Technical Note

Reefing of the Posteromedial Capsule in Anteromedial Rotatory Instability

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Abstract: The posterior oblique ligament (POL) is the main component of the posteromedial corner (PMC) of the knee and plays a crucial role in acting as a secondary restraint against translation, rotation, and valgus forces. Injuries to the PMC often occur in association with acute or chronic deficiency of the anterior cruciate ligament and may result in anteromedial rotatory instability. A surgical technique for treatment of acute and chronic injuries of the posteromedial structures was first established by Hughston in 1973. This procedure involves an advancement and reefing of the POL and adherent posterior capsule to the stout tissue of the intact medial collateral ligament, potentially using suture anchors if the POL tissue is detached from bone. Additionally, in cases of residual laxity, the semimembranosus tendon may be advanced anteriorly to improve dynamic stabilization. This procedure appears to be useful in cases of moderate posteromedial insufficiency and avoids retrieval of a medial tendon graft from the region of the medially stabilizing hamstrings or from the healthy contralateral side.

Rupture of the anterior cruciate ligament (ACL) is the most common ligament injury of the knee, making ACL reconstruction (ACLR) a frequently performed procedure. The main interest of the last decade has been in changes in surgical technique by shifting from isometric transtibial reconstruction to anatomical ACLR. However, the incidence of reinjury to the reconstructed ACL remains high, especially in young competitive athletes. Unaddressed or missed injury to the capsular ligaments likely places additional strain on a reconstructed ACL, which can contribute to late graft failure. Valgus stress combined with external rotation of the lower leg is the most common injury mechanism for ACL rupture and has a high probability of concomitant injuries to the posteromedial corner (PMC) of the knee.[1] As ACLR is performed arthroscopically, concomitant injuries to the capsular ligaments tend to be neglected, possibly leading to residual laxity, and therefore may lead to higher forces in the reconstructed ACL.

The first detailed description of the anatomic structures of the posteromedial corner and their importance in restoring instability was published by Jack Hughston in 1973.[2] This includes the structures between the posterior border of the superficial medial collateral ligament (MCL) extending around the joint line to the medial border of the posterior cruciate ligament. Important structures in this area include the posterior oblique ligament (POL), posterior horn of the medial meniscus, the associated joint capsule, and the distal attachment of the semimembranosus.[3] The POL plays a crucial role in this functional complex. It originates from the adductor tubercle and attaches slightly proximal to the semimembranosus tendon. The POL has fascial connections extending to both the semimembranosus tendon and the posterior horn of the medial meniscus, acting as a secondary restraint against translation, rotation, and valgus forces.[1,2]

Surgical Technique

Preoperative Evaluation

Preoperative magnetic resonance imaging (MRI) is the imaging modality of choice in complex knee

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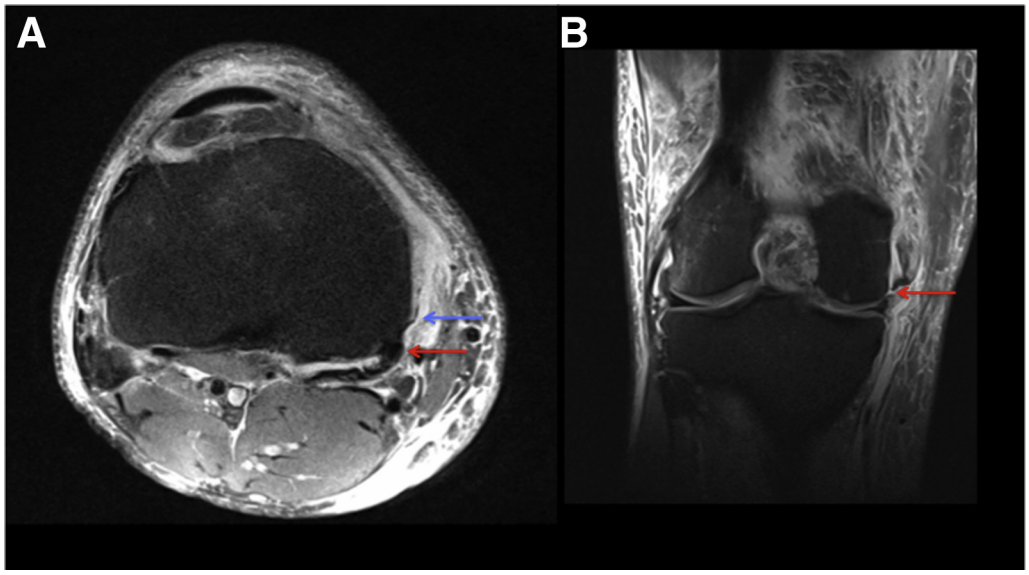

Fig 1. Imaging of injuries to the posteromedial capsule (PMC) is challenging, and anteromedial rotatory instability remains mainly a clinical diagnosis. Particularly in an acute injury, magnetic resonance imaging (MRI) is helpful in diagnosis of injuries to the PMC as a thorough clinical examination in the office is often difficult due to patient guarding. (A) Axial T2-weighted MRI showing edema and possible tibial detachment of the POL (blue arrow) with the semimembranosus tendon (red arrow) seemingly intact. (B) Coronal T2-weighted MRI demonstrating edema of the PMC and injury to the meniscofemoral connections of the posterior oblique ligament (red arrow).

injuries. Edema and soft-tissue thickening can be indicative of injuries to the PMC (Fig 1), although identifying its components and the extent of injury on MRI can be challenging. Therefore, the authors find it essential to perform a preoperative knee examination under anesthesia in every patient (Video 1). Helpful tests include the pivot shift with external rotation of the lower limb, which is typically positive in cases of posteromedial deficiency, as is the anterior drawer test in external rotation. The superficial MCL provides its greatest restraint at 30° of knee flexion, while the POL tightens the knee in full extension. Therefore, a positive valgus stress test in full extension can also be an indication for posteromedial surgery and should be documented by fluoroscopy.

Surgical Procedure

Intervention to the posteromedial capsule is performed in the appropriate patient based on physical exam, preoperative imaging, and arthroscopy as an additional procedure to ACLR (Table 1). In complex knee injuries, the patient is positioned supine with both knees in extension. Initially, anatomic ACL reconstruction is performed, including arthroscopy, graft harvesting, and tunnel drilling. The ACL graft is inserted and fixed on the femoral side. Posteromedial surgery should be performed before final fixation of the ACL graft on the tibial side.

In severe injuries to the PMC, the medial side shows instability during stress testing as previously described, and commonly the meniscus can be seen lifting off the tibia or femur during arthroscopic examination (Video 1). Posterior capsular hemorrhage may also be seen in acute cases (Fig 2). The "spin sign" has been described as movement of the tibial plateau independent of the meniscus and femur, which occurs in cases of a tear of the meniscotibial attachment. This also can occur when the femur moves independently of the meniscus and tibia, indicating a tear in the meniscofemoral attachment.

For an easier and accurate approach, a suture can be placed arthroscopically into the lesion in an outside-in-technique with a spinal needle (Table 2). The operative leg is then positioned into a figure-of-4 with the hip externally rotated and the knee flexed at 30°. Landmarks are drawn on the medial side of the knee, and a skin incision is made over the posterior border of the superficial MCL. The subcutaneous tissue is dissected down to the sartorial fascia, which is then incised

Table 1. Surgical Steps for Reefing of the Posteromedial Capsule

1.	Evaluation of the knee under anesthesia (clinical and arthroscopic)
2.	Approach to the posteromedial capsule of the knee by opening the capsule on the posterior border of the medial collateral ligament
3.	Analysis of characteristics of injury: POL, meniscotibial and femoral connections, deep medial collateral ligament, capsule
4.	Reattachment of POL to adductor tubercle/pes anserinus profundus
5.	Reefing of POL and attached capsule
6.	If necessary, advancing of capsular arm of semimembranosus tendon

POL, posterior oblique ligament.

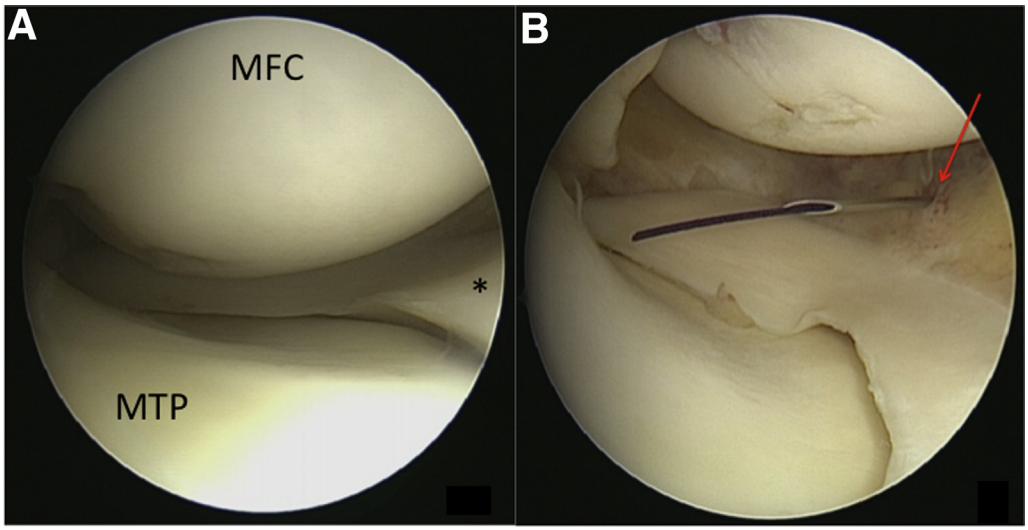

Fig 2. (A) View from the high anterolateral portal to the medial compartment of the right knee. (B) During stress testing, the medial compartment widens and the meniscus (*) is lifted off the femur. This indicates a severe injury to the posteromedial corner of the knee, in this case to the meniscofemoral attachment. Posterior capsular hemorrhage (red arrow) can also be seen, and a suture is placed into the lesion in an outside-in-technique for an easier and accurate approach when performing the open reefing of the posteromedial capsule. (MFC, medial femoral condyle; MTP, medial tibial plateau.)

longitudinally (Fig 3A). The posteromedial capsule is then inspected and examined for injury and laxity. The plane between the posterior limit of the superficial MCL and the POL is then located and further dissected (Video 1). This leads to the creation of a dorsomedial pouch, which allows the individual characteristics of the injury to be analyzed. The meniscotibial and meniscofemoral connections of the POL are inspected for injury, as is the deep MCL. If the meniscus is completely detached from the capsule, a suture is passed through the peripheral rim of the medial meniscus to the periosteum of the proximal tibia and the capsule, thus performing an open meniscus repair.

The first portion of the capsular reefing consists of the reattachment of the POL to its insertion on the adductor tubercle. If an avulsion injury exists, this can be done with a suture anchor (Fig 3B). In this case, the authors used a Y-Knot Flex 1.8-mm all-suture anchor (Conmed, Utica, NY). If the femoral insertion is intact and the capsule is attenuated without tearing, the proximal part of the POL can be sutured to the intact insertion of the superficial MCL (sMCL) using a 2-0 vicryl suture. In the case of a tibial injury of the POL, the suture anchor is placed to its tibial insertion at the pes anserinus profundus slightly proximal to the insertion of the semimembranosus tendon.

As a second step, the attenuated POL and adherent posteromedial capsule are advanced using 3 0 PDS sutures. A plane between the superficial and deep MCL is first developed. The capsule is then advanced under the stout tissue of the intact sMCL using 3 horizontal mattress sutures in a pants-over-vest technique (Video 1). The first is placed on the femoral side from the capsule and running more superiorly to the sMCL, the second more distal over the tibial from the capsule to more inferiorly on the superficial MCL, and a third in the central/middle horizontally over the joint line (Fig 3 C and D). A running suture is then placed for more specific tensioning.

As a last step, the capsular arm of the semimembranosus is palpated for residual laxity. If lax, the capsular arm can be advanced to the POL/MCL, using 2 or 3 mattress sutures.

The knee is then placed through a range of motion and then tested with a gentle valgus stress in full extension and 30° of knee flexion. The sartorial fascia is closed with a running suture followed by standard approximation of the subcutaneous and skin layers.

Table 2. Pearls and Pitfalls of Reefing of the Posteromedial Capsule

Pearls	Pitfalls
• Examination under anesthesia is crucial in decision making for surgical intervention of the posteromedial corner.	• Locating plane between superficial medial collateral ligament and posterior oblique ligament can be difficult.
• Arthroscopic placement of outside-in suture facilitates open approach to posteromedial corner.	• Be aware of close relationship to the saphenous nerve.
• Use absorbable suture for capsule reefing as subcutaneous sutures may be irritating.	• If using an all-suture anchor, the surgeon must ensure it is entirely seated through the cortical bone or it will fail.

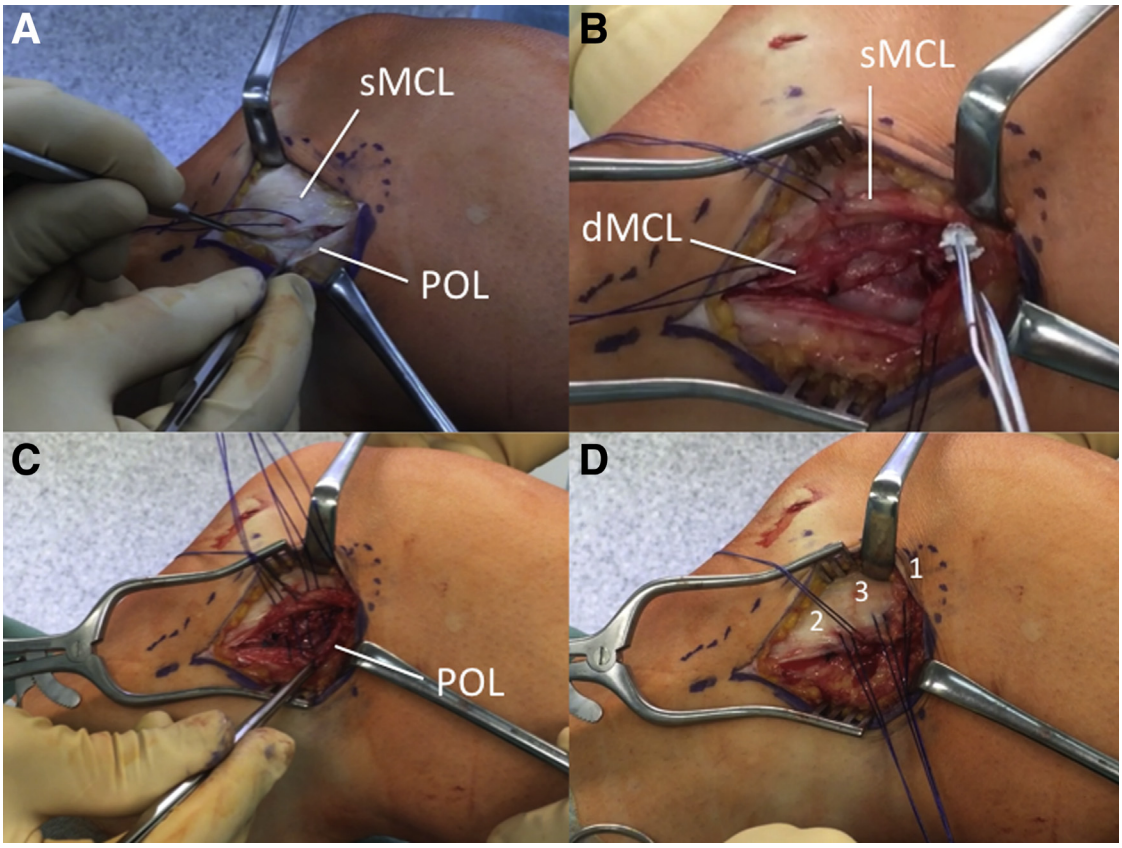

Fig 3. (A) Open approach to the posteromedial corner of a right knee with the leg in a figure-of-4 position. Incision to the posteromedial capsule is done between the posterior limit of the superficial medial collateral ligament (sMCL) and the posterior oblique ligament (POL). (B) A dorsomedial pouch is created, showing detachment of the POL from its femoral insertion. First, the POL is reattached to its femoral insertion using a suture anchor (Y-Knot Flex 1.8 mm). dMCL, deep medial collateral ligament. (C, D) The stretched and deformed POL and attached posteromedial capsule is then advanced under the stout tissue of the intact sMCL using 3 horizontal mattress sutures in a pants-over-vest technique. The first is placed on the femoral side from the capsule and running more superiorly to the sMCL (1), the second more distal over the tibial from the capsule to more inferiorly on the superficial MCL (2), and a third in the central/middle horizontally over the joint line (3). A running suture is then placed for more specific tensioning.

Discussion

Injuries to the PMC significantly differ from an isolated injury to the MCL. Biomechanical studies have demonstrated that additional sectioning of the POL, when the MCL was already sectioned, significantly increased external and internal rotation at all flexion angles as well as valgus and anteroposterior translation. This results in anteromedial rotatory instability (AMRI).[4] Furthermore, one biomechanical study found that higher loads are transferred to the ACL after sectioning the POL, and a clinical study has shown higher failure rates of the ACL with deficiency of the posteromedial structures.[5]

In cases of AMRI, most investigators recommend reconstruction of the PMC with a hamstring graft.[4,6] Hughston described a larger case series of 41 patients

Table 3. Advantages and Disadvantages of Reefing of the Posteromedial Capsule

Advantages	Disadvantages
• Exact location of the injury is analyzed and addressed.	• Advancing of the capsular arm of the semimembranosus may be painful.
• No retrieval of the medially stabilizing hamstrings.	• Prolonged bracing (6 weeks) is necessary to prevent valgus stress.
• Fewer implants compared with reconstruction with a hamstring graft.	• In cases of severe anteromedial rotatory instability, autograft reconstruction of the posteromedial capsule may be necessary.
• No interference of drill tunnels for anterior cruciate ligament and posteromedial capsule reconstructions.	

with surgical repair of the posteromedial corner including reefing of the POL and the capsule. He found good results at an average follow-up of 20 years.[7] With the rise of arthroscopic surgery, focus switched to reconstruction of the intra-articular ligaments of the knee, while the repair of the capsular ligaments was abandoned. Current research regarding risk factors for ACL graft failure have outlined the importance of concomitant injuries to capsular ligaments and suggest that utility of these concomitant procedures may still exist. In cases of severe AMRI, an anatomical reconstruction of the PMC should be done; however, the morbidity of harvesting a hamstring tendon in an already unstable medial knee may be problematic. From a biomechanical perspective, preserving the dynamic stabilizers of the injured knee likely is important.[8] In the authors' eyes, this fact is the crucial advantage of the presented procedure. However, in cases of severe AMRI, isolated reefing of the PMC may be insufficient, and reconstruction with autograft may be necessary. Studies comparing these reconstruction and repair techniques are currently lacking. Advantages and disadvantages of the described technique are outlined in Table 3.

The Hughston procedure appears to be useful in cases of moderate posteromedial insufficiency and allows the surgeon to avoid retrieval of a tendon graft that may provide stability. This may be indicated in combination with ACL and/or posterior cruciate ligament reconstruction with persistent posteromedial laxity leading to AMRI.

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