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A Technique of Superficial Medial Collateral Ligament Reconstruction Using an Adjustable-Loop Suspensory Fixation Device



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Abstract: This report describes superficial medial collateral ligament reconstruction of the knee using a novel method of graft fixation with the ACL Tightrope RT (Arthrex, Naples, FL). After tibial fixation with either a standard interference screw or staple, femoral fixation of the semitendinosus tendon is performed with the adjustable-loop suspensory fixation device, which allows for both initial graft tensioning and re-tensioning after cyclical knee range of motion. This provides the ability for the graft to accommodate for resultant soft-tissue creep and stress relaxation, thereby allowing for optimal soft-tissue tension and reduction in laxity at the end of the procedure.

The medial collateral ligament and posteromedial corner have recently been the focus of a number of publications detailing new anatomic methods of reconstruction.^{1,2} LaPrade and colleagues^{3,4} have added a significant amount to the literature regarding medial knee anatomy and anatomic reconstruction. Combined reconstruction of the superficial medial collateral ligament (sMCL) and the posterior oblique ligament (POL) has been recommended for injuries to these respective ligaments.^{5,6} In addition, POL reconstruction is particularly important in cases of posteromedial instability and excessive recurvatum.^{1,7} Good clinical results have been shown with the LaPrade technique.¹

This report describes the novel use of an adjustable length–loop suspensory fixation device (ACL Tightrope RT; Arthrex, Naples, FL) for femoral fixation of the sMCL (Video 1, Tables 1 and 2). The device provides the ability to tension after tibial fixation and to re-tension after cyclical range of motion of the knee. This allows

compensation for creep and stress relaxation, providing the ability to titrate tension of the graft to the desired level. This can be performed in isolation or along with POL reconstruction.

Surgical Technique

After induction of general anesthesia, the patient is positioned supine with a lateral thigh post and footrest. A tourniquet is applied and inflated before skin incision. Examination under anesthesia is performed, confirming the preoperative diagnosis. Particular attention is given to the presence of recurvatum, valgus opening in extension, or posteromedial rotation to determine whether concomitant POL reconstruction is required.

An arthroscopic examination is performed first. Attention should be paid to the pattern of medial opening, that is, meniscomfemoral or meniscotibial.⁴ If concomitant anterior cruciate ligament (ACL) reconstruction is being performed, it is performed first. The graft choice for the ACL reconstruction can be either autograft or allograft; however, the ipsilateral hamstring is preserved for the medial collateral ligament reconstruction. Our preference is to use an ipsilateral bone–patellar tendon–bone autograft and to perform a single-bundle anatomic ACL reconstruction in this setting.

The sMCL reconstruction is a modified version of the LaPrade technique.¹ A longitudinal skin incision midway between the medial border of the patella and the medial epicondyle is extended from the vastus medialis obliquus to the level of the pes anserinus.

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Table 1. Superficial Medial Collateral Ligament Technique With Semitendinosus Autograft Using Adjustable-Loop Suspensory Fixation Device (ACL Tightrope RT)

Surgical Step	Details
Setup	Supine positioning is used with a lateral post and footrest, with the knee at 90°. A tourniquet is applied and inflated before arthroscopy.
Examination under anesthesia	It is important to assess the degree of medial opening with the knee at 30° of flexion and full extension to exclude POL injury.
Arthroscopy	The cruciates should be assessed because concomitant injury often exists. A full arthroscopic examination is performed, and intra-articular pathology is addressed first.
Medial approach	If ACL or PCL reconstruction is to be performed, it should be performed first. A skin incision midway between the medial border of the patella and the medial epicondyle is extended from the VMO to the level of the pes anserinus.
Graft harvest	Semitendinosus autograft is preferable.
Tibial fixation	The distal insertion of the sMCL is identified 6 cm from the joint line using an interference screw or staple.
Femoral fixation	The femoral origin is identified 19 mm distal to the adductor tubercle, just proximal and posterior to the medial epicondyle. Doubled graft is pulled into the tunnel with the ACL Tightrope RT and tensioned at 20°.
Cyclic motion and tensioning	The knee is cycled through a range of motion, and graft tensioning is repeated until desired tension is achieved.
Fixation of proximal tibial insertion of sMCL	Fixation is performed with a double-loaded anchor 14 mm distal to the joint line.

ACL, anterior cruciate ligament; PCL, posterior cruciate ligament; POL, posterior oblique ligament; sMCL, superficial medial collateral ligament; VMO, vastus medialis obliquus.

Full-thickness skin flaps are developed, with care taken to avoid injury to the saphenous nerve. The same skin incision may be used to harvest the bone–patellar tendon–bone autograft during ACL reconstruction if required (Fig 1A).

The pes tendons are identified, and the sartorius fascia is incised overlying the semitendinosus, which is harvested with a tendon stripper. The sartorius fascia is retracted superiorly to visualize the tibial sMCL attachment. A spinal needle is used to accurately mark the joint line, and the distal insertion of the sMCL is identified as a position 6 cm distal to the joint line and marked (Fig 1B). The sMCL remnant is elevated off

bone, and a 1.4-mm eyelet pin is inserted in an anterolateral direction. This is overdrilled with a drill corresponding to the measured diameter of the sutured end of the graft to a depth of 2.5 cm.

The semitendinosus tendon is prepared on the back table, where it is passed through an ACL Tightrope RT and doubled. The free ends are sutured together with a No. 1 Vicryl (Ethicon, Somerville, NJ) whipstitch, and the diameter is measured (Fig 2). The graft can then be pulled into the tunnel using the eyelet pin and fixed in situ with an interference screw.

Attention is then turned to the femoral attachment. An incision is made through the vastus medialis

Table 2. Pearls and Pitfalls of sMCL Reconstruction Using Adjustable-Loop Suspensory Fixation Device

	Pearl	Pitfall
Preoperative decision making	Use valgus stress radiographs to help diagnose the extent of MCL injury. ⁸	Do not presume that a positive dial test is due to a posterolateral corner injury. The increase in external rotation may be due to anteromedial laxity.
Concomitant ACL reconstruction	Use ipsilateral BPTB autograft for the ACL that can be harvested through the same incision as the MCL reconstruction.	Do not base the decision to reconstruct the MCL on the knee examination after fixing the ACL graft. It will be artificially tight because of the ACL graft fixation.
Tibial fixation	The graft may be used as a free graft or left attached to the tibia. If the latter, the graft may be redirected to the distal insertion of the sMCL using a staple.	In hard cortical bone, when using a tunnel and interference screw, it is recommended to tap the tunnel to allow easy insertion of the screw and reduce the likelihood of amputating the graft.
Femoral tunnel position	Measure the femoral position off the adductor tubercle (19 mm distal), which may be found by locating the adductor magnus tendon.	Do not use the medial epicondyle as the femoral tunnel position. The graft will tighten in flexion and capture the knee.
Graft tensioning	The graft should be tensioned at 20° of flexion.	Do not tension in >20° of flexion. The loop will not slacken, and the knee may be captured, producing an extension lag.

ACL, anterior cruciate ligament; BPTB, bone–patella tendon–bone; MCL, medial collateral ligament; sMCL, superficial medial collateral ligament.

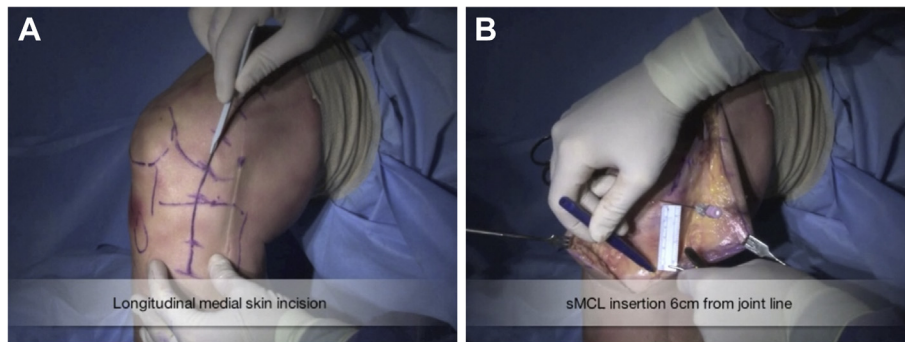


Fig 1. A right cadaveric knee specimen is shown, with the knee held at 90° of flexion. (A) Medial longitudinal incision to allow simultaneous reconstruction of superficial medial collateral ligament and harvest of bone–patellar tendon–bone graft for anterior cruciate ligament reconstruction. (B) Identification of insertion of superficial medial collateral ligament (sMCL), 6 cm distal to joint line, which is marked with a spinal needle.

obliquus fascia, and the adductor magnus tendon is palpated to confirm identification of the adductor tubercle. The femoral attachment of the sMCL is identified 19 mm distal to the adductor tubercle, slightly proximal and posterior to the medial epicondyle. An eyelet pin is inserted from medial to lateral, aiming slightly proximal and anterior (Fig 3A). The graft is then wrapped around the pin and the knee is cycled through a range of flexion/extension, with the surgeon checking for graft isometry (Fig 3B). Minimal length change should be noted, and the pin should be repositioned appropriately if the graft is found to be non-isometric. Once graft isometry is confirmed, a 4.5-mm drill is passed over the eyelet pin and the lateral femoral cortex is breached. The length of the femoral tunnel is measured and the ACL Tightrope RT loop length adjusted accordingly to match this length. This will allow for easy passage and flipping of the button without breaching the lateral soft tissues.

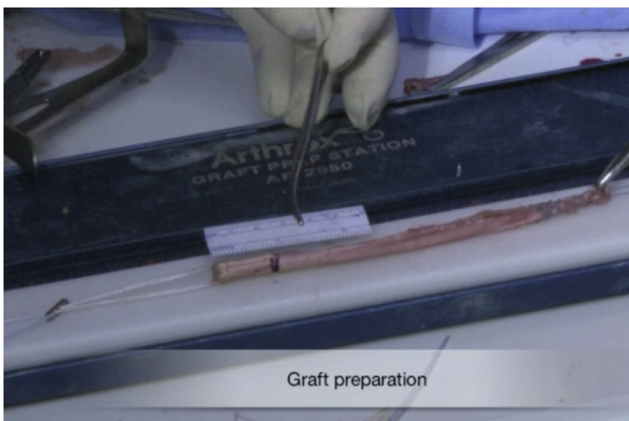


Fig 2. Doubled semitendinosus tendon prepared on surgical back table, looped through an ACL Tightrope RT adjustable-loop suspensory fixation device, and whipstitched at the free ends with a No. 2 FiberWire (Arthrex).

The femoral socket is drilled with the appropriate-diameter drill to a depth that will allow the graft to be tensioned without bottoming out. The minimum socket depth is gauged by measuring the additional graft length extending beyond the eyelet pin.

The graft is pulled deep to the sartorius fascia using blunt curved forceps (Fig 3C). The ACL Tightrope RT sutures are then pulled through the femoral tunnel using the eyelet pin, and the button is flipped to lie on the lateral cortex of the femur. The white ACL Tightrope RT sutures are alternately tensioned while the knee is held at 20° of flexion with a varus force being applied (Fig 3D). This shortens the loop pulling the graft into the tunnel. The knee is cycled through a range of motion to remove creep from the graft. The graft is then re-tensioned using the ACL Tightrope RT sutures, again with the knee in 20° of flexion. This process is repeated until satisfactory tension is achieved across the graft. If desired, additional femoral fixation can be placed using an interference screw at the femoral tunnel aperture.

The proximal tibial insertion of the sMCL is identified 14 mm distal to the joint line. A metal 4.5-mm Cork-screw anchor (Arthrex) is inserted in this position, just anterior to the insertion of the direct arm of the POL (Fig 3E). The sutures of the proximal anchor are passed through the graft in a mattress fashion and tied.

If the semitendinosus tendon is long enough, the tibial insertion may be maintained and the tendon rerouted to the sMCL insertion through a staple instead of the interference screw. In this instance, at least 30 cm of tendon is required. The free end of the graft is passed through the loop of the ACL Tightrope RT and passed back under the staple, which is then impacted flush with the tibia. Once this has been performed, the remainder of the procedure is completed as described earlier.

The surgeon performs a final check of the reconstruction by applying a valgus force to the knee, confirming that medial stability has been restored. The

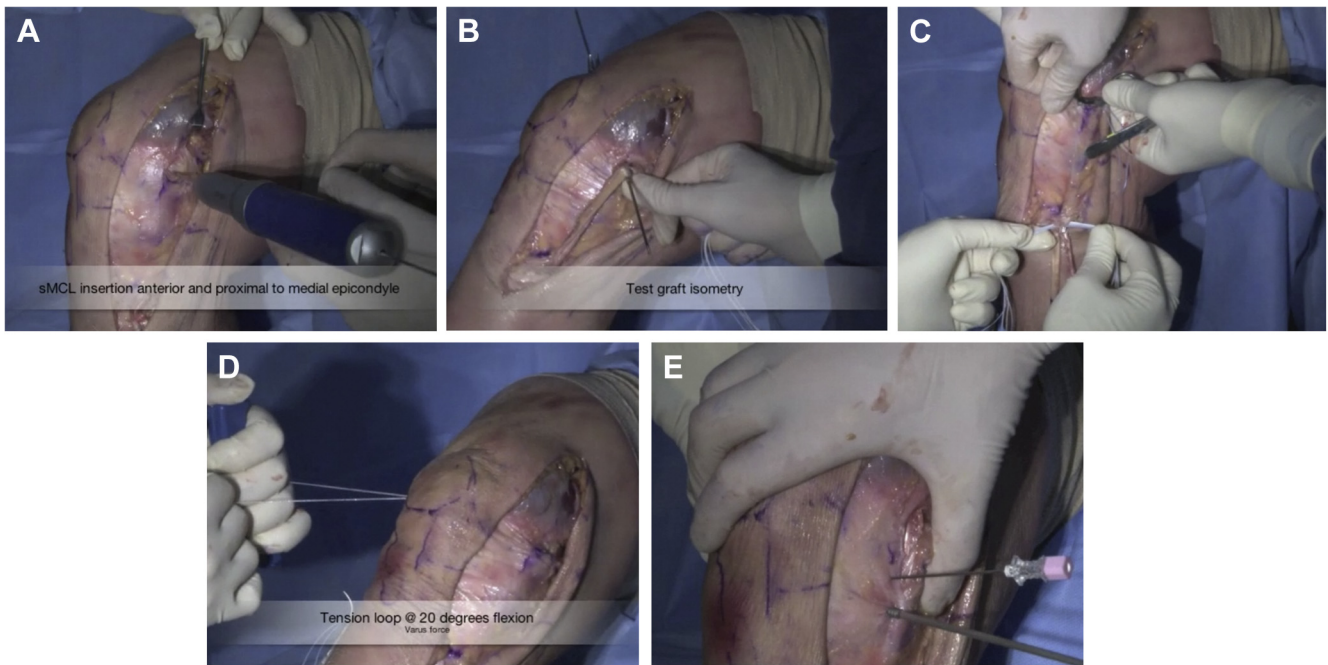


Fig 3. In a right cadaveric knee specimen, with the knee held at 90° of flexion, full-thickness subcutaneous flaps are retracted, allowing access to the medial condyle of the femur. (A) A 2.4-mm guide pin is inserted into the proximal origin of the superficial medial collateral ligament (sMCL), slightly posterior and proximal to the medial epicondyle. (B) The graft is fixed distally with an interference screw in a socket. Graft isometry is checked by wrapping the graft around the pin and cycling the knee through a range of flexion/extension. Length change behavior is noted, and the pin position may be changed depending on the presence of increased tension in extension (position too proximal) or increased tension in flexion (position too anterior). (C) The graft is pulled deep to the sartorius fascia (instrument lying deep to fascia). (D) The graft is pulled into the femoral socket and the adjustable loop shortened by pulling on the white sutures, with the knee held at 20° of flexion and varus force applied. (E) A 4.5-mm Corkscrew anchor is inserted at the proximal insertion of the sMCL (14 mm distal to the joint line, which is marked with a spinal needle), and the sutures are tied over the graft.

wounds are then irrigated and closed in standard fashion.

Postoperatively, the knee is kept in a hinged brace with 0° to 90° of motion for 2 weeks and allowed full range thereafter. Toe-touch weight bearing is recommended for 6 weeks postoperatively, with weight bearing as tolerated thereafter. The brace should be worn for 3 months and then exchanged for an ACL brace used for sports and recreational activities for at least 1 year postoperatively.

Discussion

The described technique is a modification of the LaPrade technique, using the same anatomic principles of graft placement for reconstruction of the sMCL but different fixation techniques.¹ Cortical suspensory fixation has been shown to provide fixation of soft-tissue grafts that is superior to interference screw fixation alone.⁹ A particular benefit of this technique is the robust femoral fixation with the ACL Tightrope RT, as well as tibial fixation with either the staple leaving the distal insertion intact or an interference screw for a free graft. The ability to re-tension the graft after cycling the knee through a range of motion is particularly

attractive. Re-tensioning enables removal of creep from the graft, providing a more secure final construct.

An ipsilateral hamstring graft is used to reconstruct the sMCL. We are unaware of any evidence to suggest that using the ipsilateral hamstring has any detrimental effect on medial-sided stability after sMCL reconstruction.

The 2 potential complications that may be encountered with our technique pertain to the tibial fixation and tensioning of the graft (Table 2). If one is fixing the tibial side in tough cortical bone using an interference screw, it is prudent to tap the tunnel first to allow easy passage of the screw to prevent graft amputation. Furthermore, during graft tensioning, the adjustable suspensory loop should not be shortened when the knee is flexed greater than 30° because this has the potential to capture the knee in flexion and prevent extension. In conclusion, this is a simple technique, using anatomic principles of graft placement and allowing for re-tensioning of the graft after initial placement and range of movement.

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