Technical Note

Medial Quadriceps Tendon Femoral Ligament Reconstruction Technique and Surgical Anatomy

Sheeba M. Joseph, M.D., M.S., and John P. Fulkerson, M.D.

Abstract: Medial patellofemoral ligament reconstruction risks patellar fracture with the osseous violation necessary for patellar attachment. Anatomic studies identify an entire medial patellofemoral complex of structures responsible for medial restraint to patellar lateral instability. One specific component of this complex is the medial quadriceps tendon femoral ligament (MQTFL). This note presents the technique, pearls and pitfalls, and critical surgical anatomy necessary for successful MQTFL reconstruction—a treatment strategy for patellar instability with no increased risk for patellar fracture. An autograft hamstring tendon or allograft tendon is fixed to the anatomically identified femoral origin and passed deep to the vastus medialis obliquus to then weave around the distal medial quadriceps tendon. This simulates the native anatomic interdigitation of the MQTFL with the quadriceps tendon and provides a stable restraint to prevent lateral patellar subluxation or dislocation.

Various treatment strategies exist to address patellofemoral instability. One subgroup of treatments concerns reestablishing the medial restraints of the patellofemoral joint. The common techniques for medial patellofemoral ligament (MPFL) reconstruction risk patella fracture.[1-6] Reconstruction of the medial quadriceps tendon femoral ligament (MQTFL) has been described,[7] and here we provide updated technique details, pearls and pitfalls of surgical reconstruction, and correlative anatomic dissections to better characterize the procedure and assist surgeons with successful reconstruction of this key restraint to lateral patella subluxation or dislocation.

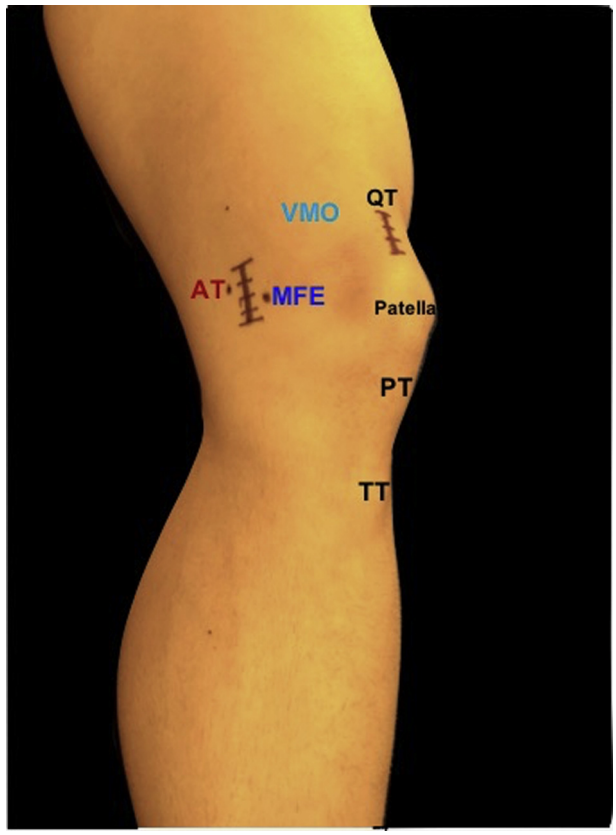

Fig 1. Left knee with proposed medial quadriceps tendon femoral ligament reconstruction skin incisions drawn and surface landmarks demarcated (AT, adductor tubercle; MFE, medial femoral epicondyle; PT, patellar tendon; QT, quadriceps tendon; TT, tibial tubercle; VMO, vastus medialis obliquus.)

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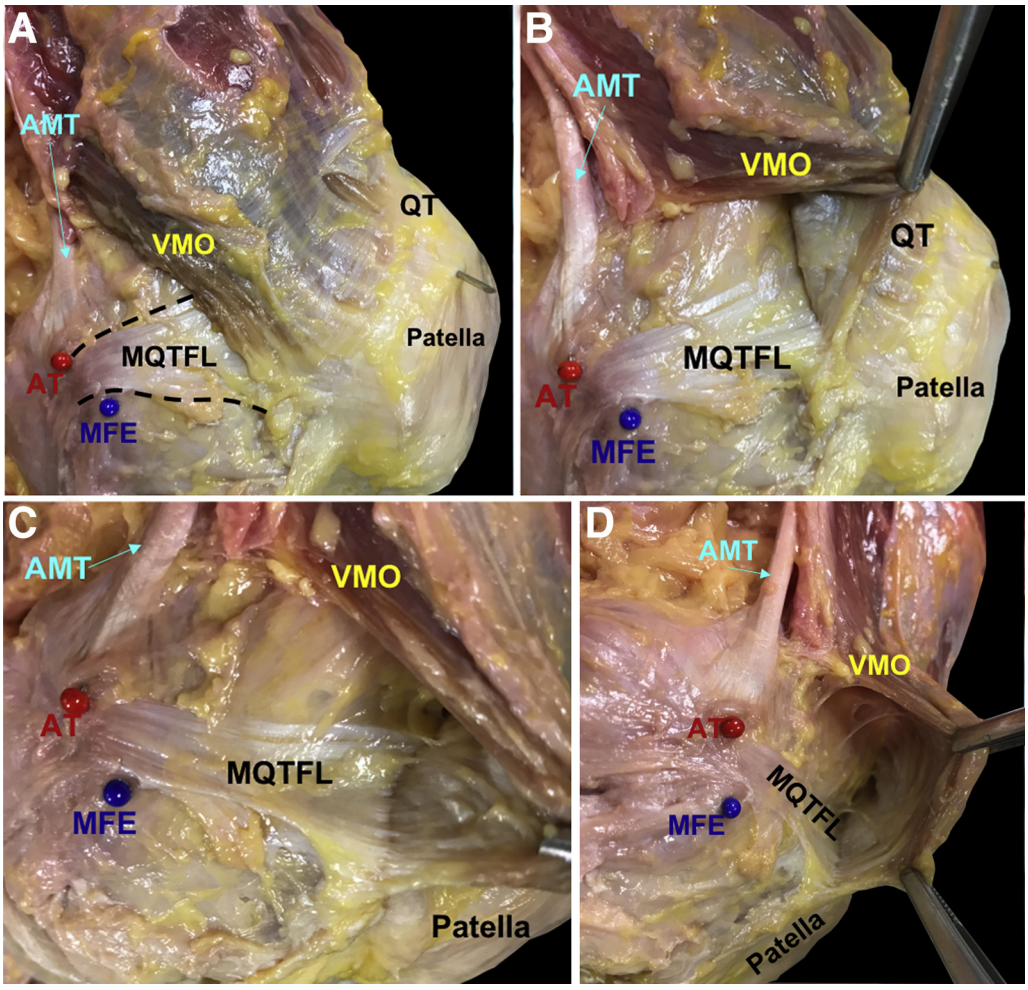

Fig 2. Cadaveric dissection of a left knee highlighting anatomic landmarks surrounding the medial quadriceps tendon femoral ligament (MQTFL) origin and insertion. (A) Spinal needle exiting at superior pole of patella. (B) Forceps elevating the VMO border revealing MQTFL's deeper continued trajectory. (C, D) Closer views highlighting MQTFL's decussation with undersurface of VMO and QT. (AMT, adductor magnus tendon; AT, adductor tubercle; MFE, medial femoral epicondyle; MQTFL, medial quadriceps tendon femoral ligament; VMO, vastus medialis obliquus.)

Surgical Technique

Indications

Preoperative evaluation is paramount in determining the surgical design for restoring optimal patellofemoral tracking (usually by tibial tubercle transfer) and addressing any associated chondral pathology prior to MQTFL reconstruction.

Procedure

For MQTFL reconstruction, the patient is positioned supine, and a bump beneath the contralateral hip may permit easier access to the medial knee (Video 1).

A diagnostic arthroscopy is performed to confirm and document the patient's patellar tracking, chondral pathology, and degree of patellar rotation/tilt. An intra-articular lateral release or open lateral lengthening may be performed and should be done in proportion to the degree of lateral tightness that the surgeon anticipates will balance well with the forthcoming MQTFL reconstruction. Once the diagnostic arthroscopy, intra-articular work, tibial tubercle transfer surgery (as appropriate), and associated necessary chondral lesion stabilization are complete, the MQTFL open portion of the procedure commences.

1) Two longitudinal 3- to 5-cm incisions are required. The first incision is centered over the saddle region between the adductor tubercle and medial femoral epicondyle, following the trajectory of the adductor magnus tendon proximally. The second incision lies just proximal to the superomedial corner of the patella over the vastus medialis obliquus (VMO)—quadriceps tendon (QT) junction (Fig 1).
2) The femoral attachment site is identified after dissection down to the medial femur through the first incision, taking care to avoid the greater saphenous vein, the saphenous nerve posteriorly,

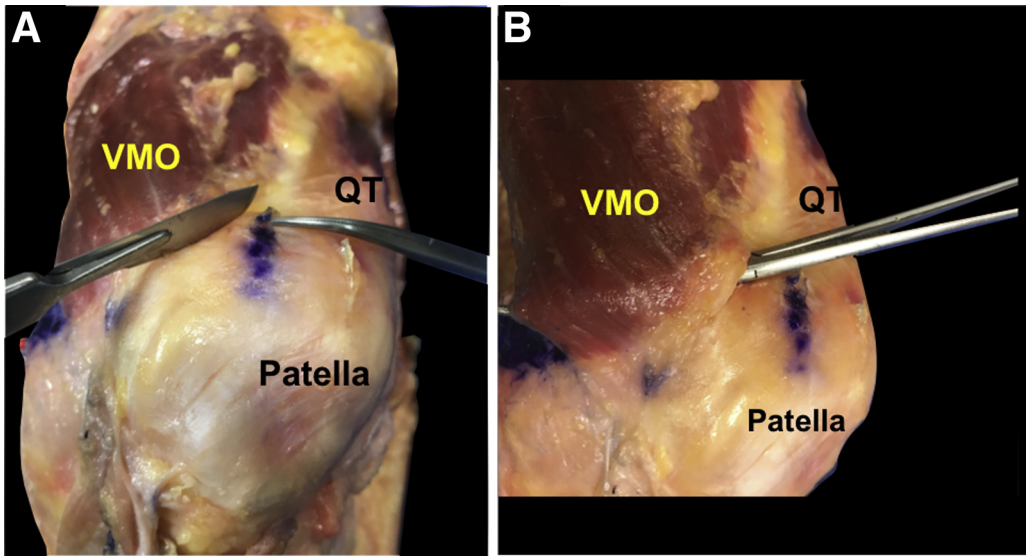

Fig 3. Cadaveric dissection of a left knee showing VMO incision with scalpel positioned in desired trajectory along with a hemostat pointing out the superomedial pole of the patella (A). The hemostat is then passed into the incision and deep to the VMO (B). (QT, quadriceps tendon; VMO, vastus medialis obliquus.)

and the infrapatellar branch of the saphenous nerve anteriorly. The adductor tubercle is identified and confirmed by the tendinous portion of adductor magnus inserting proximally. A guide pin is placed at the anticipated location for the femoral socket at the distal extent of the adductor tubercle and within the proximal "saddle" region between the adductor tubercle and the medial femoral epicondyle (Fig 2). Anatomic dissection referencing these landmarks results in very accurate, anatomic placement of the femoral attachment. The guide pin is over-reamed with an 8-mm reamer, taking care to reference and preserve the anterodistally located medial collateral ligament origin. Irrigation removes bony reaming debris.

3) A semitendinosus autograft or suitable allograft tendon (we use allograft posterior tibialis tendon) is selected. The tendon graft is whip-stitched with a braided No. 2 ultra-high-molecular-weight polyethylene suture (e.g., No. 2 Ultrabraid suture, Smith & Nephew, Memphis, TN) at one end. This end of the graft will be fixed at the femoral insertion site.
4) A second incision is carried down to the junction of the VMO and the QT. The skin is retracted medially/posteriorly and distally to reveal the VMO's insertion onto the superomedial patella. A 1.5-cm oblique incision is made within the VMO following the superomedial patella's border (Fig 3). The plane deep to the VMO is bluntly dissected with a hemostat posteriorly and medially toward the adductor tubercle and the previously inserted guide pin.
5) The skin is then retracted anteriorly and laterally, and a 1-cm longitudinal incision is made at the junction of the medial and central thirds of the QT (Fig 4). A hemostat is used to develop a partial-thickness (i.e., approximately 5- to 8-mm deep) passage between this QT incision and the VMO incision.

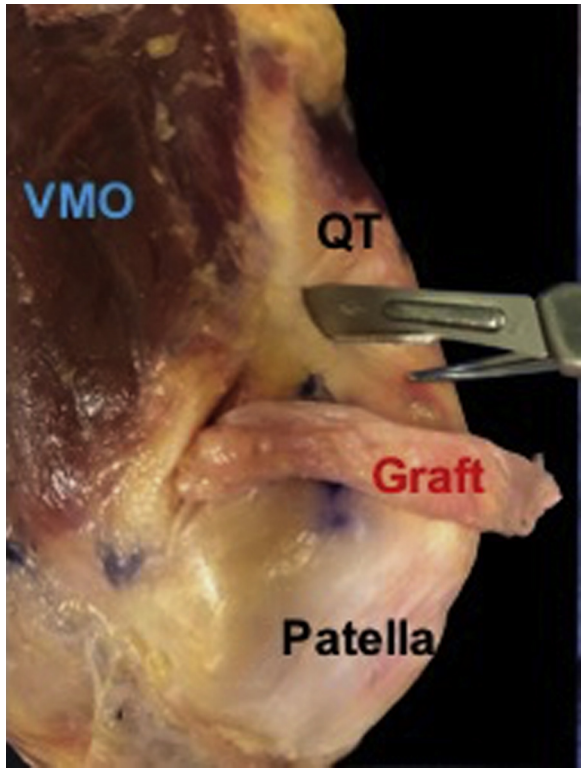

Fig 4. Cadaveric dissection of a left knee showing quadriceps incision. The scalpel blade is positioned at the location of desired incision, and the hemostat marks the superior pole of the patella. (QT, quadriceps tendon; VMO, vastus medialis obliquus.) Note that the graft has already been passed through the VMO incision in this image.

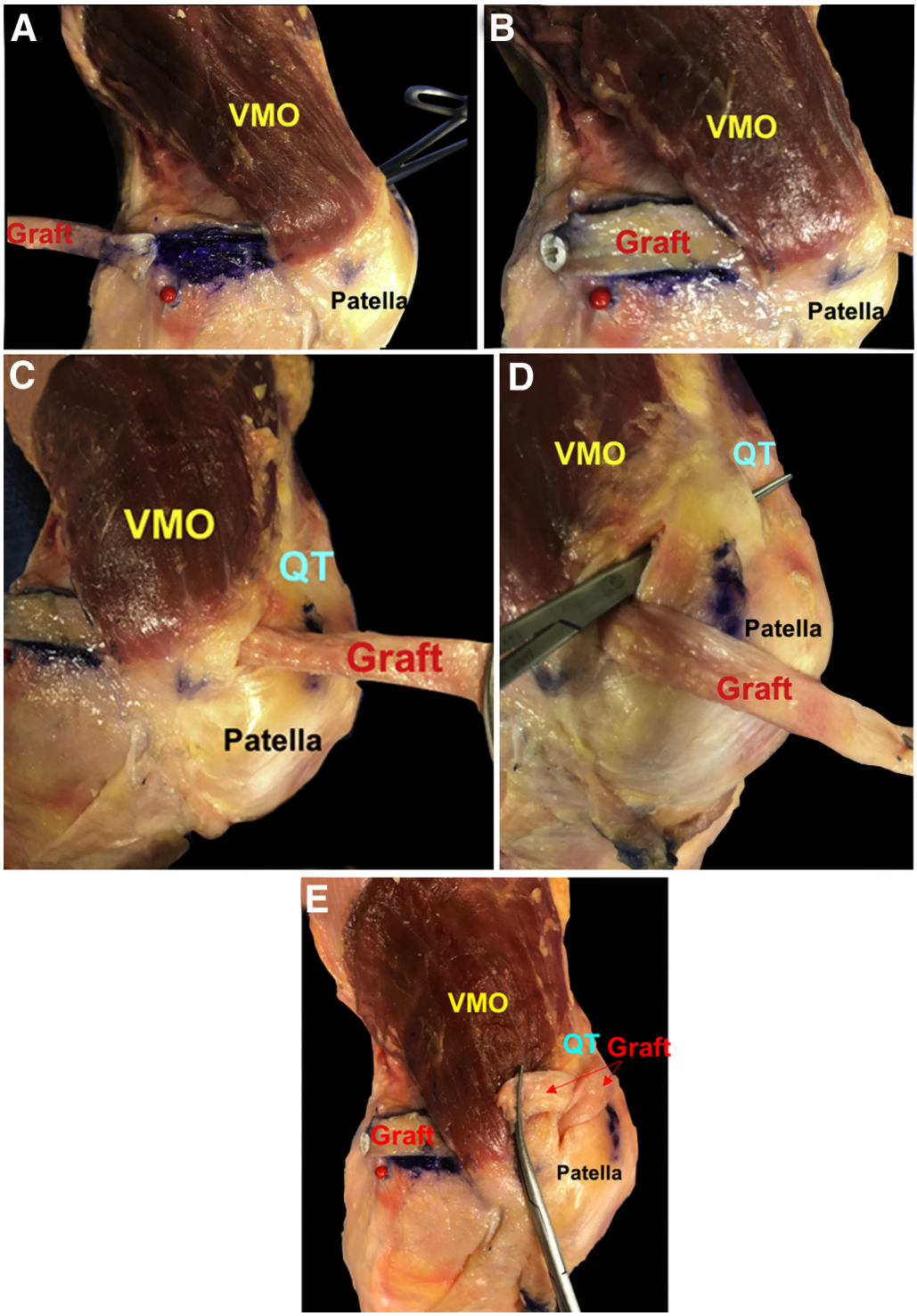

Fig 5. Cadaveric dissections of a left knee showing passage of the graft. (A) Hemostat placed into the VMO incision and deep to VMO to exit at the most medial border over the anatomic medial quadriceps tendon femoral ligament (highlighted in purple marker) to retrieve the graft after it has been fixed at the femoral insertion point in the saddle region just proximal to the medial femoral epicondyle (red pin head). (B, C) Direct medial view and an oblique view demonstrate the graft passed deep to VMO and exits more anteriorly from the VMO incision. (D) Hemostat placed into the VMO incision and out the quadriceps tendon incision via a partial-thickness connection between the 2 incisions. (E) The graft is placed in the hemostat, and by way of retrieving the hemostat, the graft is delivered into the quadriceps incision and back out the VMO incision. This image shows the ending position with the hemostat still holding the graft after delivery. (QT, quadriceps tendon; VMO, vastus medialis obliquus.)

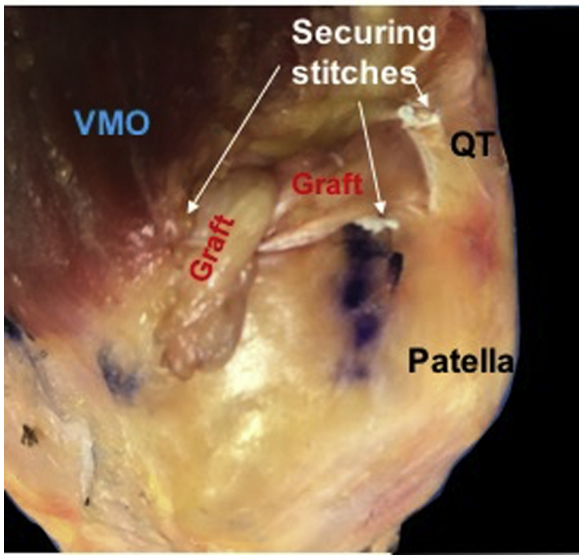

Fig 6. Cadaveric specimen of a left knee with graft passed in final position and securing stitches holding graft at desired length and tension. (QT, quadriceps tendon; VMO, vastus medialis obliquus.)

6) With these incisions and connecting planes developed, the graft is then passed to reconstruct the MQTFL. The whip-stitched end of the tendon for femoral attachment is affixed by an anchoring device (e.g., 7-mm Tenolock Anchor, Conmed, Tampa, FL) into the 8-mm femoral socket previously created, thereby establishing the MQTFL's femoral origin. Next, the graft is passed deep to the VMO and out the VMO incision by way of a hemostat. Then, a hemostat is directed from the VMO incision through the QT in the plane previously established and out the QT incision (Fig 5). Finally, the graft end exiting the VMO incision is pulled into the quadriceps incision with the passed hemostat and pulled back in the direction of the femoral insertion under the medial third of the QT and out the VMO incision.

Securing the Graft

To assess graft tension, a blue mark is placed on the graft at the most lateral aspect where it dives into the QT incision with the knee in approximately 30° of flexion. The knee is cycled while holding slight tension on the free end of the graft exiting the VMO incision. The mark on the graft is observed for movement deep to the QT or medially away from the incision as occurs if the MQTFL construct lengthens or shortens, respectively, with range of motion (Video 1). With anatomic precision of the femoral attachment, the mark on the graft generally does not move more than about 1 to 2 mm, with no tension necessary by the graft, confirming appropriate graft placement. Smooth patellar tracking includes slight lateral deviation of the patella as the knee nears full extension and centralization after the first 10° to 20° of knee flexion.

Once the surgeon is satisfied with the MQTFL graft length and tension, "setting it to length" as described by Farr and Schepsis,[8] the graft is secured with the knee in 30° of flexion. The limb of graft passing over the medial third QT between the VMO incision and the QT incision is sutured to the quad tendon with No. 2 nonabsorbable suture (e.g., No. 2 Ultrabraid suture, Smith & Nephew), taking care to pass the suture at oblique angles to both the transversely directed graft limb and the longitudinally oriented QT fibers so as to ensure no pull-out of the suture. Typically, 2 to 3 figure-of-8 ties are made here (Fig 6). Then, the free end of the graft exiting from the VMO incision is sutured back onto the first limb exiting from the VMO incision in similar fashion. Usually, 2 such ties are sufficient here. This final construct (Fig 7) creates a robust and anatomic medial restraint to the patella and extensor mechanism without the risks of osseous tunnels. The knee is once again cycled to reconfirm appropriate patellar tracking and graft tensioning.

With the arthroscope, the surgeon visualizes intra-articular tracking during range of motion. A valuable

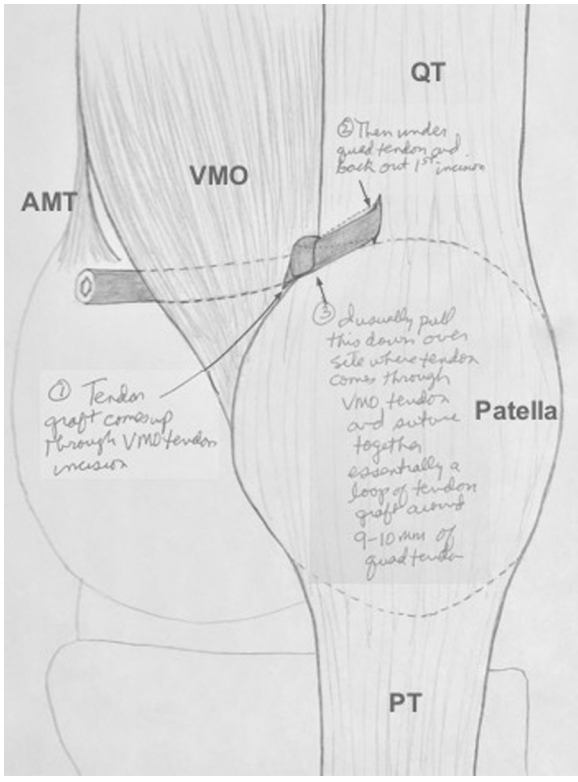

Fig 7. Schematic drawing of final medial quadriceps tendon femoral ligament reconstruction construct in a left knee. (AMT, adductor magnus tendon; PT, patellar tendon; QT, quadriceps tendon; VMO, vastus medialis obliquus.) Note that the securing stitches are not drawn.

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
Indications	
Particularly desirable in contact athletes with increased risk of patella trauma/fracture.	Failure to recognize and correct underlying patellar maltracking.
Particularly desirable in patients with patella lesions, previous surgery, or revision of failed medial patellofemoral ligament reconstruction.	
Possibly better option for any patient needing medial patellofemoral complex restoration.	
Diagnostic Arthroscopy	
Assess patellar tracking during full range of motion and location of chondral lesions to fine-tune final graft tension.	Failure to recognize and adjust reconstruction to avoid loading areas of chondral wear.
Attention to restrictive lateral structures that create tilt allows lateral release or lengthening as needed.	Failure to confirm appropriate tracking after graft placement.
	Distortion of tracking by inflow or arthroscope placement.
Femoral Attachment	
Graft fixation on femoral side based on full understanding of relevant anatomy (Fig 2).	Nonanatomic tunnel or fixation placement related to inadequate understanding of anatomy or inaccurate radiographic localization.
Always identify the adductor magnus tendon, adductor tubercle, and medial epicondyle.	Mistaking medial epicondyle for adductor tubercle: always identify adductor longus tendon to assure correct location of adductor tubercle.
Quadriceps Attachment	
Pass securing suture in oblique direction to both quadriceps tendon and the graft to ensure no pull-through of suture if otherwise placed in line with tendon or graft orientation (Fig 6).	Inadequate graft fixation.
Be sure to close incisions in quadriceps tendon before final determination of proper graft placement. Consider these incisions as the graft is tensioned to allow slight lateral mobility and to avoid overtensioning.	Intra-articular graft placement or failure to close incisions before final evaluation of tracking.
Securing the Graft	
Place mark on graft at most lateral aspect of graft where it meets the quadriceps tendon to best observe lengthening/shortening (pistoning) of the graft with range of motion.	Fixation devices on the femoral side that spin or cut into the graft.
Place corner stitches to secure graft to quadriceps tendon and be sure to close incisions in quadriceps tendon before confirming appropriate tensioning of graft.	Overtensioning the graft.
Better a little loose than too tight!	Tightening the graft such that pressure is added to an articular (symptomatic or asymptomatic) chondral lesion of the patella.
Remove fixation sutures and replace as needed to optimize graft fixation and graft length on quadriceps tendon fixation side.	Failure to close incisions in quadriceps tendon when determining fixation length of graft.

advantage of this MQTFL reconstruction technique is that the surgeon may cut the fixation sutures to reestablish graft tension to optimize tracking. Once the surgeon is satisfied, the graft is fixed as described previously, and the excess graft material beyond the second site of fixation near the VMO incision is then cut sharply and removed. Wounds are closed in standard fashion. Table 1 highlights the pearls and pitfalls of this technique.

Postoperative Care

Patients are placed in a knee immobilizer postoperatively. The immobilizer should be removed once a day to perform a single, maximal knee flexion as tolerated. They are tasked with the goal of achieving 90° flexion by postoperative weeks 3 to 4 and achieving 120° flexion by postoperative weeks 6 to 8. Patients are permitted to weight bear to tolerance on the operative extremity. Crutches are used for 6 weeks or until patients achieve limp-free ambulation with good quadriceps control. Physical therapy further guides safe weight bearing without crutches and escalates range of motion and strengthening. Patients return to straight forward running by 4 months and full sports by 6 to 8 months.

Discussion

Treatment of patellofemoral instability in the past has ranged from medial soft tissue reefing to VMO advancements to reinforcement of medial structures.[9] More recently, MPFL reconstruction has become a widely accepted strategy. However, the traditional MPFL reconstruction technique risks patellar fracture—a complication reported at a 3.6% rate.[1] In a series by Parikh and Wall[2] of 5 patients, 4 required repeat surgeries after the index procedure to treat patellar fracture and reported unresolved symptoms

of pain, an extensor lag, persistent instability, quadriceps weakness, or required additional hospitalization—specifically inpatient rehabilitation for 1 patient. Patellar fracture is a serious complication after MPFL reconstruction and generates the risk for a protracted postoperative course and incomplete rehabilitation or even chronic pain.

To avoid patellar osseous violation as is required with MPFL reconstruction, we return to the anatomy of the medial knee that has been described extensively.[10-16] In addition to the MPFL, the medial patellotibial ligament, medial patellomeniscal ligament, MQTFL, and medial patellofemoral complex (MPFC) have all been described and studied.[17-20] Stemming from these anatomic studies, additional research has focused on the attachment points of these structures in the constant endeavor for anatomic reconstruction techniques. The proximal aspects of the MPFC have been described as interdigitating with the undersurface of the VMO,[17] and we have seen similar anatomy (Fig 2 B and C). Further evaluation describes this suprapatellar medial restraint to the patella and the extensor mechanism as the MQTFL.[7,12] Reconstructing the MQTFL avoids patellar osseous violation, and as described here, critically reestablishes anatomy and allows very precise graft tensioning and convenient retensioning to avoid the dreaded complications of medial subluxation or medial patellar overload with overtensioned MPFC restraints. However, it must be noted that the risk of overtensioning MPFC restraints with MQTFL reconstruction is not entirely eliminated but rather reduced with attention to anatomic landmarks, as in MPFL reconstruction. Another potential risk with MQTFL reconstruction is violation of the suprapatellar joint capsule during development of the intratendinous plane in the medial QT. This is a similar risk with QT harvest for anterior cruciate ligament reconstruction; violation of the suprapatellar capsule has not been described as detrimental to patient outcomes in these cases.[21-23] The authors have never found this to be a problem.

As presented herein, MQTFL reconstruction offers an anatomy-driven approach to patella stabilization while eliminating the risk of patella fracture. The procedure has been successful in preventing patella instability in many athletes including intercollegiate and professional athletes and 1 Olympic athlete.

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