromedial horn of the medial meniscus.

Layers of the medial side of the knee

Layer	Contents
Layer 1	Sartorius, sartorial fascia
Between 1 and 2	Gracilis and semitendinosus tendons
Layer 2	Superficial medial collateral ligament (MCL)
	Posterior oblique ligament
	Semimembranosus tendon
Layer 3	Deep MCL

Table 1

More recently, LaPrade et al. have published on the anatomy of the medial side of the knee.[19] Anatomical specimens were dissected to create a quantitative analysis of the bony and soft tissue anatomy of the area. They revealed that the medial epicondyle is the most anterior and distal bony prominence of the medial femur. Two other bony prominences were the adductor tubercle and gastrocnemius tubercle. On average, the adductor tubercle was 12.6 mm proximal and 8.3 mm posterior to the medial epicondyle; whereas the gastrocnemius tubercle was 6.0 mm proximal and 13.7 mm posterior to the medial epicondyle (Figure 3).

Superficial MCL

The superficial MCL (sMCL) is the largest structure of the medial side of the knee. It has one femoral and two tibial attachments. The femoral attachment is round to oval and is situated in a depression that is 3.2 mm proximal and 4.8 mm posterior to the medial epicondyle. Note that the sMCL does NOT insert directly onto the medial epicondyle.

The tibial attachments are at two distinct sites. The proximal tibial attachment is primarily to soft tissues rather than directly to bone; with the majority of it attaching to the anterior aspect of the semimembranosus tendon. This is at approximately 1 cm from

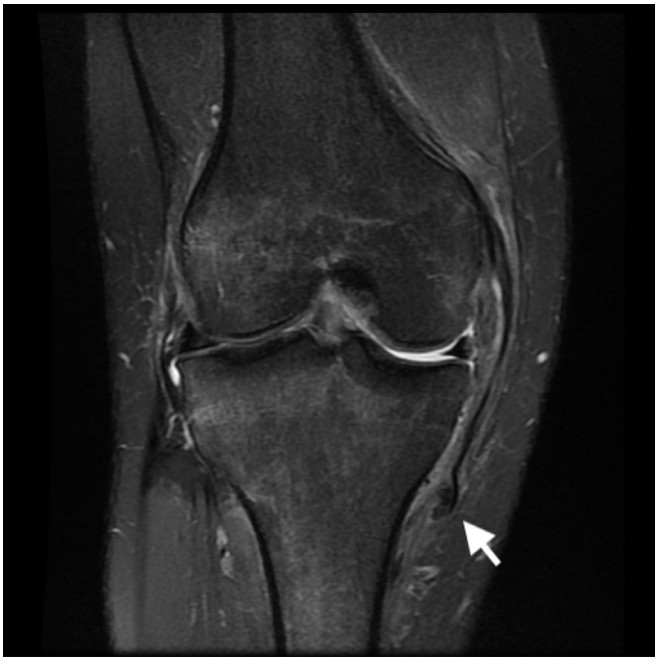

Figure 2 Distal avulsion of the medial collateral ligament (MCL), with the MCL lying superficial to the pes anserinus tendons.

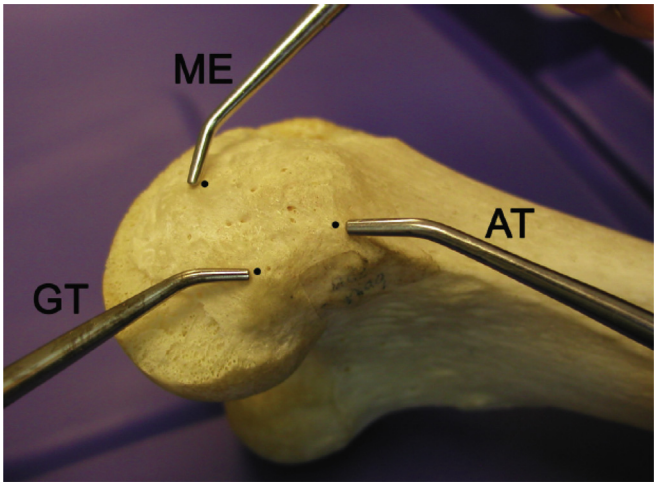

Figure 3 Bony anatomy of the medial side of the knee showing the relationship between the ME (medial epicondyle), AL (adductor tubercle) and GT (gastrocnemius tubercle). Source: reproduced from reference 19 with permission from Wolters Kluwer Health.

the joint line.[19] More distally, the attachment is broad and located just anterior to the posteromedial tibial crest, where it forms the floor of the pes anserinus bursa. The posterior portion of the sMCL blends with the anterior aspect of the semimembranosus tendon along its distal aspect (Figures 4 and 5). This attachment is 6 cm distal to the articular surface. There is no connection between the superficial and deep portions of the MCL.[19]

Deep MCL

The deep MCL is a condensation of the medial joint capsule, and is most distinct along the anterior border of the ligament. The posterior border of the deep MCL blends with the POL. There are two distinct components to the deep MCL: meniscofemoral and meniscotibial. The former is longer, thinner and more commonly injured than the latter. The meniscotibial limb inserts just distal to the edge of the articular surface of the medial tibial plateau.[19]

Posterior oblique ligament

The posterior oblique ligament (POL) consists of three arms: the superficial, central (tibial) and capsular arms.[2,20] The central arm is the largest and thickest portion of the POL. It courses from the distal aspect of the semimembranosus tendon and is a thickening of the posteromedial capsule, with distinct attachments to the medial meniscus. Anteriorly it merges with the sMCL, but can be identified by the orientation of its fibres (Figures 6 and 7). The femoral attachment is closest to the gastrocnemius tubercle, averaging 7.7 mm distal and 6.4 mm posterior to the adductor tubercle and 1.4 mm distal and 2.9 mm anterior to the gastrocnemius tubercle (Figure 4).[19]

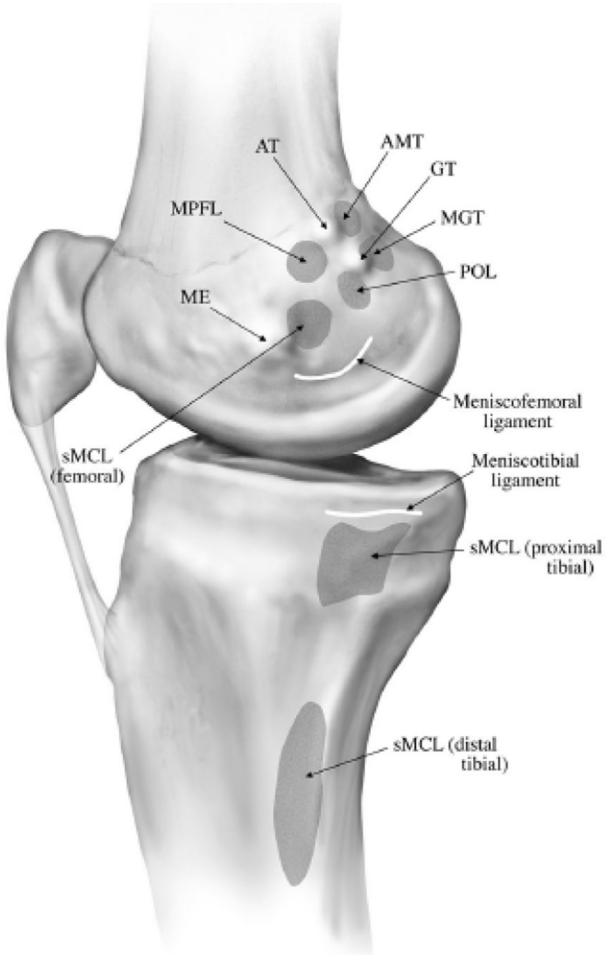

Figure 4 Attachment sites of the medial structures: ME (medial epicondyle), MPFL (medial patellofemoral ligament), AT (adductor tubercle), AMT (adductor magnus tendon), GT (gastrocnemius tubercle), MGT (medial gastrocnemius tendon), POL (posterior oblique ligament), sMCL (superficial medial collateral ligament). Source: reproduced from reference 19 with permission from Wolters Kluwer Health.

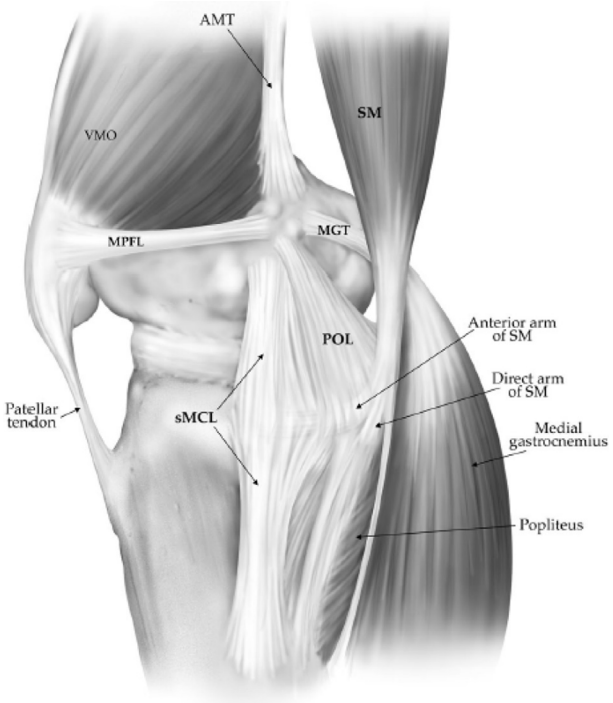

Figure 5 Relationship of the MPFL (medial patellofemoral ligament), VMO (vastus medialis obliquus muscle), SM (semimembranosus), MGT (medial gastrocnemius tendon), POL (posterior oblique ligament) and sMCL (superficial medial collateral ligament). Source: reproduced from reference 19 with permission from Wolters Kluwer Health.

Biomechanics and healing potential

The MCL is comprised of the above three structures. They work together to provide primary and secondary static stabilization against valgus, external and internal rotatory force.

The primary medial stabilizer of the knee is the proximal part of the sMCL, and the primary external rotation stabilizer is its distal portion.[1,21,22] The sMCL remains relatively isometric throughout the range of movement of the knee.[23] Gardiner showed that the sMCL experiences different amounts of strain in different parts of the flexion excursion. Stress in the anterior fibres is relatively constant throughout flexion, whereas stress in the posterior and middle fibres decreases with increasing flexion. The most amount of strain was experienced in the posterior part of the femoral insertion at full extension. This explains why femoral avulsion is the commonest injury observed in the MCL.[24]

The POL is not an isometric structure; it is in maximal tension in full knee extension. The POL is the primary restraint against internal rotation and valgus force at 0–30° of flexion. Indeed, it has been shown that with internal rotation torque at 0°, the loads on the POL are higher than that experienced by the sMCL.[25] The

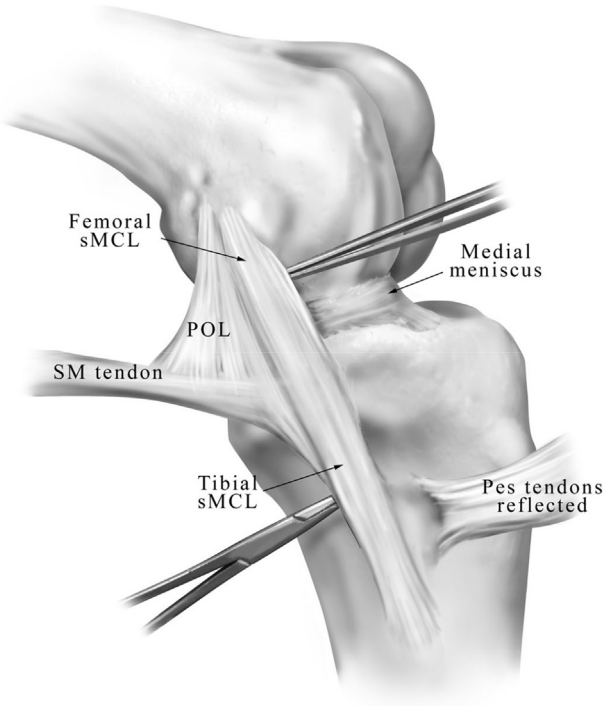

Figure 6 Medial view of the posterior oblique ligament (POL). SM, semimembranosus; sMCL, superficial medial coillateral ligament. Source: reproduced from reference 19 with permission from Wolters Kluwer Health.

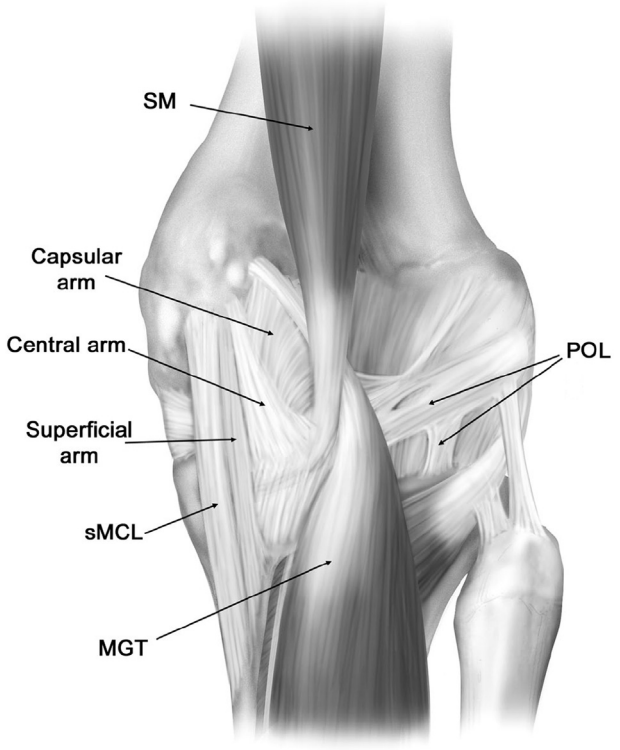

Figure 7 Posterior view of the three arms of the posterior oblique ligament (POL). MGT, medial gastrocnemius tendon; SM, semimembranosus; sMCL; superficial medial collateral ligament. Source: reproduced from reference 19 with permission from Wolters Kluwer Health.

POL fibres become lax in knee flexion and are separated from the sMCL by a bursa. An understanding of this phenomenon is crucial when reconstructing the POL, to prevent a fixed flexion deformity. The posteromedial corner of the knee has been shown to be the primary restraint against anteromedial rotatory instability.[5]

The deep MCL is a secondary stabilizer against valgus stress of the knee and a primary stabilizer against internal rotation. In particular, the meniscofemoral portion experiences most of the rotatory stress throughout the range of flexion.[26,27]

The pes anserinus is thought to play a part in valgus stability of the knee, although there is no firm evidence to support this. It is likely that these tendons function as a secondary dynamic stabiliser in the absence of a functional MCL. However, there is no evidence that sacrificing the semitendinosus tendon to reconstruct the MCL creates further instability.

This increased understanding of the biomechanics of the medial side of the knee has led to the development of a theory of a synergistic relationship between the different structures of this anatomical region. The superficial and deep MCL and the POL function on an intrinsic load-sharing relationship, and therefore injury to one component may lead to further injury to the other structures. In addition, when operative repair or reconstruction is indicated, an attempt should be made to treat all injured elements of the medial stabilizers.

Most MCL injuries do not require operative intervention. The superficial MCL is an extra-capsular structure and has been reported to have an abundant vascular supply and therefore healing potential. Injuries to the ligament heal by the classic model of haemorrhage, inflammation, repair and remodelling.[28] Immobilization following injury has a detrimental effect on the structure of the MCL ligament. Animal models have shown increased collagen degradation with prolonged immobilization after injury, and improved function with early mobilization.[29–33] This led to the development of early range of movement rehabilitation protocols in MCL injuries. Indeed, early mobilization has been shown to improve functional outcomes following iatrogenic injury to the MCL.

Treatment

Due to its healing potential, Grade I and II MCL injuries without meniscal injury can be safely treated non-operatively. Several rehabilitation programmes have been proposed, which vary according to the clinician; although there are no published data comparing them. The protocols generally consist of pain and oedema control, the use of minimally-restrictive hinged braces to reduce valgus stress, and immediate range of motion exercises. Weight-bearing should be encouraged, and limited by symptoms only. In the case of multi-ligament injuries, the cruciate ligament(s) can be reconstructed once the MCL has had adequate time to heal. An improvement in laxity of one grade can be expected with non-operative management.

Derscheid and Garrick treated 51 incomplete tears (Grades I and II) of the MCL in college American football players using a similar rehabilitation protocol. All players returned to full, unprotected sport. Although some laxity remained in Grade II injuries, it was not of any functional significance.[34]

Isolated Grade III injuries can be managed non-operatively if there are no other indications for surgery (see below). The non-operative routine is the same as for low-grade injury, aiming for functional rehabilitation; however, residual laxity may be present. A rehabilitation protocol similar to that outlined above has been shown to yield a high return to prior activity levels, but its success is dependent on an intact ACL.[35,36] Mok et al. treated 25 patients with complete MCL & ACL rupture non-operatively (cast brace and physiotherapy), all of whom returned to pre-injury sports.[37] Sandberg et al. randomized 200 patients with ACL and or MCL injuries and reported no benefit from surgical intervention to the MCL.

The indications for operative intervention in complete MCL injuries are controversial, but the following list includes those considered appropriate:

- open injury
- MCL entrapment within the joint, causing incongruent reduction of the tibiofemoral joint
- fracture avulsion of the MCL origin
- distal MCL avulsion and pes anserinus interposition (a 'Stener' lesion of the knee)
- multi-ligament knee injury (the timing of this is controversial)
- other injuries requiring surgery (e.g. meniscal tear requiring repair)
- chronic instability after non-operative management.

Surgical reconstruction techniques

The operative treatment of Grade III injuries is also controversial. There is little evidence to show the superiority of one technique over another, or indeed of repair *versus* reconstruction. The points of controversy are:

- timing of intervention (acute versus delayed)
- repair versus reconstruction
- graft type: autograft versus allograft
- early mobilization.

It is generally accepted that if early surgery is indicated for any reason, the MCL should undergo surgical repair in a Grade III injury. Hanley et al. showed improved patient reported outcomes in those undergoing early repair *versus* delayed reconstruction.[38] Repair of the structures includes re-attachment of the sMCL origin or insertion using suture anchors, as well as repair of the POL. During surgical repair (in particular of the POL), care should be taken not to over-tighten or 'catch' the knee, to prevent a fixed flexion deformity.

A relatively recent addition to simple repair of the MCL structures is the concept of internal bracing. This involves the use of synthetic non-absorbable suture-tape and bone anchors to reinforce the ligament repair. The anchors are places in the central zone of the ligament insertion points, and the tape is tensioned more loosely than the ligament repair. The philosophy is for the tape to act like a check-rein and prevent excessive stretching of the repair.[39] There have been concerns raised regarding stress shielding on the ligaments, but these concerns have not been substantiated with any evidence so far.

If there are no other indications for early surgery, a complete MCL injury should be treated according to a non-operative rehabilitation programme. Residual symptomatic laxity would be an indication for surgical reconstruction. A number of different techniques for reconstruction of the MCL have been described, which can be performed using auto- or allograft.

The first step in any surgical reconstruction will be an examination under anaesthetic, to determine the full extent of the medial laxity and any other associated ligamentous injury. This may be followed by arthroscopy, to identify other intra-articular injuries, as well as an assessment of deep MCL injury. The 'drive-through' sign is the arthroscopic appearance of excessive opening of the medial (or lateral) compartment seen in the presence of collateral injury. The location of injury to the deep MCL can also be identified, by determining whether the gap is above or below the meniscus (meniscofemoral or meniscotibial fibres, respectively). Beware of arthroscopy in acute injury due to the risk of extravasation of fluid into the thigh or leg compartments. An outflow port may be useful for fluid management in this setting.

In cases of chronic laxity, or failed repair of the MCL, a reconstruction procedure may be indicated. Bony malalignment should be addressed prior to soft tissue reconstruction. Therefore, one should consider the use of an osteotomy to correct a knee in constitutional valgus prior to attempted MCL reconstruction. There are broadly three techniques described:

1. Reconstruction of the superficial MCL alone (modified Bosworth technique)
2. Reconstruction of the superficial MCL as well as the POL (Lind technique)[40]
3. 'Anatomic' reconstruction of the sMCL and POL (LaPrade technique)[41]

Modified Bosworth

This technique involves using the semitendinosus tendon to reconstruct the sMCL without detaching its tibial insertion. A medial incision is utilised to expose the pes anserinus and the MCL. Care should be taken to protect the infra-patellar branch of the saphenous nerve if possible. The semitendinosus tendon is identified and dissected free from its vinculae and attachments to the medial gastrocnemius. It is harvested using an open-ended tendon harvester, leaving the distal insertion intact. In the setting of a chronic MCL injury, there is significant scarring of the tendons and their insertion. This makes the harvest more challenging, but has the benefit of moving the tendon insertion closer to the sMCL insertion on the tibia; thus recreating a more anatomic and isometric sMCL reconstruction. Muscle fibres are cleaned off the tendon, which is then whip-stitched.

To ensure isometric positioning of the femoral insertion, the desired position should be tested prior to fixation. A K-wire is drilled at the site of the insertion of the sMCL. The tendon is looped around the wire and the knee is taken through its range of motion (Figure 8). If there is excessive tension on the graft in flexion, a more posterior position should be selected. The wire should be moved appropriately until an isometric position has been confirmed. The graft is then secured over a screw and washer, and sutured into the posteromedial capsule, or to itself distally (Figure 9).

Lind reconstruction

This technique was described in 2009, and also uses the semitendinosus to reconstruct the sMCL; but the excess length of the

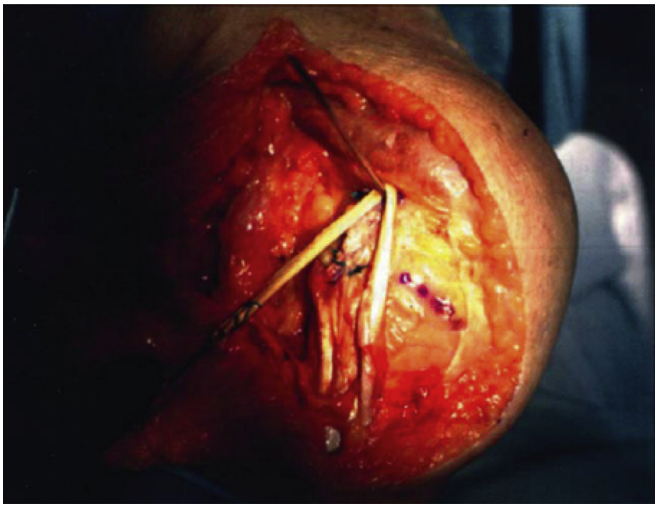

Figure 8 Testing for isometry of the superficial medial collateral ligament reconstruction. Source: reproduced from reference 42 with permission from Elsevier.

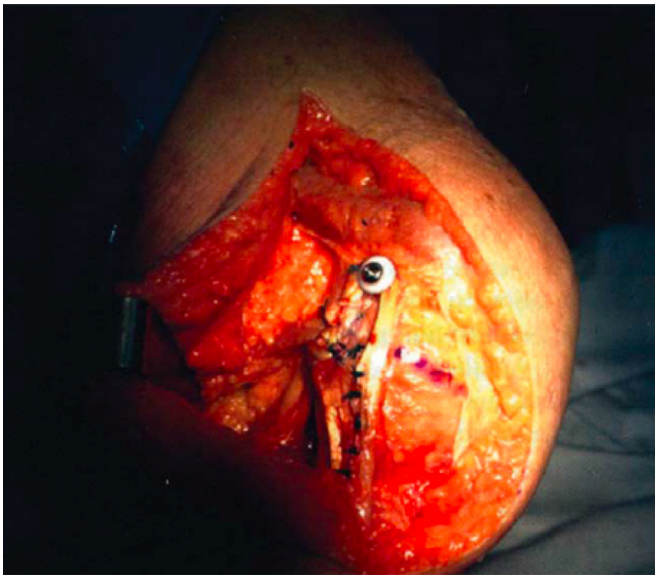

Figure 9 The graft is sutured to the soft tissues and back onto itself. Source: reproduced from reference 42 with permission from Elsevier.

tendon is used to perform an anatomical reconstruction of the central limb of the POL.[42]

A similar incision is made, followed by harvesting the semitendinosus tendon and leaving the distal insertion intact. To reconstruct the sMCL, the tendon is whip-stitched and the femoral insertion is tested for isometry. A femoral tunnel is drilled at this site according to the length and diameter of the looped graft. Care must be taken to avoid penetrating the femoral notch. The graft loops are sutured to allow insertion into the tunnel using a pull-through technique. The graft is tensioned at 10 degrees of flexion and neutral rotation, and fixed using an interference screw. The free end is used for POL reconstruction.

To reconstruct the POL, a tibial tunnel is drilled to the posteromedial corner of the tibial condyle from anterior to posterior, according to the size of the graft (usually 6 mm). The hole is aimed at 10 mm below the tibial plateau, posterior and lateral to the semimembranosus insertion. The free graft is passed through the tunnel from posterior to anterior using a pull-through technique, and tensioned at 60° of flexion and neutral rotation. Fixation is performed using an interference screw, and the reconstruction resembles an inverted 'V' on the medial side of the knee (Figure 10).

LaPrade reconstruction

This technique was described in 2012 following anatomical studies of the medial knee structures.[43] Two grafts are used to recreate the sMCL and POL separately. The distal insertion of the sMCL is identified, and a tunnel drilled at this site to fit the graft girth. This site is slightly posterior to the pes anserinus tendon insertions and consistently 6 cm distal to the articular surface. The tibial POL tunnel is drilled next. The insertion point of the central arm of the POL is identified, just anterior to the semimembranosus tendon insertion. A tunnel is drilled towards Gerdy's tubercle to a depth of 25 mm.

The origins of the two ligaments are identified on the femur. The most consistent landmark to use is the adductor tubercle, since this is generally not scarred in MCL injuries. Equally, the medial epicondyle can be used as a reference, since the sMCL origin is just proximal and posterior to this landmark. Two Beath or Eyelet pins are drilled into these points. If satisfied with correct anatomical identification of the origins, these points can be reamed according to the size of the graft. Beware tunnel convergence in this situation.

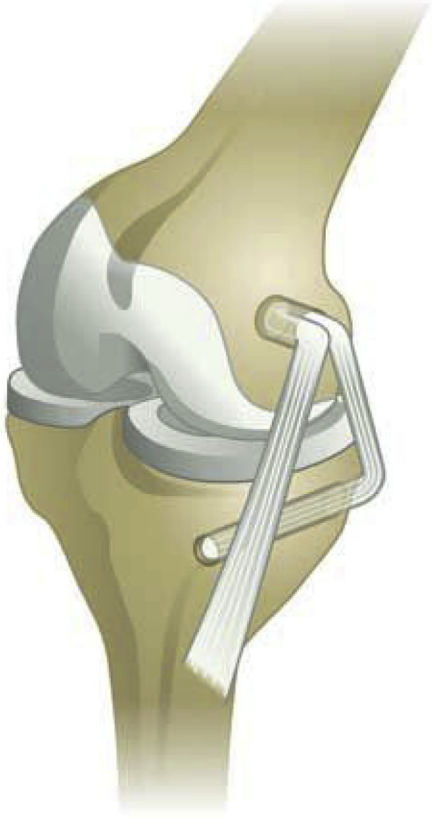

Figure 10 Lind reconstruction of the superficial medial collateral ligament and posterior oblique ligament. Source: reproduced from reference 40 with permission from SAGE Publications. Copyright 2009, American Orthopaedic Society for Sports Medicine.

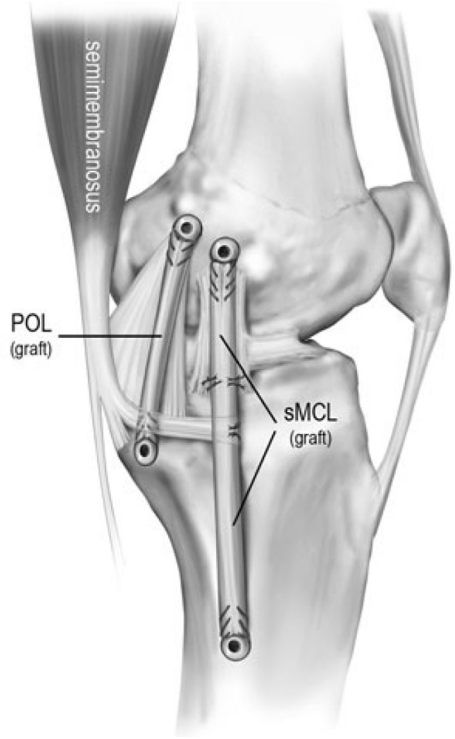

Figure 11 LaPrade technique for superficial medial collateral ligament and posterior oblique ligament. Source: reproduced from reference 44 with permission from SAGE Publications. Copyright 2009, American Orthopaedic Society for Sports Medicine.

The grafts are passed into the femoral tunnels and secured with interference screws. The grafts are passed under the sartorial fascia and pulled into the appropriate tibial tunnels. The POL is tensioned and fixed at full extension and neutral rotation. The sMCL is tensioned and fixed at 20° flexion and slight varus reduction, to ensure no medial joint gapping.

Once the grafts are secured, fixation of the proximal tibial attachment of the sMCL is performed. This is on average 12.2 mm distal to the joint line and immediately medial to the anterior arm of the semimembranosus insertion. Fixation is performed using a suture anchor at this point. The knee is then flexed to determine the 'safe zone' of flexion, which can be initiated immediately postoperatively. See Figure 11.

Postoperative rehabilitation and outcomes

Postoperative rehabilitation following MCL reconstruction varies widely between and within centres. The LaPrade post-operative regime is well described, and involves initiation of range of movement immediately, within the 'safe zone' determined intraoperatively. Further knee flexion is allowed after 2 weeks. Patients can initiate weight-bearing after 6 weeks and initiate gait-training exercises. Once gait has normalized, lower limb strengthening exercises can begin, usually at 4–5 months post-operatively. Return to sports is based on passing activity specific tests.[41]

Outcomes following MCL reconstruction are poorly reported due to the low frequency of isolated MCL injury requiring reconstruction. Patient-reported outcome measures (PROMs) for multi-ligament knee injury requiring MCL repair are more commonly reported, but are biased by the heterogeneity of the population.

Nevertheless, the outcomes reported by LaPrade et al. for 28 reconstructions appear encouraging. There was no recurrent laxity in their study sample, and average IKDC values increased from 43.5 to 76.2 postoperatively.[41] Similarly, Lind et al. reported 40-month follow up of 50 patients who had undergone MCL reconstruction, with or without concurrent ligament reconstruction. KOOS profiles improved by 10 points post-operatively, which matched that following ACL reconstruction. 91.2% of patients were satisfied with the results.[40]

Hanley et al. reported on early repair *versus* delayed reconstruction in the context of multi-ligament knee injury, with a sample size of 38 patients treated over 10 years and with a mean follow-up of 6 years. They found that those having early repair had betters PROMs than delayed reconstruction.[38] Westermann et al. reported on 33 patients who underwent concurrent MCL repair at the same time as their ACL reconstruction. They found that those undergoing MCL repair had higher re-operation rate for arthrofibrosis and lower PROMs and activity levels.[42]

Conclusion

In conclusion, MCL injuries are very common, and most do well with non-operative management. It is important to obtain a thorough history and to perform a detailed examination, to assess all elements of the MCL complex and to rule out other injuries. Bracing in conjunction with a non-operative rehabilitation protocol usually leads to satisfactory outcomes. However, if early surgery is indicated for any other reason, repair of the MCL structures may be performed at the same time. Reconstruction should be reserved for chronic instability of the MCL or in the context of multi-ligament knee injury. ◆

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