Technical Note

Medial Quadriceps Tendon Femoral Ligament Reconstruction for Anatomic Reconstruction of the Medial Patellofemoral Complex

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Abstract: The medial patellofemoral complex (MPFC) refers to the primary static restraint to lateral patellar translation. Originally thought of as the medial patellofemoral ligament, anatomic studies over the past 10 years have identified the additional fibers that attach to the quadriceps tendon, which some have termed the medial quadriceps tendon femoral ligament. Anatomic studies have demonstrated that the MPFC midpoint is at the junction of the medial border of the quadriceps tendon and the articular surface of the patella, indicating that fixation can be on either structure. This technique describes a single-bundle reconstruction technique with anatomic fixation on the quadriceps tendon at the MPFC midpoint that involves fixation on the extensor mechanism first.

The medial patellofemoral complex (MPFC) refers to the primary static restraint to lateral patellar translation. Originally thought of as the medial patellofemoral ligament (MPFL), anatomic studies over the past 10 years have identified the additional fibers that attach to the quadriceps tendon, which some have termed the medial quadriceps tendon femoral ligament (MQTFL).[1,2] Despite the attachment to both structures, the common origin of the fibers on the femur indicates that the structure is a single ligament, which has been shown to vary in its attachment site on the extensor mechanism.[3] Therefore, the term *MPFC* has been proposed to allow for the variability in the attachment sites.[4]

Anatomic studies have demonstrated that the average MPFC midpoint is at the junction of the medial border of the quadriceps tendon and the articular surface of the patella (Fig 1). Despite the broad and variable attachment on the extensor mechanism, a study of in vivo length changes of the MPFC fibers identified that this midpoint was the most isometric point when performing femoral fixation at the center of the femoral MPFC footprint.[1] Given that the junction of the quadriceps tendon and patella serves as the anatomic landmark for fixation, anatomic reconstruction of the MPFC can be based on either the patella or quadriceps tendon.

Patellar-based fixation has been associated with risk of patella fracture, primarily in association with large or multiple tunnels, or violation of the anterior cortex.[5,6] Despite the evolution of the technique to use small suture anchors, cases of fracture have been reported when utilizing suture anchors.[7] Fulkerson and Edgar[1] have described the MQTFL reconstruction technique designed to minimize the risk of patella fracture, in which graft fixation is performed first on the femur. The current technique describes MQTFL reconstruction with anterior fixation first, which allows for anatomic reconstruction and femoral tunnel isometry when reconstructing the central fibers of the MPFC.

Surgical Technique

Preoperative Preparation

The surgical procedure is performed in the supine position. A semitendinosus allograft is thawed and confirmed to be 6 mm diameter throughout. Diagnostic arthroscopy is performed, and chondral defects and concurrent injuries are addressed as needed.

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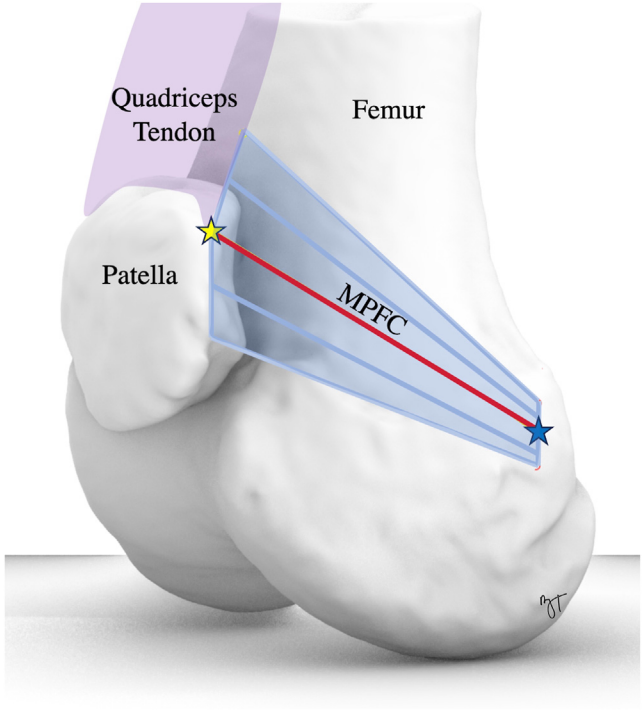

Fig 1. Illustration of a right knee demonstrates the medial patellofemoral complex fibers originating from the femur and attaching to the patella and quadriceps tendon. The yellow star indicates the midpoint of the anterior attachment, while the blue star indicates the midpoint of the femoral attachment. (MPFC, medial patellofemoral complex.)

Quadriceps Tendon Fixation

A 1-inch longitudinal incision is made centered over the junction of the medial border of the quadriceps tendon and superomedial border of the patella. The superomedial corner of the patella is identified, and a 1-cm longitudinal incision is made through layers 1 and 2 at this location with care not to violate layer 3 (Video 1, 0:13). Soft tissue is then cleared off the distal quadriceps tendon, and a partial-thickness 1-cm incision is made at the junction between the medial and central third of the distal quadriceps tendon attachment (Video 1, 0:18).

A right-angle clamp is passed from the slot on the distal quadriceps, to exit at the incision at the superomedial corner of the patella, with care not to penetrate the capsule (Video 1, 0:24).

The graft is retrieved using the clamp and folded over on itself (Video 1, 0:33). A looped suture is utilized to place a locking suture for approximately 1 inch of the overlapped graft, from medial to lateral, ending at the superomedial corner of the patella (Fig 2B and Video 1, 0:39). One limb of the suture is passed through the patellar periosteum from an anterior to posterior fashion using a free needle (Video 1, 0:54). The 2 free ends of sutured graft are tied to the patellar periosteum to complete the extensor mechanism fixation (Video 1, 1:03). The proximal aspect of the slot in the quadriceps tendon is closed using interrupted sutures to prevent propagation of the defect in the quadriceps tendon (Fig 2C, Fig 3, and Video 1, 1:08).

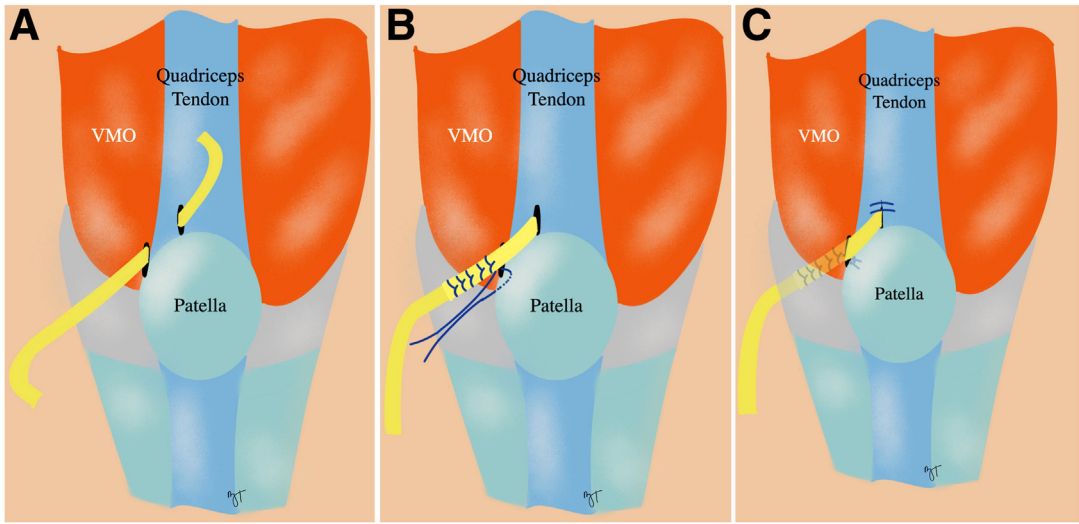

Fig 2. (A) In this illustration of a left knee, the graft is passed through a 1-cm incision at the midpoint of the medial patellofemoral complex (MPFC), exiting through a 1-cm incision at the junction of the medial and central thirds of the distal quadriceps tendon. (B) After the graft is passed through the midpoint of the MPFC and the quadriceps tendon, it is secured to itself using a looped suture, after which 1 limb of the suture is passed through the patellar periosteum at the junction of the medial border of the quadriceps tendon. (C) After passing 1 limb of the suture through the patellar periosteum at the MPFC midpoint, the 2 ends of the looped suture are tied to secure the graft to the superomedial corner of the patella. The proximal aspect of the incision in the quadriceps tendon is closed using interrupted sutures. (VMO, vastus medialis obliquus.)

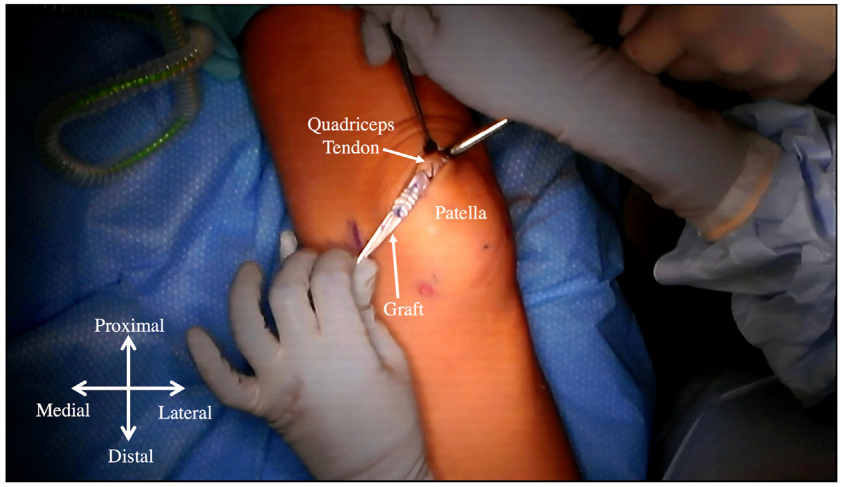

Fig 3. Intraoperative view of a left knee demonstrates the medial patellofemoral complex graft that has been looped through the quadriceps tendon and secured to itself.

Femoral Tunnel Placement

Attention is directed to the medial femur, and a 1-inch incision is made posterior to the medial epicondyle and distal to the adductor tubercle (Video 1, 1:22). A bony depression can be palpated at the anatomic footprint, generally 1 cm distal to the adductor tubercle. This area can be palpated posterior to the medial epicondyle and anterior to the gastrocnemius tubercle. A guide pin is placed at this location and directed anteriorly and proximally to avoid the joint line and posterior neurovascular structures (Video 1, 1:31). Once the pin is placed based on anatomic references, the position of the guide pin is confirmed using fluoroscopy. A perfect lateral radiograph is obtained to assess the position of the pin (Fig 4 and Video 1, 1:39). A position 4 mm posterior to the posterior cortical line and distal to the origin of the posterior condyle, proximal to the Blumensaat line, is targeted.

Once the pin is confirmed to be in an appropriate position based on anatomic and radiographic landmarks, the isometric function of the graft is assessed by looping the free end of the graft around the guide pin, indicating the position of the proposed femoral tunnel (Video 1, 1:43).

A marking pen can be used to mark the graft to ensure <5-mm length change of the graft from 0° to 70° of flexion (Video 1, 1:46). Once this is confirmed, the graft is passed between layer 2 and layer 3 and retrieved at the site of the femoral tunnel (Fig 5 and Video 1, 1:56). The arthroscope can be inserted into the knee joint at this point to confirm that the graft has not penetrated the capsule.

The knee is brought to approximately 60° of flexion to allow the patella to engage in the trochlea, and the slack is removed from the graft. The graft is marked at the aperture of the tunnel at the location of the guide pin to indicate the appropriate length of the graft for the reconstruction (Video 1, 2:01). When utilizing a 20-mm implant, a second mark is placed on the graft 20 mm distal to the aperture marking, which will correspond with the blind end of the femoral tunnel (Fig 6A). The

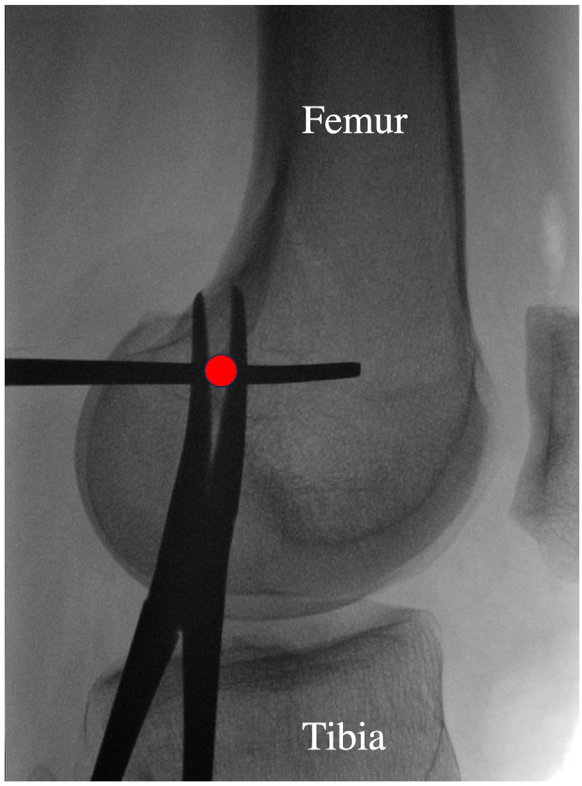

Fig 4. Intraoperative fluoroscopy is critical to determining appropriate femoral tunnel position. A lateral fluoroscopic image demonstrates pin position distal to the posterior condyles, proximal to the Blumensaat line, and slightly posterior to the point described by Schottle[8] to allow for the anterior margin of the subsequently reamed tunnel to approximate the radiographic medial patellofemoral complex midpoint.

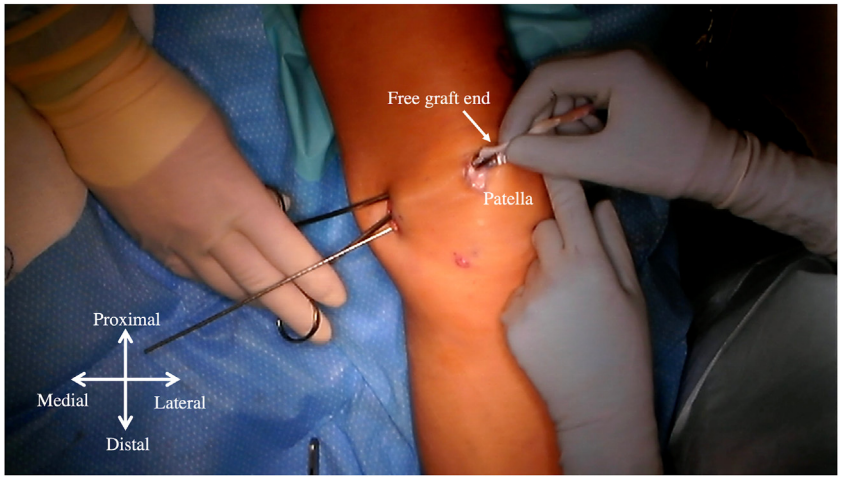

Fig 5. In this procedure on a left knee, after the medial patellofemoral complex graft is secured on the extensor mechanism, the graft is passed between layer 2 and layer 3 of the medial knee and retrieved through the femoral incision.

size and depth of the femoral tunnel should correspond to the chosen fixation device. In this case, the femoral tunnel is drilled to a size of 8 × 20 mm to correspond to the 6-mm anchor and graft.

Once the surrounding soft tissue from the tunnel is cleared, the graft is secured to the fixation device and placed within the tunnel, aligning the marked portion of the graft with the aperture of the tunnel to ensure appropriate length (Fig 6B and Video 1, 2:08). In this case, since an expanding anchor is utilized (Conmed Tenolok), once the anchor is seated, prior to deploying the anchor, the graft function can be assessed and adjusted as needed (Video 1, 2:26). The patella should have 2 quadrants of lateral translation in extension and less than 1 quarter quadrant with the knee at 30° of flexion, and deep flexion should correspond with

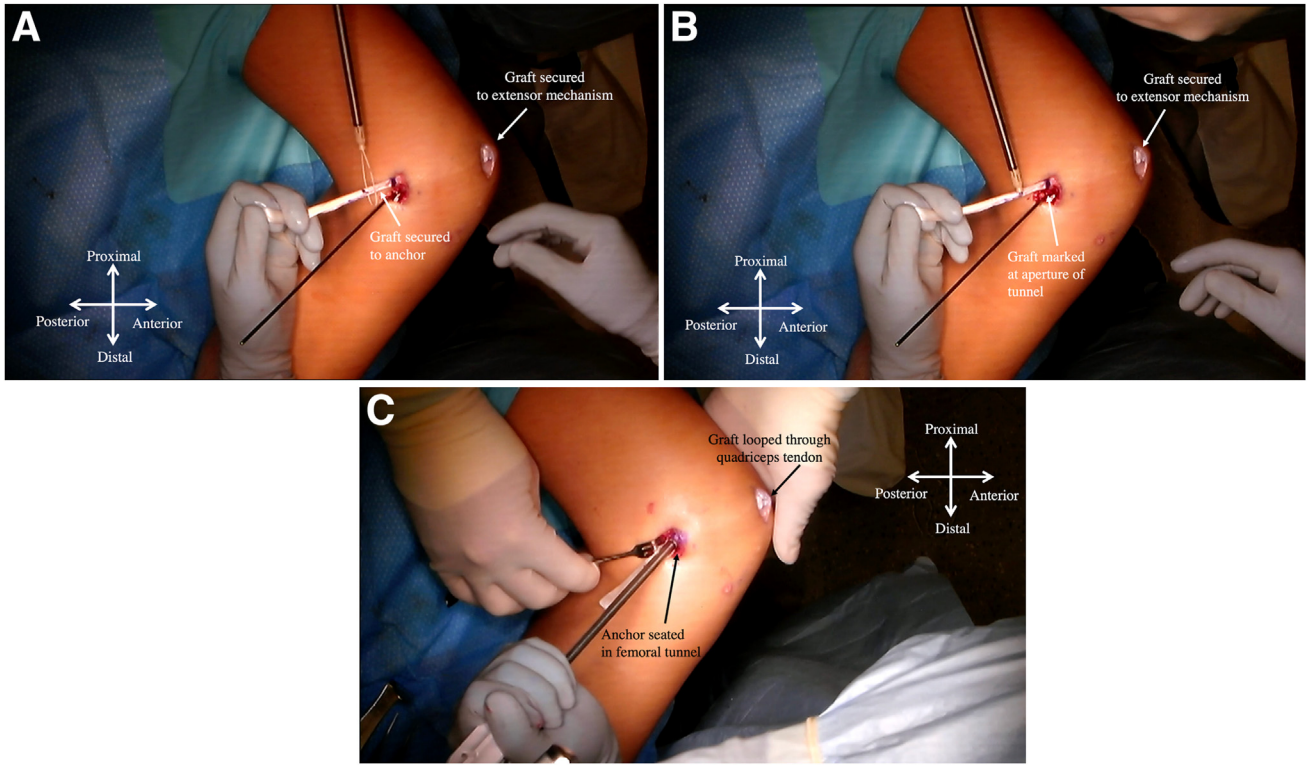

Fig 6. In this procedure on a left knee, for fixation within the femoral tunnel, the graft is (A, B) secured to the fixation device and (C) placed within the tunnel, aligning the marked portion of the graft with the aperture of the tunnel to ensure appropriate graft length.

Table 1. Advantages and Disadvantages

Advantages	Disadvantages
No implant required for fixation on extensor mechanism	Looping the graft through the extensor mechanism may require longer graft lengths than in some techniques.
Low cost due to fewer implant costs	Defect in quadriceps tendon may limit future quadriceps tendon procedures (e.g., ACL graft).
No risk of patella fracture	
Excellent option for revision MPFL cases	
Expanding anchor allows for confirmation of appropriate graft tension prior to final fixation.	

ACL, anterior cruciate ligament; MPFL, medial patellofemoral ligament.

slackening of the graft. Once these are confirmed, the anchor is deployed within the tunnel for definitive fixation of the graft (Fig 6C and Video 1, 2:54).

Discussion

MQTFL reconstruction was originally described by Fulkerson and Edgar[1] with fixation on the quadriceps tendon proximal to the superior pole of the patella. While biomechanical studies have demonstrated that fixation in position proximal to the superior patellar pole led to unfavorable biomechanical function,[9] more recent updates have incorporated the fixation to the anatomic MPFC midpoint, at the junction of the medial border of the quadriceps tendon and border of the patella, similarly to the currently described technique.[10]

A study on in vivo length changes of the MPFC demonstrated that this midpoint corresponded to the MPFC midpoint on the femur (1 cm distal to the adductor tubercle), with favorable length changes during knee range of motion. In contrast, proximal fixation on the quadriceps tendon by 15 mm led to graft length changes that correlated to patella alta, while distal fixation by 15 mm near the equator of the patella was influenced by tibial tuberosity to trochlear groove (TTTG) distance and tended to tighten in flexion. Furthermore, these length changes were accentuated when 2 or more morphologic risk factors (TTTG distance, patella alta, trochlear dysplasia) were present, emphasizing the importance of assessing and addressing concurrent pathology at the time of MQTFL reconstruction.

The currently described technique provides an anatomic, implant-less fixation on the extensor mechanism to reconstruct the MPFC using MQTFL reconstruction. In comparison to previous MQTFL techniques, the current technique describes options for fixation on the extensor mechanism performed prior to femoral fixation. The advantage of performing fixation on the extensor mechanism prior to femoral tunnel placement is that this can allow for assessment and adjustment of the femoral tunnel to minimize length changes and optimize function of the graft. This technique also minimizes risk of fracture by avoiding patellar drilling and provides a viable alternative to MPFL reconstruction, particularly in the setting of revisions or a small patella in which bony fixation may be concerning for risk of patella fracture. Additionally, the lack of implants needed for anterior fixation can be helpful when implants are not available or accessible, which can also aid in reducing costs. Disadvantages of this technique include limitations for quadriceps tendon-based procedures (e.g., anterior cruciate ligament graft harvest) subsequent to this procedure (Table 1).

This technique describes a single-bundle reconstruction of the MPFC to re-create the MQTFL in the treatment of patellar instability. The technique avoids the need for patellar drilling during fixation on the extensor

Table 2. Pearls and Pitfalls

Pitfalls	Pearls
During fixation on the extensor mechanism, improperly placed incisions can lead to insufficient soft tissue bridge or nonanatomic fixation.	Removing the overlying soft tissue to visualize the medial quadriceps tendon border can be helpful in identifying anatomic landmarks.
The graft can inadvertently be passed subcutaneously instead of between layers 2 and 3.	Visualizing layers 2 and 3 from the anterior incision can help identify the proper layers for graft passage.
The graft can inadvertently be passed into the joint instead of between layers 2 and 3.	After graft passage, arthroscopic visualization can confirm that the graft has not penetrated layer 3.
Inappropriate femoral tunnel positioning can negatively affect graft function.	Femoral tunnel position should be confirmed using anatomic landmarks, radiographic landmarks, and confirming isometry prior to reaming and fixation.
Overtension of the graft can lead to increased patellofemoral contact pressures.	Avoid overtensioning by "removing the slack" from the graft with the knee at 60° of flexion.

mechanism, minimizing the risk of patella fracture (Table 2). Securing the graft first on the quadriceps tendon allows for anatomic fixation, as well as for ease of assessing isometry during femoral tunnel placement. For optimal outcomes, the presence of concurrent morphologic risk factors should be appropriately identified and addressed when performing MQTFL reconstruction in the treatment of patellar instability.

Disclosures

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