Medial Quadriiceps Tendon Femoral Ligament Reconstruction Technique and Surgical Anatomy

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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.

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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,
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 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.)
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 Teno lock 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, 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

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**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.)

**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

| Indications                                                                 | Pearls                                                                                                           | Pitfalls                                                                                           |
|----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| Particularly desirable in contact athletes with increased risk of patella trauma/fracture. | Failure to recognize and correct underlying patellar maltracking.                                               | Overtensioning the graft. Adam, a complication reported at a 3.6% rate.1 In a series by Parikh and Wall2 of 5 patients, 4 required repeat surgeries after the index procedure to treat patellar fracture and reported unresolved symptoms. |
| Particularly desirable in patients with patella lesions, previous surgery, or revision of failed medial patellofemoral ligament reconstruction. | Nonanatomic tunnel or fixation placement related to inadequate understanding of anatomy or inaccurate radiographic localization. | Tightening the graft such that pressure is added to an articular (symptomatic or asymptomatic) chondral lesion of the patella. |
| Possibly better option for any patient needing medial patellofemoral complex restoration. | Distortion of tracking by inflow or arthroscope placement.                                                     | Failure to close incisions in quadriceps tendon when determining fixation length of graft.          |

Table 1. Continued

| Pearls                                                                 | Pitfalls                                                                                                           |
|-----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Place corner stitches to secure graft to quadriceps tendon             | Overtensioning the graft. |
| and be sure to close incisions in quadriceps tendon before confirming appropriate tensioning of graft. | Failure to remove fixation sutures and replace as needed to optimize graft fixation and graft length on quadriceps tendon fixation side. |
| Better a little loose than too tight!                                   | Better a little loose than too tight!                                                                            |
| Remove fixation sutures and replace as needed to optimize graft fixation and graft length on quadriceps tendon fixation side. | Tightening the graft such that pressure is added to an articular (symptomatic or asymptomatic) chondral lesion of the patella. |

Discriminating 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 Wall2 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. In addition to the MPFL, the medial patellofibial ligament, medial patellomeniscal ligament, MQTFL, and medial patellofemoral complex (MPFC) have all been described and studied. 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, and we have seen similar anatomy (Fig 2B and C). Further evaluation describes this suprapatellar medial restraint to the patella and the extensor mechanism as the MQTFL. 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. 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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References

1. Schiphouwer L, Rood A, Tigchelaar S, Koëter S. Complications of medial patellofemoral ligament reconstruction using two transverse patellar tunnels. Knee Surg Sports Traumatol Arthrosc 2017;25:245-250.
2. Parikh SN, Wall EJ. Patellar fracture after medial patellofemoral ligament surgery: A report of five cases. J Bone Joint Surg Am 2011;93: e97(1-8).
3. Ellera Gomes JL. Medial patellofemoral ligament reconstruction for recurrent dislocation of the patella: A preliminary report. Arthroscopy 1992;8:335-340.
4. Mikashima Y, Kimura M, Kobayashi Y, Miyawaki M, Tomatsu T. Clinical results of isolated reconstruction of the medial patellofemoral ligament for recurrent dislocation and subluxation of the patella. Acta Orthop Belg 2006;72:65-71.
5. Dhinwa BS, Bhamra JS, James C, Dunnet W, Zahn H. Patella fracture after medial patellofemoral ligament reconstruction using suture anchors. Knee 2013;20:605-608.
6. Shah JN, Howard JS, Flanagan DC, Brophy RH, Carey JL, Lattermann C. A systematic review of complications and failures associated with medial patellofemoral ligament reconstruction for recurrent patellar dislocation. Am J Sports Med 2012;40:1916-1923.
7. Fullkerson JP, Edgar C. Medial quadriceps tendon-femoral ligament: Surgical anatomy and reconstruction technique to prevent patella instability. Arthrosc Tech 2013;2:e125-e128.
8. Farr J, Schepsis AA. Reconstruction of the medial patellofemoral ligament for recurrent patellar instability. J Knee Surg 2006;19:307-316.
9. Stiebel M, Edgar C, Schepsis AA. Chapter 11: Reconstruction of the medial patellofemoral ligament. In: AANA advanced arthroscopy: The knee. Philadelphia, PA: Saunders Elsevier, 2010.
10. Feller JA, Feagin JA, Garrett WE. The medial patellofemoral ligament revisited: An anatomical study. Knee Surg Sports Traumatol Arthrosc 1993;1:184-186.
11. Panagiotopoulos E, Strzelczyk P, Herrmann M, Scuder G. Cadaveric study on static medial patellar stabilizers: The dynamizing role of the vastus medialis obliquus on medial patellofemoral ligament. Knee Surg Sports Traumatol Arthrosc 2006;14:7-12.
12. Tanaka MJ. The anatomy of the medial patellofemoral complex. Sports Med Arthrosc 2017;25:e8-e11.
13. Kruckeberg BM, Chahla J, Moatshe G, et al. Quantitative and qualitative analysis of the medial patellar ligaments: An anatomic and radiographic study. Am J Sports Med 2017. 363546517729818.
14. LaPrade RF, Engebretsen AH, Ly TV, Johansen S, Wentorf FA, Engebretsen L. The anatomy of the medial part of the patella. J Bone Joint Surg Am 2007;89:2000-2010.
15. Mochizuki T, Nimura A, Tateishi T, Yamaguchi K, Muneta T, Akita K. Anatomic study of the attachment of the medial patellofemoral ligament and its characteristic relationships to the vastus intermedius. Knee Surg Sports Traumatol Arthrosc 2013;21:305-310.
16. Baldwin JL. The anatomy of the medial patellofemoral ligament. *Am J Sports Med* 2009;37:2355-2361.

17. Conlan T, Garth WP, Lemons JE. Evaluation of the medial soft-tissue restraints of the extensor mechanism of the knee. *J Bone Joint Surg Am* 1993;75:682-693.

18. Desio SM, Burks RT, Bachus KN. Soft tissue restraints to lateral patellar translation in the human knee. *Am J Sports Med* 1998;26:59-65.

19. Tanaka MJ, Voss A, Fulkerson JP. The anatomic midpoint of the attachment of the medial patellofemoral complex. *J Bone Joint Surg Am* 2016;98:1199-1205.

20. Philippot R, Boyer B, Testa R, Farizon F, Moyen B. The role of the medial ligamentous structures on patellar tracking during knee flexion. *Knee Surg Sports Traumatol Arthrosc* 2012;20:331-336.

21. Slone HS, Romine SE, Premkumar A, Xerogeanes JW. Quadriceps tendon autograft for anterior cruciate ligament reconstruction: A comprehensive review of current literature and systematic review of clinical results. *Arthroscopy* 2015;31:541-554.

22. Hurley ET, Calvo-Gurry M, Withers D, Farrington SK, Moran R, Moran CJ. Quadriceps tendon autograft in anterior cruciate ligament reconstruction: A systematic review. *Arthroscopy* 2018;34:1690-1698.

23. Belk JW, Kraeutler MJ, Marshall HA, Goodrich JA, McCarty EC. Quadriceps tendon autograft for primary anterior cruciate ligament reconstruction: A systematic review of comparative studies with minimum 2-year follow-up. *Arthroscopy* 2018;34:1699-1707.