Reconstruction of the Posteromedial Corner of the Knee 116

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Contents

Abstract

Within the past decade, an innovative surgical technique designed to restore the native characteristics of injured structures of the posteromedial corner (PMC) of the knee has emerged. This technique is anatomically based and has been validated through biomechanical testing. In this approach, two separate grafts are used to reconstruct the superficial medial collateral ligament (sMCL) and posterior oblique ligament (POL). Surgical complications are often avoided by ensuring that the reconstruction tunnels are placed accurately by the utilization of anatomic landmarks. It is recommended that an early range of motion program be used for the postoperative rehabilitation protocol to enable early restoration of knee flexion and decrease the incidence of arthrofibrosis. This chapter focuses on the surgical treatment recommended for complex acute and chronic injuries to the posteromedial corner of the knee.

Introduction

Even though the superficial medial collateral ligament (sMCL) has been the most commonly reported ligament injury, the majority of these injuries are isolated and can be treated nonsurgically (Bollen 2000; Pedowitz et al. 2003). While most studies have reported good results from nonsurgical treatment, there are certain subsets that progress to chronic sMCL instability

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(Sandberg et al. 1987; Edson 2006). These include those associated with knee dislocations, meniscotibial-based avulsions where the distal attachment of the sMCL is pulled proximal to the pes tendons, and valgus gapping in full extension. It is reported in the literature that in these circumstances initial nonsurgical treatment – while it may be recommended by many centers – often results in continued instability and an ensuing surgical reconstruction (Lind et al. 2009).

Recently, an innovative surgical treatment of chronic posteromedial knee injuries has been proposed. This approach is based upon the principles of defining the anatomy both qualitatively and quantitatively, revisiting clinically based biomechanical studies and then performing biomechanical validation of anatomic-based reconstructions. From this, clinical outcome studies on patients were performed to evaluate the procedure. Thus, these surgical reconstruction recommendations for the posteromedial knee are based upon several peer-reviewed studies (LaPrade et al. 2007; Griffith et al. 2009a, b; Coobs et al. 2010), which have been built upon each other and evolved into the recommended surgical treatment technique (LaPrade and Wijdicks 2012a).

In addition, because the highest postoperative complication rate after medial knee injury treatment has been reported to be arthrofibrosis, an anatomic-based reconstruction method that can withstand the rigors of early mobilization has been developed (Lind et al. 2009; LaPrade and Wijdicks 2012a, b). The goal of this reconstruction is to start range of motion exercises on postoperative day 1 in order to minimize the risk of arthrofibrosis. Peer-reviewed publications have validated that these anatomic reconstructions do not stretch out and also have a very low risk of arthrofibrosis (LaPrade and Wijdicks 2012a).

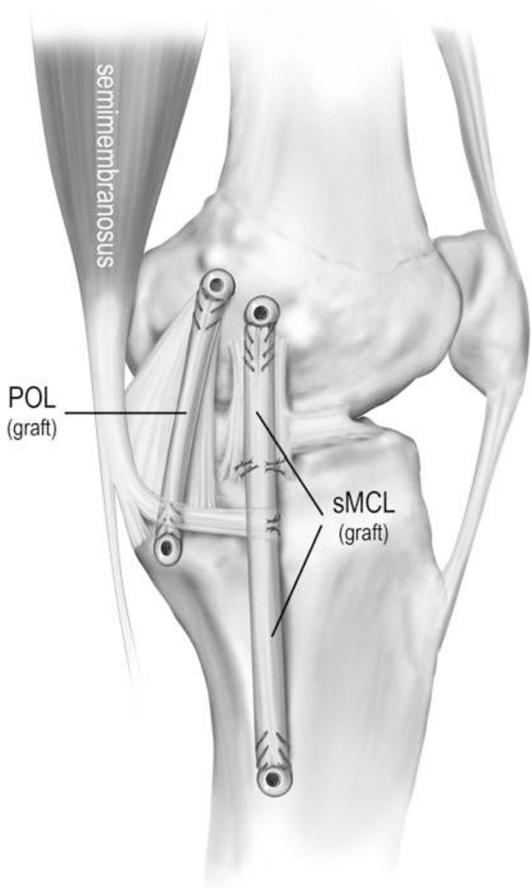

Fig. 1 A left medial knee reconstruction procedure demonstrating the reconstructed sMCL and POL. Note that the proximal tibial attachment point of the sMCL, which was primarily to soft tissues and located just distal to the joint line, was recreated by suturing the sMCL graft to the anterior arm of the semimembranosus (Reprinted with permission from Coobs BR, Wijdicks CA, Armitage BM, et al (2010) An in vitro analysis of an anatomic medial knee reconstruction. Am J Sports Med 38:339–347)

Anatomic Reconstruction for the Posteromedial Corner of the Knee

The preferred technique for the treatment of complete medial knee injuries is a biomechanically validated anatomic reconstruction of both the sMCL and the POL. In this technique, the two aforementioned ligaments are reconstructed by restoring their native attachment sites with two separate grafts (Fig. 1; Coobs et al. 2010).

Surgical Technique

All patients undergo an examination under anesthesia to confirm that they have both an increase in valgus gapping and external rotation in the affected knee. The increase in external rotation is validated both on the anteromedial drawer test at 90° of knee flexion and the dial test at 30° and 90° of knee flexion. The technique has evolved to the point where all operative knees are placed into a leg holder and the contralateral legs into a stirrup to prevent potential pressure areas. A leg holder is often used because a large percentage of the time either an arthroscopy or a concurrent cruciate ligament reconstruction is being performed on the affected knee.

It is recommended that the surgical approach be performed prior to the arthroscopy to prevent fluid extravasation, which makes it very difficult to visualize the medial and posteromedial knee structures. The authors have found it particularly more difficult to identify the femoral-based medial knee structures compared with the anatomic landmarks associated with other knee ligament injuries.

An anteromedial skin incision is made from the distal aspect of the vastus medialis oblique muscle, centered between the medial border of the patella and the adductor tubercle, and coursing over the midportion of the tibia. This incision should extend approximately 7–8 cm distal to the joint line. As part of the surgical approach, one should typically start distally after the initial skin incision, identify the pes anserine tendons, and then dissect along the sartorius fascia proximally. The first important anatomic attachment site to identify is the distal aspect of the sMCL. If one elects to harvest the semitendinosus tendon as the reconstruction graft, an open hamstring harvester is used to harvest this tendon at this point in time. Technically, it is very important to release all of the adhesions on this portion of the knee, which are often much more present in this situation than when the graft may be harvested for an ACL reconstruction, to ensure that the graft is not amputated and that at least 28–30 cm of overall graft length is obtained for the reconstruction. Once the pes anserine bursa is identified, the remnant of the distal attachment of the sMCL is identified. Based upon anatomic studies, the midportion of this attachment site is almost always 6 cm distal to the medial joint line (LaPrade et al. 2007). Thus, one can identify the medial joint line and use a surgical marker to outline this position. A reconstruction tunnel is then reamed for this portion of the reconstruction.

The distal tibial sMCL tunnel attachment location is important to locate as far posterior along the medial aspect of the proximal tibia as possible. An anteriorly placed tunnel can result in the graft stretching out with early knee motion. One should utilize an islet pin and a cruciate ligament aiming device to drill across the proximal tibia while aiming anterior to avoid the common peroneal nerve and enter exactly 6 cm distal to the medial joint line on the tibia. A 7-mm closed socket tunnel is then reamed directly over the islet pin. The more distal aspect of this tunnel should be notched to facilitate interference screw fixation later in the procedure. A passing stitch can then be placed using the islet pin at this point in time to allow for easier graft passing later in the case.

Next, one can dissect more proximal to identify the POL attachment site on the posteromedial aspect of the tibia. The sartorius fascia must be further incised to identify the anterior arm of the semimembranosus. The most important portion of the POL for knee stability is the central arm. The central arm attaches to the tibia and along the anterior arm of the semimembranosus (LaPrade et al. 2007). Identification of this structure, which is rarely injured, allows one to place the tibial tunnel for the POL reconstruction graft.

The tibial tunnel for the POL graft is slightly more distal and along the groove that the anterior arm of the semimembranosus forms (LaPrade et al. 2007). A guide pin is inserted here, using a cruciate ligament aiming device, and it exits the anterolateral aspect of the tibia slightly distal to Gerdy's tubercle. A 7-mm reamer is then used to drill a closed socket tunnel over the guide pin at this location. An additional passing stitch can also be placed at this point in time to allow for easier graft passage later in the case.

A more proximal dissection can now be carried out to identify the sMCL and POL femoral attachment sites. These attachment sites are much more difficult to identify, especially in chronic cases where there may be heterotopic ossification present and thickened medial knee tissue, which make it difficult to palpate the actual bony landmarks. In order to best identify these structures, it is important to identify the vastus medialis oblique attachment on the adductor magnus tendon. A curved hemostat is placed under the adductor magnus tendon, which allows a direct identification of the adductor tubercle. Once the adductor tubercle is identified, it is easier to identify the medial epicondyle and the gastrocnemius tubercle. It is especially important to identify these bony landmarks so that a precise anatomic restoration can be performed for the attachment sites of the POL and sMCL in the femur. It is well recognized that even a slight misplacement of 5 mm of these attachment sites can cause the graft to stretch out or have the knee become arthrofibrotic postoperatively.

Once the adductor tubercle has been located, the medial epicondyle can be identified. The sMCL femoral attachment site is 3.2 mm proximal and 4.8 mm posterior to the medial epicondyle in a bony depression in this area (LaPrade et al. 2007). A cruciate ligament aiming device is used to drill an islet pin across the anterolateral aspect of the distal thigh at this point in time. Next, the attachment site of the POL on the femur should be located, and this is done by identifying the gastrocnemius tubercle. The attachment site of the POL should be approximately 1.4 mm distal and 2.9 mm anterior to the gastrocnemius tubercle (LaPrade et al. 2007). An islet pin can then be placed using an aiming device, which is positioned parallel to the sMCL attachment site. Once the two guide pins are in place, one can measure between the two landmarks to verify that the normal relationship of 12.9 mm is maintained (LaPrade et al. 2007). If it appears that the relationship is off, one should further validate that the proper locations of the attachment sites have been identified by verifying that the medial epicondyle, adductor tubercle, and gastrocnemius tubercle have been correctly identified. Once it has been determined that these guide pins are in the desired locations, a 7-mm reamer is used to ream 25-mm deep closed sockets over both islet pins. Passing sutures are then pulled across the femur with the loops on the medial side to allow for graft passage later in the case.

It is preferable to identify these medial knee attachment sites, ream the tunnels, and place passing stitches prior to any intra-articular work. This allows one to identify them under the best circumstances, without fluid extravasation, and the passing stitches are used to easily pass the grafts later in the case, especially if the tourniquet has to be let down.

The arthroscopy can now be performed. The medial portals can often be placed through the skin incision that has been made as part of the posteromedial knee reconstruction approach. Any cruciate ligament reconstructions can be performed along with meniscal repairs, at this point in time. If the cruciate ligaments do need to be reconstructed, one can pass the grafts into the femur, fix them in place in the femur, and hold off fixing the tibial attachment sites until the medial knee reconstruction grafts have been placed into their respective femoral tunnels and secured.

The medial knee reconstruction grafts can be prepared from an autogenous semitendinosus graft or an allograft. Anatomic studies have verified that the length of the sMCL graft is almost always 16 cm, whereas the POL graft is almost always 12 cm (Coobs et al. 2010). Thus, an assistant can prepare the grafts ahead of time and be fairly certain that these grafts will be of the correct length at the time of surgical reconstruction (Fig. 2). This helps to ensure that the case can proceed in a timely fashion with minimal need to go over a 2-h tourniquet time.

Each graft is marked with a methylene blue marking pen 25 mm from each end to allow for more precise graft placement within the tunnels, especially as the case proceeds, and it is difficult to visualize the structures due to the use of arthroscopic fluid and potential bleeding after the tourniquet has been let down.

Next, both the sMCL and POL grafts can be passed into the femur. A bioabsorbable interference screw is placed anterior to the graft at both femoral locations. It is important to make sure that the screw is recessed down to the cortical level so it is not prominent since this can otherwise cause postoperative pain in these areas. A 7-mm cannulated bioabsorbable screw is used to fix each graft to the femur. After each graft is secured, it is

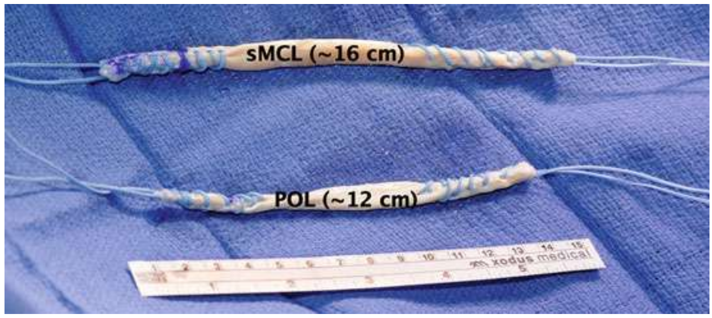

Fig. 2 The 16-cm superficial medial collateral ligament (*top*) and 12-cm posterior oblique ligament (*bottom*) grafts can be prepared preemptively

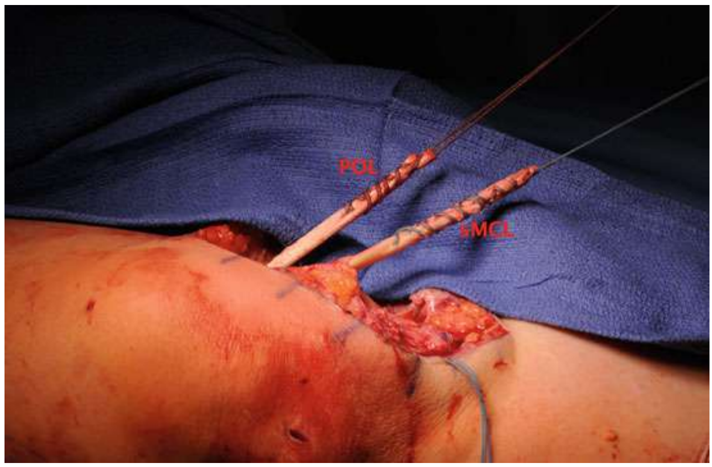

Fig. 3 Traction is applied to each graft to ensure secure fixation within each reconstruction tunnel

important to apply medial traction on the grafts to ensure that the grafts are well secured within each reconstruction tunnel (Fig. 3).

The sMCL graft is passed under the sartorius fascia and distally to the tibial reconstruction tunnel. The passing stitch can then be used to pull the graft into its respective tunnel (Fig. 4). Likewise, the POL graft is passed through the substance of the posteromedial capsule and into its reconstruction tunnel. At this point in time, the cruciate ligament grafts can be secured in their respective tibial tunnels. For posterior cruciate ligament reconstructions, the anterolateral bundle graft is fixed at 90° of knee flexion, whereas the posteromedial bundle graft is fixed in full extension (Girgis et al. 1975; Van Dommelen and Fowler 1989; Spiridonov et al. 2011). The ACL reconstruction graft is also fixed close to full extension.

Once the cruciate ligament reconstruction grafts have been fixed, one should proceed with

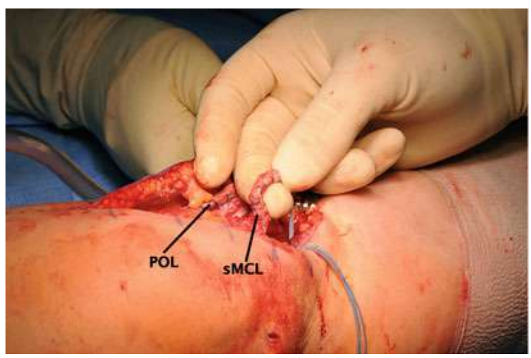

Fig. 4 A passing stitch is used to guide the superficial medial collateral ligament graft into its respective tibial tunnel

the stabilization and securing of the medial knee grafts into their respective tibial tunnels. The sMCL graft is fixed first with the knee in slight varus, to prevent any medial gapping, in neutral rotation and at 20° of knee flexion. Because the tibial bone can be quite hard at this location, sometimes a notching may be necessary of the reconstruction tunnel, or other means to increase the tunnel size, to allow for the bioabsorbable screw to be placed without damaging the sMCL graft (Fig. 5). Once this graft is placed using a screw inserted distally within the tunnel to secure the sMCL graft, one should verify that all of the valgus instability has been eliminated, that the graft is taut, and that one can flex from at least 0° to 105° of knee flexion on the table without having any significant tension on the reconstruction graft. Once this graft has been secured, the POL graft can be fixed (Fig. 6). It is important to recognize that the POL is tightest in full extension and it becomes loose with flexion (Griffith et al. 2009b). Thus, the graft must be secured in full extension, to avoid overconstraining the graft and risk having it stretch out or completely fail as when striving to achieve full knee extension. Taken together, the POL graft is fixed with the knee in full extension, in neutral rotation, and with traction on the graft.

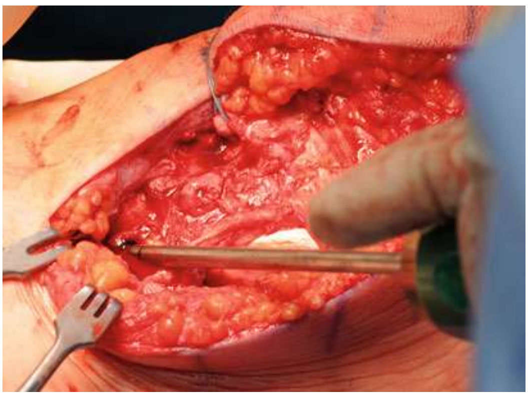

Fig. 5 The graft for the superficial medial collateral ligament is fixed at the distal tibial attachment site with the knee (*right* knee shown) at 20° of flexion, slight varus alignment, and in neutral rotation

In addition, the proximal tibial attachment of the sMCL must be secured at this point in time (Fig. 7). Wijdicks et al. validated that this attachment site strength is equivalent to a suture anchor, so it is advisable to use a suture anchor at this proximal tibial attachment site to reattach the sMCL graft to the tibia in order to encourage tissue integration and the return to full ligament functionality during load bearing (Wijdicks et al. 2010a). The attachment site is approximately 12–13 mm distal to the joint line and directly over the termination of the anterior arm of the semimembranosus and the tibia (LaPrade et al. 2007). When structures are completely blown apart, it is very rare that this portion of the medial knee is injured, and one can identify it to ensure that the correct attachment relationship can be restored.

A thorough exam under anesthesia should now be performed to verify that all associated instability has been eliminated. Internal rotation should be checked near full extension, valgus instability at 0° and 20°, and anteromedial rotation at 90° of flexion. It is important to verify that one can flex

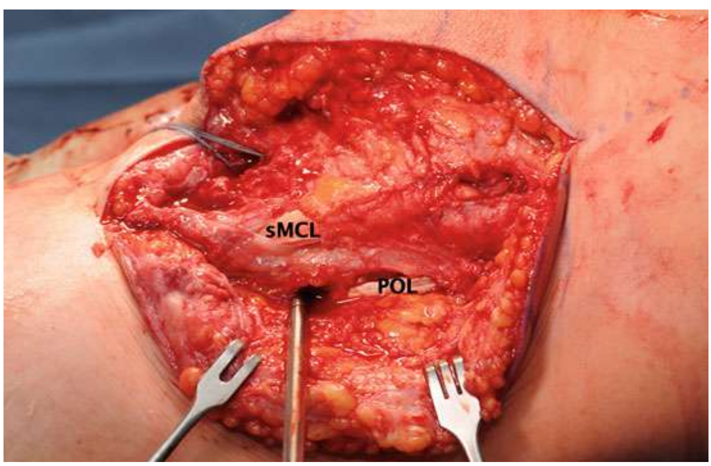

Fig. 6 The graft for the posterior oblique ligament is fixed at the tibial attachment site of the knee (*right* knee shown) at full extension, in neutral rotation, and with traction applied to the graft

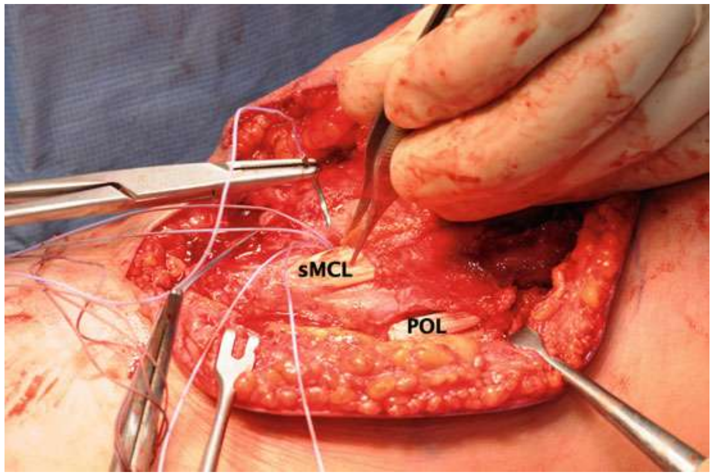

Fig. 7 The graft for the superficial medial collateral ligament is secured at the proximal tibial attachment site with suture anchors

the knee from at least 0 to 90° such that an early motion program can be initiated in physical therapy on the first postoperative day.

After the examination under anesthesia verifies restoration of valgus and rotatory stability, the closure is performed. Initially, the patient is placed into an immobilizer in full extension until his or her quadriceps control is sufficient.

Potential Surgical Complications

Intraoperative complications may arise from improper placement of the reconstruction tunnels. Therefore, a thorough knowledge of medial knee anatomy is required, especially in patients who have been recognized to have risk of heterotopic ossification or very thick medial knee structures. Placement of the sMCL femoral tunnel can easily be malpositioned. It is not uncommon for the authors to see reconstruction tunnels which are more than 1 cm from the anatomic attachment site in referral. In these circumstances, whereby identification of the normal and injured anatomy may be difficult, peer-reviewed publications that identify the attachment sites of these structures on radiographs should be reviewed and the use of intraoperative fluoroscopy would be advised (LaPrade et al. 2010). Intraoperative tunnel convergence is also potentially possible. Convergence can be avoided with the use of passing sutures to identify where these tunnels are located, and this is particularly helpful when one performs a PCL reconstruction. A concurrent double-bundle PCL reconstruction with a complete medial knee reconstruction needs to be carefully planned. One should not place the medial knee grafts directly transversely across the femur in the coronal plane, but should instead aim anterolateral to avoid the PCL reconstruction tunnels. When this is done, the risk of tunnel convergence is much lower. The final main intraoperative-based complication is a potential injury to the saphenous nerve. The sartorial branch of the saphenous nerve is located 4.8–5 cm perpendicularly from the anterior border of the sMCL, 2 cm distal to the joint line (Wijdicks et al. 2010b). Therefore, by sticking along the sartorius fascia and gently dissecting, the biggest risk of injury to this structure would be due to adhesions during graft harvest.

Postoperative Rehabilitation

The authors advocate an early motion program as part of the rehabilitation protocol. It is recommended that one determine the "safe zone" ranges of motion intraoperatively and utilize this in the first few postoperative days. The authors support having indwelling femoral nerve blocks to assist with pain control such that the physical therapist can work with the patient on knee motion prior to any stiffness developing. In general, one should strive for a range of motion of 0–90° on postoperative day 1, and after 2 weeks, range of motion is increased as tolerated. The patients are non-weight bearing for the first 6 weeks and strive to work on quadriceps activation, edema control, and knee motion during the first few weeks. As part of this, patellofemoral mobility should be aggressively pursued.

After 6 weeks postoperatively, the knee is placed into a hinged knee brace and patients are allowed to increase their weight bearing as tolerated. They may wean off crutches when they can ambulate without a limp. They may also start the use of a stationary bike once they have achieved 95–100° of knee flexion. The goal is to have them walking normally within 1 or 2 weeks after the initiation of ambulation. They may also start some simple leg presses, usually to a maximum of 70° of knee flexion, between weeks 6 and 12.

The goal is to obtain bilateral valgus stress radiographs to verify sufficient healing between 4 and 5 months postoperatively. If a concurrent cruciate ligament reconstruction is performed, this time frame may be pushed out to up to 6 months, especially for double-bundle PCL reconstructions. After verification of graft healing with valgus stress radiographs, patients are allowed to initiate agility exercises, perform side-to-side activities, and use a balance ball. Jogging in a brace may also be initiated at this point in time. Once the patient has appropriate endurance, strength, and agility, a functional sports test is performed to determine if they are able to return back to full activities. The patients should wear a knee brace for the first year postoperatively to protect their medial knee reconstruction graft (s) from stretching out.

Conclusions

In conclusion, an anatomic-based posteromedial knee reconstruction has been validated to improve patient function and restore knee stability. An early rehabilitation program can be performed to allow early motion and significantly decrease the risk of arthrofibrosis, and it has been validated that these reconstructions do not result in the graft stretching out. Thus, anatomic-based posteromedial knee reconstructions to restore complex acute and chronic medial knee injuries are recommended.

Cross-References

▶ Medial Collateral Ligament and Anterior Cruciate Ligament Synergy: Functional Interdependence
▶ Medial Side Instability and Reconstruction
▶ Rehabilitation of Complex Knee Injuries and Key Points
▶ Special Considerations for Multiple-Ligament Knee Injuries

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