



Reconstruction of the Medial Collateral Ligament and the Posterior Oblique Ligament With a Flat Tibialis Allograft: the “Trifid Flat Reconstruction”

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Abstract: We describe a technique for grade III medial-side injuries (medial collateral ligament [MCL] + postero-oblique ligament [POL]) using a single tibialis anterior or posterior allograft with 2 tunnels. This technique reconstructs the 2 bundles of the MCL and the POL, taking inspiration from Lind technique. This offers several improvements over the classic Lind technique: it accounts for the flat shape of the MCL and the POL, the anterior strand for the deep MCL reconstruction is isometric and more oblique, and the femoral implantation site of the superficial MCL is more anatomic.

Medial-side knee injuries frequently are underdiagnosed when assessing anterior cruciate ligament (ACL) ruptures. Willinger et al.¹ reported that 67% of presumed “isolated ACL injuries” had a lesion to the medial side (medial collateral ligament [MCL], posteromedial complex, and medial meniscus) of the knee.¹ These injuries occur during valgus and external rotation trauma in sports such as soccer, skiing, and martial arts.² According to the Hughston classification, later revised by Fetto and Marshall,³ grade I and II injuries usually respond well to various types of nonoperative management.⁴ Grade III lesions, characterized by valgus laxity at both 0° and 30° of knee flexion, may require surgery in athletes.⁴

The functions of each of these structures have been described extensively over time and confirmed recently.⁴⁻⁶ The superficial medial collateral ligament (sMCL) is the primary passive restraint against valgus

and an important restraint to external tibial rotation. A previous study highlighted that different zones (anterior, intermediate, and posterior third) inside the MCL perform different functions.⁵ The deep medial collateral ligament (dMCL) is a major restraint to external tibial rotation at 30° of flexion whereas the postero-oblique ligament (POL) primarily restrains to internal tibial rotation in extension.⁶

Two techniques, often seen as the “gold standard” for addressing medial side rotatory and frontal instability, were proposed by Lind et al. in 2009 and LaPrade et al. in 2012, both of which involve reconstruction of the sMCL and the POL.^{7,8} However, laboratory testing has indicated that these techniques do not always restore native knee stability because they may underestimate the importance of the dMCL as a primary restraint to external tibial rotation.⁹⁻¹¹ Moreover, because the native MCL is a broad, flat structure, its contributions to external and internal rotation and valgus control are not fully reproduced by round tubular grafts alone.¹¹

Our objective was to describe a surgical technique that addresses chronic valgus and both external and internal tibial rotational laxities. This technique reconstructs the 2 bundles of the MCL and the POL, taking inspiration from Lind’s technique. We reserve our technique for grade III medial-side injuries (MCL + POL) using a single tibialis anterior or posterior allograft with 2 tunnels.

This technique offers several improvements over the classic Lind technique (Fig 1). It accounts for the flat shape of the MCL and the POL, rather than using

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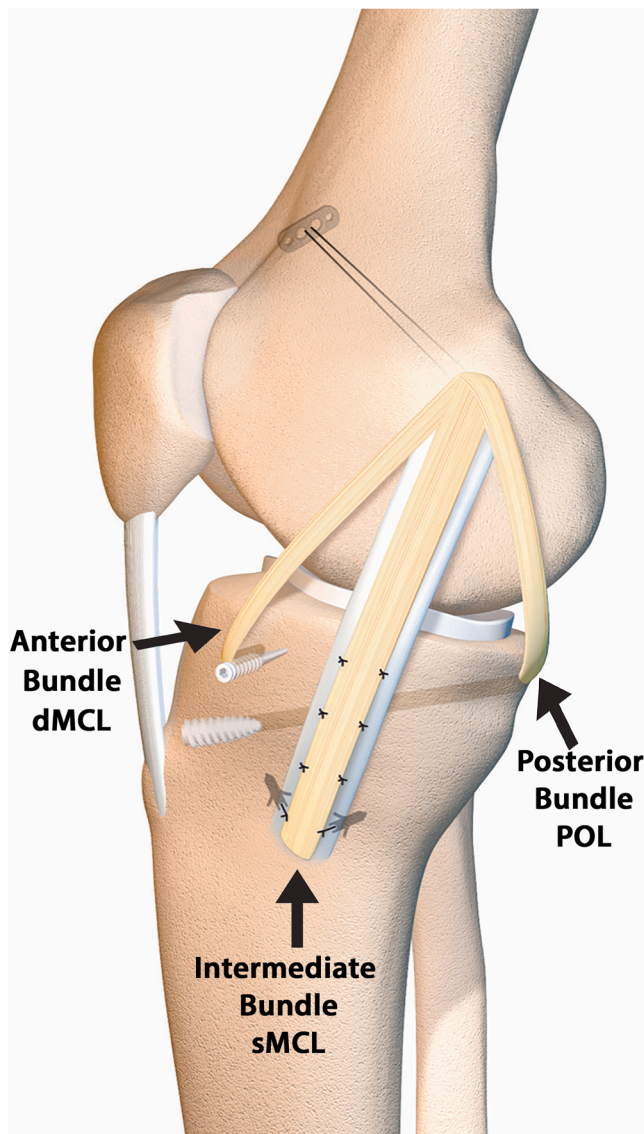


Fig 1. Medial view of a right knee. The complete medial-side reconstruction (sMCL + dMCL + POL) is a “trifid flat graft” to control frontal and rotatory laxities. The MCL reconstruction thus forms an inverted “V” with an angle around 30° between the sMCL and dMCL bundles. The flat shape of the MCL and the POL, is restored better than using round tubular grafts. (dMCL, deep medial collateral ligament; MCL, medial collateral ligament. POL, posterior oblique ligament; sMCL, superficial medial collateral ligament.)

round tubular grafts. The sMCL reconstruction is completely anatomic. The anterior strand for the dMCL reconstruction is isometric and more oblique to better control external tibial rotation.¹¹⁻¹³

The femoral implantation site of the sMCL is more anatomic than in Lind’s original description. The complete medial-side reconstruction (sMCL + dMCL + POL) is a “trifid graft” to control frontal and rotatory laxities.

Table 1. Advantages and Disadvantages of the Trifid Flat Reconstruction

Advantages

- sMCL and POL are anatomic reconstructions
- Single femoral socket for combined MCL-POL reconstruction
- The flat shape of the MCL and the POL is restored
- dMCL is isometric but not anatomic to resist external rotation
- Suspensory femoral fixation allows for a final retensioning to remove creep, if desired.

Disadvantages

- No clinical or biomechanical data
- Costs of all the implants
- Allografts may not be readily available and can be costly
- Lengthy rehabilitation is often necessary

ACL, anterior cruciate ligament; dMCL, deep medial collateral ligament; POL, posterior oblique ligament; sMCL, superficial medial collateral ligament.

Surgical Technique

Preoperative Evaluation

Standard radiographs and magnetic resonance imaging are performed preoperatively. Magnetic resonance imaging helps identify not only the presence of medial-side injuries but also delineates their precise location and severity (involving the sMCL, dMCL, POL, menisci, and cartilage). Advantages and disadvantages of the procedure are presented in [Table 1](#).

Positioning and Testing

The patient is placed supine on the operating table with the knee in 80° of flexion, then stabilized with a lateral support (Maquet Getinge Group, Rastatt, Germany) and a foot bar (Maquet Getinge Group) so that the knee can be mobilized from full extension up to 120° of flexion. A physical examination under anaesthesia (Lachman, pivot shift test, drawer test in external rotation, dial tests at 30° and 90° flexion, varus and valgus stress in extension and 20° of flexion) is performed and compared with the contralateral knee. According to the results of the examination of the knee (laxity in valgus-extension and laxity in external and internal rotation), the decision to carry out a “trifid flat reconstruction” (sMCL + dMCL + POL) is made. See [Video 1](#) for the full technique performed in a left knee.

Graft Selection and Preparation

A single anterior or posterior tibialis allograft (28-32 cm in length) is chosen depending on availability. The tendon portion is divided into 2 bundles: approximately two-thirds of the width for the sMCL and one-third for the dMCL. This bundle is reinforced with a strong braided ultra-high molecular weight polyethylene nonabsorbable whipstitch suture (XBraid No. 2; Stryker, San Jose, CA), with each bundle measuring at least 10 cm. The sMCL component is maintained in a

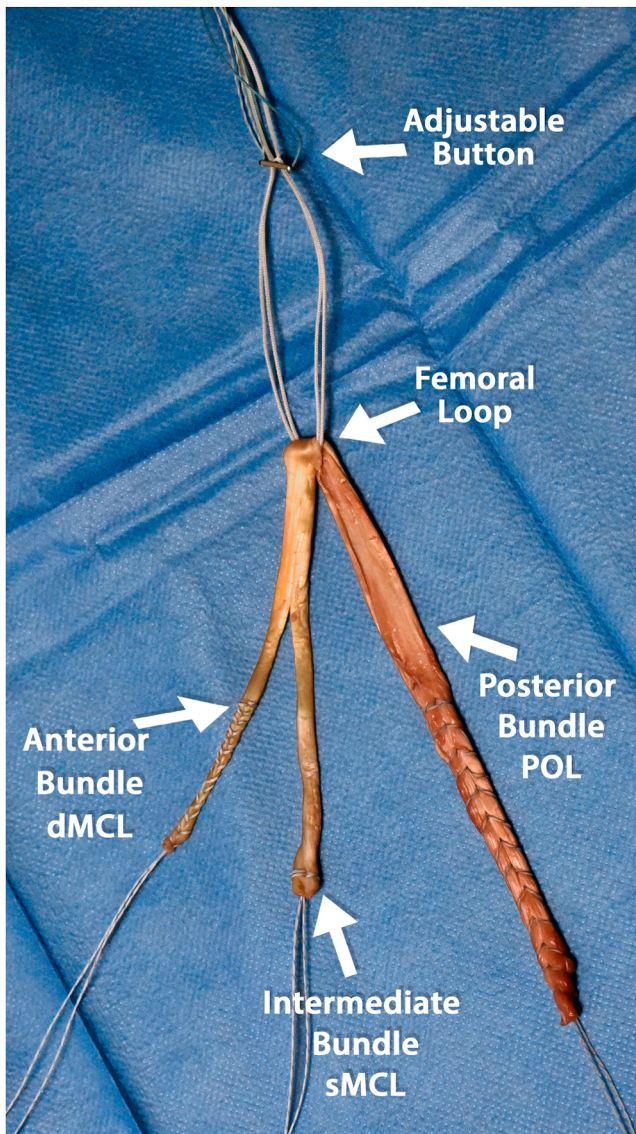


Fig 2. Medial view of a right knee. The graft has a “trifid flat configuration” with an anterior bundle for the sMCL, an intermediate bundle for the dMCL, and a posterior bundle for the POL. (dMCL, deep medial collateral ligament; MCL, medial collateral ligament. POL, posterior oblique ligament; sMCL, superficial medial collateral ligament.)

flat configuration using a raspatorium to produce a flat graft. The opposite aponeurotic end of the graft is whipstitched with a nonabsorbable suture (XBraid No. 2, Stryker) for the POL reconstruction and is calibrated. The graft has a trifid configuration with an anterior bundle for the dMCL, an intermediate bundle for the sMCL, and a posterior bundle for the POL (Fig 2). The graft is then folded and the loop is calibrated and connected to an adjustable cortical button (ProCinch adjustable loop; Stryker). After preparation, the graft is soaked in a vancomycin solution (1 mg/mL) for approximately 5 minutes.¹⁴

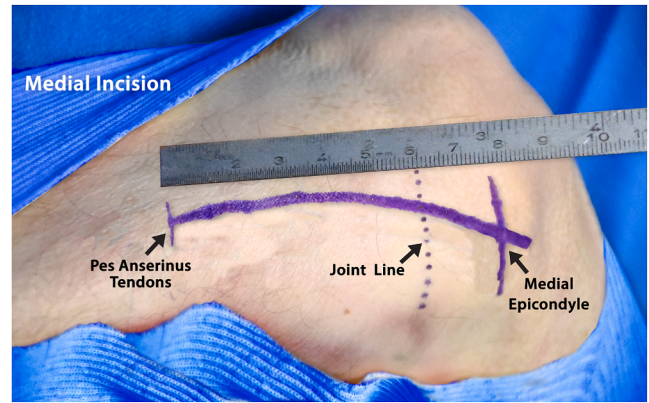


Fig 3. Medial view of a right knee. A 10- to 11-cm skin incision is made from the medial epicondyle to the upper limit of the hamstring tendons. The surgery can be performed with 2 small incisions to prevent arthrofibrosis.

Diagnostic Arthroscopy

An arthroscopy is performed to treat associated intra-articular lesions and to evaluate the knee under valgus stress in flexion and extension. Joint opening above the medial meniscus is suggestive of proximal injury of the MCL whereas opening below suggests a distal injury (“drive-through sign”).

Medial Exposure

A pneumatic tourniquet is not routinely used, but we request hypotension from the anaesthesiologist. A 10- to 11-cm skin incision is created from the medial epicondyle to the upper limit of the hamstring tendons (Fig 3). Sharp dissection is carried down to the superficial fascia (layer 1). After incision of the layer 1, the sMCL is identified over its entire length, taking care to preserve the infrapatellar branch of the saphenous nerve, if seen.

Creation of Femoral and Tibial Tunnels

The femoral insertion of the MCL is the medial epicondyle, approximately 3 cm proximal to the joint line. The femoral insertion of the POL is about 8 to 10 mm posterior to this site. A single femoral insertion for the MCL and the POL is identified proximal and posterior to the apex of medial epicondyle. An isometric test is performed with a compass (FH Orthopedics, Heimsbrunn, France) to ensure that the reconstruction does not gain tension during knee flexion while maintaining the knee in neutral rotation. The inferior tip of the compass is the tibial insertion of the sMCL; the superior tip determines the femoral insertion of the sMCL (Fig 4). A 2.4-mm diameter K-wire is drilled into the pilot hole bicortically and oriented 20° anteriorly and proximally. A 4.5-mm cannulated drill is used to create a continuous femoral tunnel, and then a 30-mm deep socket is drilled at a diameter matching the graft loop.

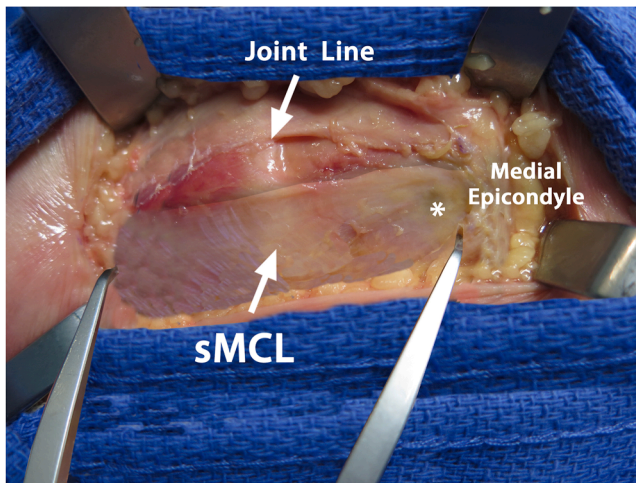


Fig 4. Medial view of a right knee. An isometric test is performed with a compass to ensure that the reconstruction does not gain tension during knee flexion while maintaining the knee in neutral rotation. An isometric test is performed with a compass (FH Ortho) to ensure that the reconstruction does not gain tension during knee flexion while maintaining the knee in neutral rotation. The inferior tip of the compass is the tibial insertion of the sMCL, the superior tip determines the femoral insertion of the sMCL. (sMCL, superficial medial collateral ligament.)

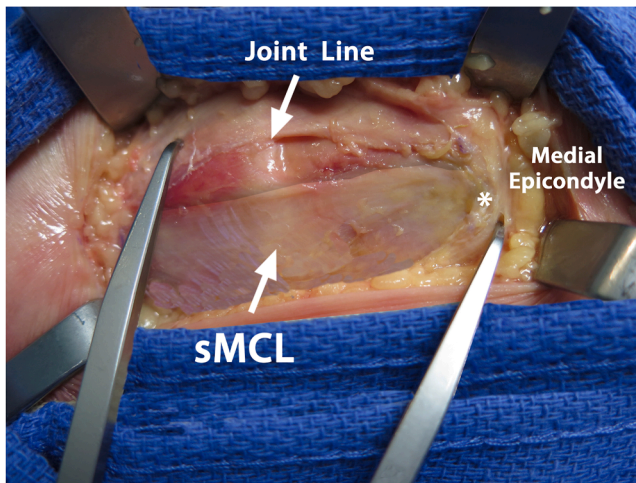


Fig 5. Medial view of a right knee. The dMCL insertion is located 20 mm below the joint line and 20 to 25 mm in front of the anterior edge of the sMCL. Isometry of the dMCL is sought with the compass between the femoral insertion and the dMCL insertion while the knee is taken through a full range of motion. The divergence angle between the dMCL and the sMCL is about 30°. (dMCL, deep medial collateral ligament; sMCL, superficial medial collateral ligament.)

The length of the socket is crucial to ensure there is adequate socket depth for retensioning of the graft after being secured distally. Passing sutures are placed

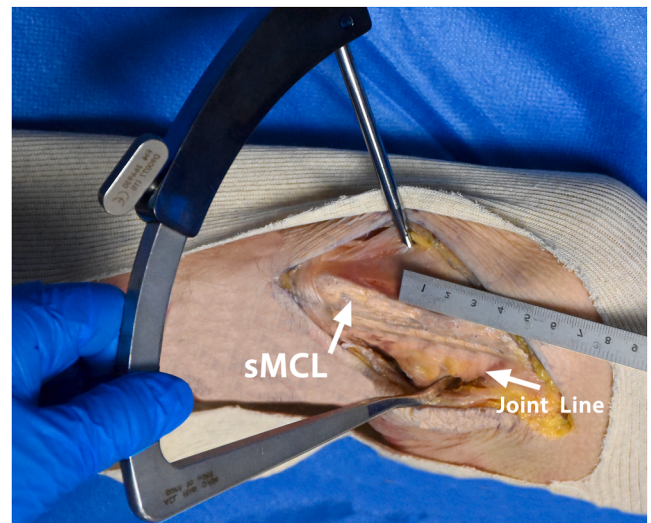


Fig 6. Medial view of a right knee. For the POL, a tibial tunnel is drilled at the posteromedial tibial plateau corner emerging 10 mm below the articular surface, above the direct insertion the semimembranosus tendon with an angulated awl (FH Orthopedics) set to 60°. The anterior exit is 3 to 4 cm below the joint line. (MCL, medial collateral ligament; POL, posterior oblique ligament).

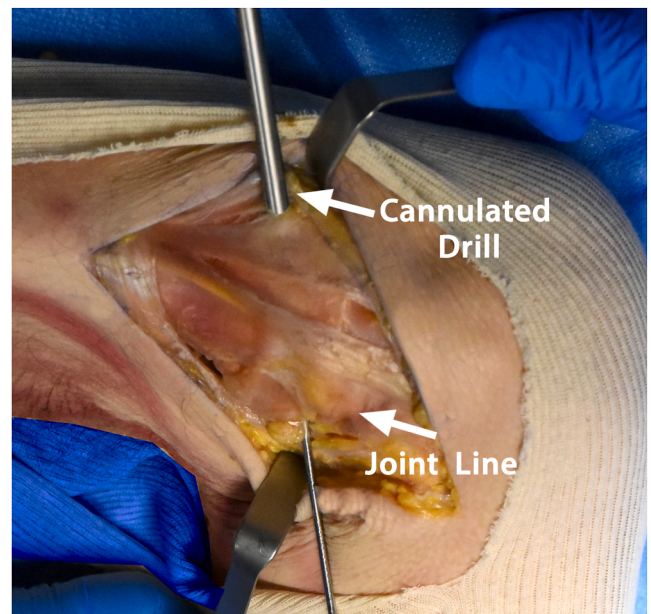


Fig 7. Medial view of a right knee. The tunnel diameter drill (6 or 7 mm) matches the tibialis tendon strand allocated for the POL. (MCL, medial collateral ligament; POL, posterior oblique ligament).

through the guide pin eyelets and pulled through the femur.

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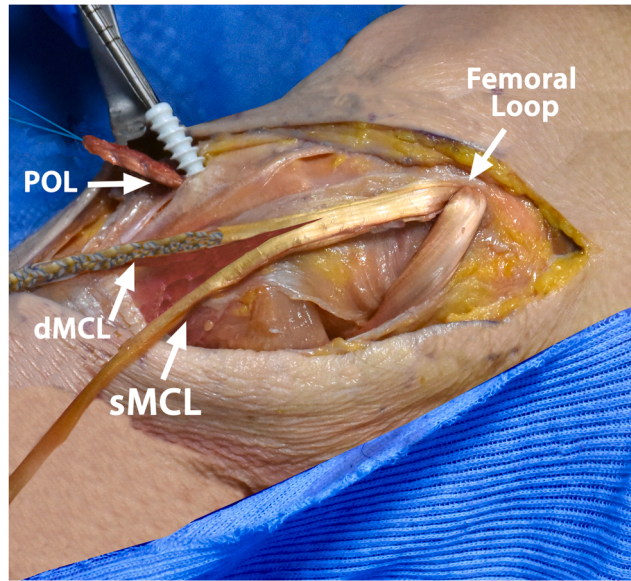


Fig 8. Medial view of a right knee. The POL is pulled into the posterior tibial tunnel and secured at 0° of flexion with a bio-composite interference screw (PLLA- β TCP, diameter: 6 or 7 mm and length: 25 mm) (FH Orthopedics). (MCL, medial collateral ligament; PLLA- β TCP, poly-L-lactic acid- β -tricalcium phosphate; POL, posterior oblique ligament.)

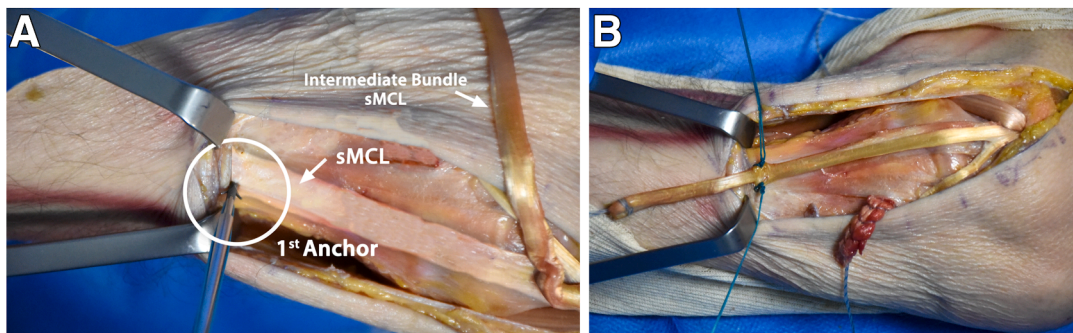


Fig 9. Medial view of a right knee. (A) The pes tendons and sartorius expansion are retracted inferiorly to expose the tibial insertion of the sMCL (approximately 5-7 cm distal to the joint line). Two suture anchors (GII Quick Anchor Plus; DePuy Mitek) are used to secure the graft distally with a braided polyester suture at the anterior and posterior inferior border of the anatomic tibial sMCL insertion. (B) The allograft edges are sutured to the residual tissue of the sMCL by several absorbable sutures (VICRYL 2-0; Ethicon) to cover the native ligament. Knots for the sMCL are tied at 30° of flexion. (sMCL, superficial medial collateral ligament.)

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Fixations

Fixations are performed after the tendon femoral loop is pulled into the socket over a length of 15 to 20 mm and the free end of the POL is drawn into the tibial tunnel. The tendon loop is pulled into the femoral socket and provisionally tensioned with an adjustable button on the femoral lateral cortex (ProCinch adjustable loop; Stryker). We start tibial fixation with the POL (posterior bundle). The POL is pulled into the posterior tibial tunnel and secured at 0° of flexion with a biocomposite interference screw (poly-L-lactic acid- β -tricalcium phosphate [PLLA- β TCP], diameter: 6

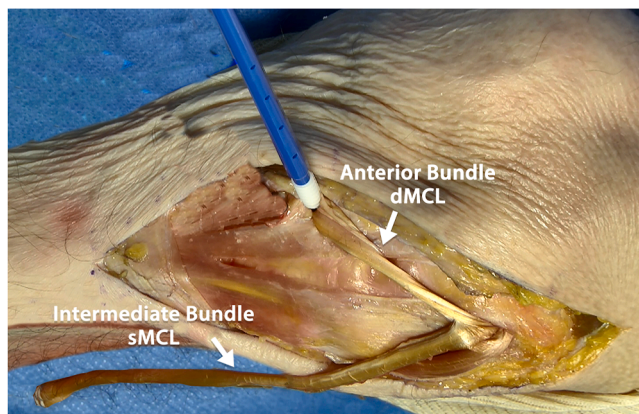


Fig 10. Medial view of a right knee. Fixation of the dMCL (anterior bundle). A continuous 4.5-mm diameter tibial tunnel is drilled. The dMCL is secured with a 4.75-mm SwiveLock anchor at 30° of flexion (Arthrex). (dMCL, deep medial collateral ligament.)

or 7 mm and length: 25 mm; FH Orthopedics) (Fig 8). The POL bundle passed into the tibial tunnel is tensioned at 0° of flexion with the foot neutral. Then, we fix the distal fibers of the sMCL (intermediate bundle). The pes tendons and sartorius expansion are retracted inferiorly to expose the tibial insertion of the sMCL (approximately 5-7 cm distal to the joint line). Two suture anchors (GII Quick Anchor Plus; DePuy Mitek, Raynham, MA) are used to secure the graft distally with a braided polyester suture at the anterior and posterior inferior border of the anatomic tibial sMCL insertion (Fig 9 A and B). The allograft edges are sutured to the residual tissue of the sMCL by several absorbable sutures (VICRYL 2-0; Ethicon, Sommerville, NJ) to cover the native ligament. Knots for the sMCL are tied at 30° of flexion. Any additional allograft is excised. We end with the dMCL (anterior bundle). A continuous 4.5-mm diameter tibial tunnel is drilled. The dMCL is secured with a 4.75-mm SwiveLock Anchor (Arthrex) (Fig 10). The sMCL and the dMCL are tensioned with the knee at 20° of flexion and neutral rotation. The MCL reconstruction thus forms an inverted “V” with an angle around 30° between the sMCL and dMCL bundles (Fig 11). Returning to the proximal construct, suspensory femoral fixation allows for a final retension, applying maximal manual force to remove creep. The knee is examined and found to have improved stability with the application of valgus and rotation forces. Technical pearls and pitfalls are presented in Table 2.

Postoperative Care

A hinged knee brace is worn for 6 weeks. Knee flexion from 0 to 90° is allowed for the first 2 weeks, then 0 to 120° for the subsequent 4 weeks. Partial weight-bearing (15-20 kg) is permitted for 6 weeks.

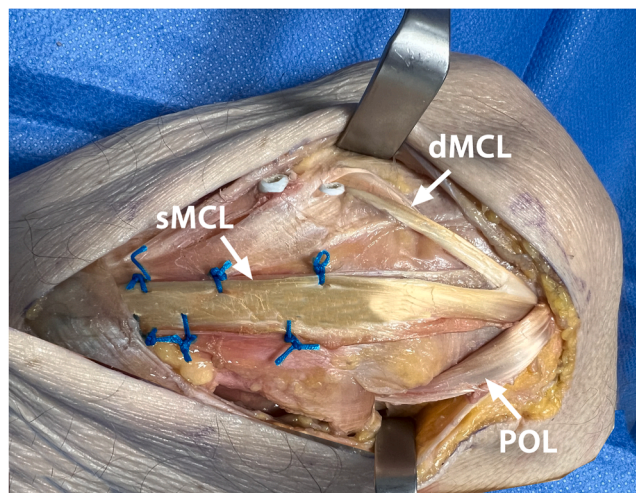


Fig 11. Medial view of a right knee. The dMCL is secured with a 4.75-mm SwiveLock anchor (Arthrex). The sMCL and the dMCL are tensioned with the knee at 20° of flexion and neutral rotation. Returning to the proximal femoral construct, suspensory femoral fixation allows for a final retension, applying maximal manual force to remove creep. (dMCL, deep superficial medial collateral ligament; sMCL, superficial medial collateral ligament.)

After this period, free activity and full weight-bearing are allowed without the brace. Controlled sports activities (running, cycling) are allowed after 3 months, whereas contact sports may resume after 6 months. When combined ACL and medial-side reconstructions are performed, return to contact sports is generally delayed until 9 months.

Discussion

The principal indication for this “trifid flat reconstruction” (sMCL + dMCL + POL) is chronic valgus-extension laxity (grade III), implying a disruption of the MCL and POL. This reconstruction is also indicated in acute disruptions unsuitable for primary repair or in case where the ligament tissue quality is poor. In cases of symptomatic chronic anteromedial rotatory instability, identified by a positive anterior drawer test in external rotation (Slocum test) and a positive valgus-flexion test (grade II), a sMCL + dMCL reconstruction may be sufficient. Using tibialis anterior or posterior allografts is particularly advantageous in acute severe disruptions or chronic instability involving the entire medial side and avoids the potential donor-site morbidity of an autograft.¹⁵ This is particularly advantageous in the setting of a multiligament knee reconstruction. Another benefit of the allograft is its inherently flat morphology, which more accurately mimics the natural shape of the native MCL than a round tubular autograft (such as gracilis or semitendinosus tendon).^{15,16} In addition, suturing the

Table 2. Surgeon Pearls and Pitfalls

Step	Pitfalls	Pearls
Clinical examination	To mistake an anteromedial drawer test or valgus test in extension to clinically identify MCL and POL injuries	Comparative clinical examination under anaesthesia in flexion and extension
Graft preparation	To injure the “trifid preparation” for sMCL, dMCL, and POL	Tendinous end is more resistant than the aponeurotic end
Femoral fixation	Non anatomic tunnel placement for the sMCL Knot blockage before manual maximal traction	Familiarity with medial knee anatomy is paramount to successful completion of an anatomic reconstruction Sufficient length of the femoral socket (>30 mm) before retension
Tibial sMCL fixation	Insufficient fixation strength with the 2 anchors, 6 cm below the joint line to ensure anatomic fixation at the sMCL	Additional sutures of the intermediate bundle to the native sMCL
Tibial dMCL fixation	Insufficient anterior insertion of the dMCL,	Approximately 30° of divergence between the sMCL and the dMCL

dMCL, deep medial collateral ligament; MCL, medial collateral ligament. POL, posterior oblique ligament; sMCL, superficial medial collateral ligament.

allograft to the remaining sMCL fosters biologic integration and can optimize mechanical function.¹⁷

An advantage of this technique is the creation of a significantly oblique (approximately 30°) and isometric anterior strand for the dMCL to restrain excessive external rotation (Robert et al., unpublished laboratory data, 2025). In contrast, a single-strand sMCL reconstruction, as described in Lind’s original technique, is less capable of achieving this challenge.⁹ Shatrov et al.¹⁸ and Borque et al.¹² have proposed a short isometric construct slightly oblique to replicate the dMCL, but the use of synthetic ligament can be of concern, given the high stiffness of the material in case of poor isometry.

Our modified MCL technique aligns with recent biomechanical insights into anteromedial knee laxity to provide robust dMCL and sMCL reconstruction. There is today a lack of studies validating this technique and other novel dMCL reconstruction techniques using biomechanical data on medial stability and mid- to long-term clinical follow-up.

Disclosures

All authors (H.R., A.H., H.C.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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