Technical Note

Single-Incision, Single Patellar Tunnel For Double-Bundle Medial Patellofemoral Ligament Reconstruction: A Technical Note

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Abstract: The medial patellofemoral ligament (MPFL) is the main medial stabilizer of the patella, while reconstruction of the ligament is a common surgery performed by orthopedic surgeons. Although several surgical methods have been described regarding MPFL reconstruction, the common goals of these surgeries are to imitate the anatomic features of the native MPFL. In the single-incision and single patellar tunnel and double-bundle MPFL reconstruction technique, we will present the anatomical footprint of the MPFL located in the medial aspect of the patella, which is filled with the graft. In this technique, graft fixation is performed in the femoral tunnel using only one bioabsorbable screw without the need for fixation in the patella.

Introduction

Lateral patellar instability is the most common knee pathology encountered by orthopedic surgeons in girls aged 10-17 years and with an annual incidence of 5.8-7.7 per 100,000.[1] Redislocation risk has been reported to vary between 39 and 69% after the first dislocation, while untreated lateral patellar instability has been reported as a noninnocent pathology, causing 50% patellofemoral arthritis within 25 years.[1]

The medial patellofemoral ligament (MPFL) is the primary medial stabilizer of the patella that prevents lateral patellar translation by 50-60% during early flexion and has, therefore, been the subject of research in many anatomical studies.[2] MPFL is a fan-shaped structure that is 14-41 mm wide and located at the medial upper pole of the patella, not extending to the distal of the patella equator, and adheres to the patella at the articular border of the patella and to the quadriceps muscle at the medial border in the anterior.[2]

Although many surgical methods have been described for MPFL reconstruction, risks of these surgeries, such as iatrogenic patellar fracture, excessively tight or loose grafts due to nonanatomically opened tunnels, and rerupture have been reported.[3] Our technique consists of a single incision, which allows for opening a single patellar oblique tunnel toward the caudal end and passing a double-bundle graft through the tunnel and fixing it in the femoral tunnel using a single bioabsorbable screw, eliminating the need of extra fixation in the patella. We believe that this technique, in which double-bundle MPFL reconstruction with a single incision can be performed without the need for a fixation material in the patella, is a surgical method that can be easily performed by orthopedic surgeons.

Ethical Consent

Our study was performed by the Department of Orthopedics and Traumatology, Ankara University. The patient, who had MPFL reconstruction surgery, signed written informed consent for surgery and video recording of the surgery.

Surgical Technique

Graft Harvesting and Preparation

The point 2 cm to the medial and 2 cm to the distal of the tibial tubercle, which is the insertion point of pes anserinus, is marked with a surgical pen. A 3-cm long

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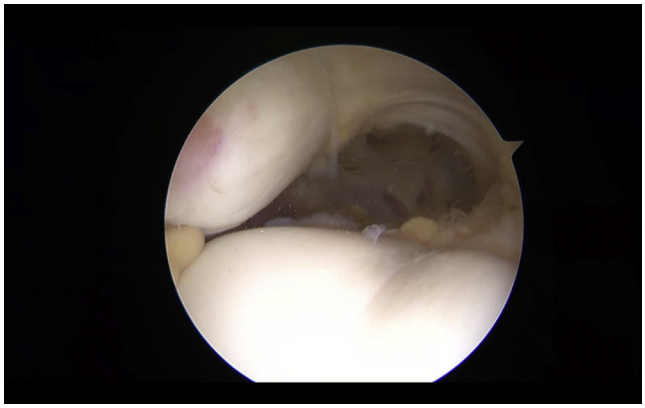

Fig 1. Right knee is seen from standard anteromedial portal. Patella is not in trochlear groove, and it is also situated laterally.

oblique skin incision starting from the middle of the above mark and extending to the tibial crest is made. After passing through the skin and subcutaneous tissues, the sartorius fascia is revealed. The sartorius fascia is cut longitudinally from where it adheres to the tibial crest and is everted (Video 1). Below the fascia, the gracilis and—right and distal to it—the semitendinosus tendons are exposed. The distal end of the semitendinosus tendon is sutured up to 3 cm to the proximal end in running configuration using no. 2 high strength suture (Ultrabaid, Smith and Nephew, Andover, MA). After the semitendinosus tendon is disconnected from the gracilis and gastrocnemius muscles, the tendon is removed using 5-mm tendon stripper (Acufex, Smith & Nephew, Andover, MA). The semitendinosus tendon is then separated from the muscle remnants, and the proximal end is sutured in the running configuration with a maximum length of 20-22 cm and 3 cm of running configuration. The diameters of the semitendinosus tendon (about 4.5 mm), and the folded form of the tendon (about 6 mm) are tested and then stored by wrapping it with a wet tampon impregnated with vancomycin.

Diagnostic Arthroscopy

The standard anterolateral portal is opened and then the anteromedial portal is opened in an outside-inside fashion using 4-mm-diameter, 30° arthroscope (Smith & Nephew, Andover, MA). With the help of a probe, the ACL, PCL, and lateral and medial menisci are checked, and necessary interventions are performed. The patellofemoral joint is evaluated by placing the arthroscope in the lateral portal, and it is confirmed that the patella is not in the trochlear groove and is displaced laterally (Fig 1).

Patellar and Femoral Tunnels

The patella and the medial epicondyle are marked with a surgical pen. Later, with the knee at 30° flexion and the hip at 30° external rotation, a 4-cm longitudinal incision is made starting at the one-third junction, close to the medial epicondyle, and middle third junction of the distance between the upper half of the patella and the medial epicondyle, and the subcutaneous tissues are passed. The knee is extended, the skin and subcutaneous fat tissue are detached from the anterior part of the patella to the lateral border of the patella with blunt dissection. The footprints of the MPFL in the patella extend from the medial of the patella, from the proximal and middle third junction, to the equator of the patella in a fan shape. For this reason, from the anterior of the patella, the subperiosteal flap is elevated

Table 1. Tips/Pearls and Pitfalls

Tips / Pearls
- Care should be taken to perform the incision between the medial border of the patella and the medial condyle, starting from the junction of the one-third close to the medial epicondyle and the middle third.
- The skin on the anterior of the patella should be detached from the subcutaneous tissue to the lateral border by blunt dissection.
- The thin end of the auto/allograft used should be determined, and this thin end should be inserted into the patellar tunnel to prevent snagging during the passage of the graft in the patellar tunnel.
- In cases where it is difficult to reach the Schöttle point located in the posterior with a single incision, knee flexion should be increased to shift the skin incision to the posterior.
- While opening the patellar tunnel, care should be taken to be in the middle of the patella in the sagittal plane or close to the joint surface to reduce the risk of iatrogenic fracture. It should not be forgotten that iatrogenic patella fractures usually occur in the anterior cortex.
- During graft fixation, imaging with arthroscopy for traction adjustment can be performed to avoid excessive traction by observing that the patella is placed in the trochlear groove.

Pitfalls
- It may be difficult to reach the posterior through a single incision in obese patients, due to the thick subcutaneous adipose tissue.
- After graft placement in the femoral tunnel, the knee should not be placed in extension from flexion during bioscrew placement. In this case, the skin incision will slide anteriorly, and there will be a mismatch at the tunnel and screw axis.
- Care should be taken to ensure that the graft is between the 1st and 2nd medial retinacular layers like the native MPFL, and to ensure that the graft is not under the skin or is intracapsular.
- While determining the Schöttle point, a flawless lateral knee radiograph (in which the posterior femoral condyles overlap exactly) should be obtained. It should not be forgotten that even a few degrees of error affect the femoral tunnel placement.
- The arthroscope, which is advanced through the anterolateral portal, while the knee is extended, should be able to easily pass through the patellofemoral joint into the suprapatellar pouch. Otherwise, it should be considered that the graft is placed too tightly.

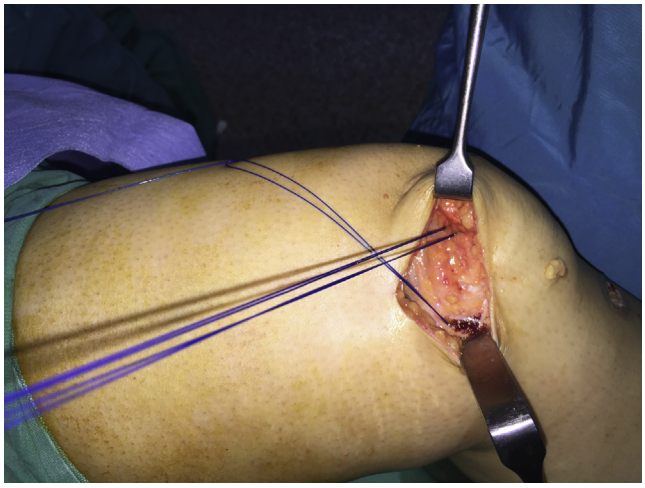

Fig 2. A single left knee incision is seen. Nylon loop sutures, which will be used for graft passage, were passed trough the apropriate patellar and femoral tunnels.

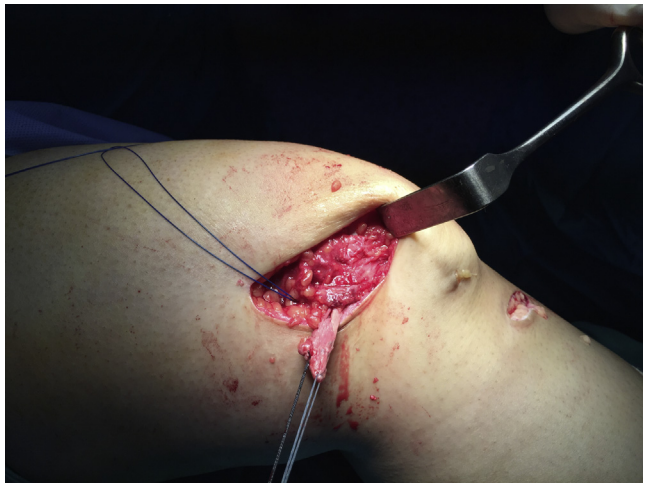

Fig 4. The graft, which was passed from patellar tunnel before, was passed between layer 1 and 2 of medial retinaculum of the left knee.

from the proximal third end of the patella to the equator, and the border of the medial bone is exposed. A 2.5-mm guidewire (Smith & Nephew, Andover, MA) is sent 15° caudally from the proximal-middle third junction of the patella and in the middle of the patella in the sagittal plane, targeting the point where the equator of the patella joins the lateral cortex, and is taken out of the skin in the lateral. The entrance of the guidewire from the proximal-middle third junction in the medial and its exit from the midline of the patella in the lateral is confirmed with anteroposterior imaging with fluoroscopy. Subsequently, lateral imaging with fluoroscopy is performed, and it is confirmed that the guidewire does not penetrate the anterior and posterior cortices of the patella. An oblique patellar tunnel is opened by sending a 4.5- to 5-mm cannulated drill (Smith & Nephew, Andover, MA) from the medial to the lateral over the guidewire. A no. 1 nylon suture is coupled with the guidewire, and the guidewire is pulled from the lateral so that the loop end of the suture exits the skin medially, and the free ends exit laterally. The skin is then retracted by placing an army-navy retractor on the anterior of the patella. The surgeon advances his/her index finger from the anterior of the patella, grabs the sutures at the lateral border of the patella and carries them to the medial skin incision. The free and loop ends of the suture are clamped using a forceps and secured until the graft passage. Then the knee is flexed 60° and when the knee is flexed, the shift of the skin incision toward the posterior is confirmed. Through the incision line, the adductor tubercle and the medial epicondyle are palpated by the surgeon in the medial of the knee, and an army-navy retractor is placed on the

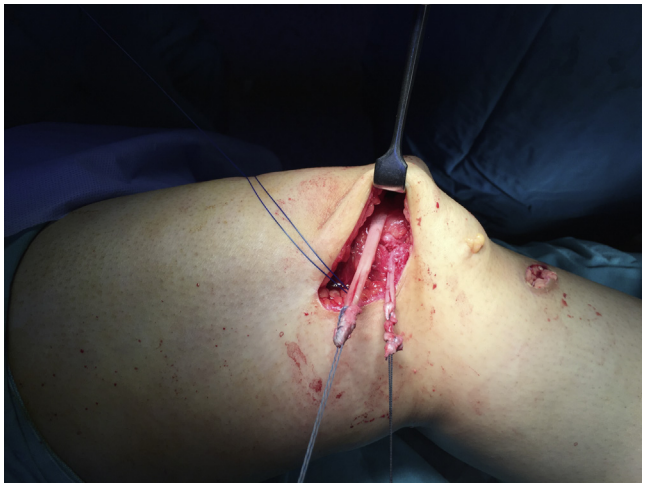

Fig 3. A graft was passed through the patellar tunnel and was turned from lateral side of the patella to medial incision in the left knee.

Fig 5. Left knee was flexed to 30° degrees, and graft was passed trough the femoral tunnel. While appropriate traction was applying the free suture ends of graft laterally, the bioabsorbable screw was placed via nitinol giude wire.

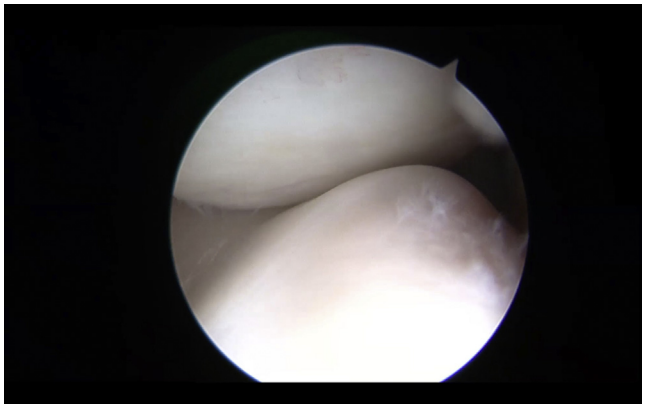

Fig 6. Right knee is seen from standard anteromedial portal. Patella is appropriately placed in trochlear groove.

posterior lip of the skin incision for easy access. A perfect lateral radiograph of the knee is obtained with the help of fluoroscopy. The Schöttle point is located at the anterior of the posterior femoral cortex, distal to the proximal origin of the medial femoral condyle, and proximal to Blumensaat's line.[4] The 2.5-mm guidewire is sent from the Schöttle point, directed to 20° proximal and anterior, and is taken out of the skin in the lateral. Then, a 6-mm cannulated drill is sent over the guidewire without penetrating the lateral cortex (Table 1). The guidewire is coupled with no. 1 nylon suture again, and the guidewire is taken out laterally, so that the loop end of the suture exits the skin medially, and the free ends exit laterally (Fig 2). The nylon suture on the femur is secured by clamping it with a forceps. The knee is extended again, the subperiosteal flap is elevated at the anteromedial border of the patella under the subperiosteal flap, and the Kelly clamp is moved bluntly between the 1st and 2nd layers until the femoral tunnel; thus, the area that the graft can pass is opened.

Graft Passage and Fixation

The sutured ends of the prepared graft are examined, and the thinner end is determined. Sutures at the thin end of the graft are coupled with the loop suture at the medial of the patella, the loop suture is pulled from the anterior of the patella, and the tendon sutures are moved from the anterior of the patella to its medial. By applying traction to the sutures, it is ensured that the graft passes through the patellar tunnel in the form of a loop, turning from the lateral border of the patella to the anterior and then back to the medial (Fig 3). Attention is paid to keep both ends of the graft passing through the tunnel evenly. Using a clamp, we passed both ends of the graft through the area previously prepared between the 1st and 2nd medial retinacular layers with the Kelly clamp. The knee is flexed 60°, and the femoral tunnel is exposed again by placing an army-navy retractor posteriorly. With the use of a clamp, the free ends of the graft are pulled posteriorly between the 1st and 2nd layers (Fig 4). Nitinol guidewire of the bioabsorbable screw is placed in the femoral tunnel. Both ends of the graft are made even again, and the free sutures at the ends of the graft are coupled with the loop suture in the femoral tunnel. The loop suture is pulled laterally out of the skin, and the sutures at the ends of the graft are taken out of the skin laterally. With the knee flexed at 30°, the arthroscope is placed in the anterolateral portal, and the patellofemoral joint is visualized. The positioning of the patella in the trochlear groove is confirmed by applying minimal traction to the free sutures of the graft removed from the skin laterally. A 7 × 25 mm bioabsorbable screw (Biosure, Smith and Nephew, Andover, MA) is placed in the femoral tunnel over the previously placed nitinol guidewire (Fig 5). The traction applied to the free sutures is terminated, and it is confirmed with the arthroscope that the patella is still positioned in the trochlear groove (Fig 6). The graft should now cover an area from the proximal-middle third junction to the equator of the patella at the medial border of the patella, as in the anatomical footprint of the MPFL (Fig 7). After irrigation, the subcutaneous tissues are sutured with absorbable sutures, and subcuticular suturing is performed using monocryl sutures. Finally, a sterile compressive bandage is applied.

Postoperative Rehabilitation

Actively and passively assisted full range of knee motion was started the day after MPFL reconstruction. Weight-bearing was gradually increased to full extent at 3 weeks postoperatively. Jogging was permitted 3 months after reconstruction. Return to sports was allowed at 6 months postoperatively, following an evaluation of muscle strength.[5]

Discussion

The native MPFL is the medial stabilizer of the patella, which consists of two functional bundles and takes its tensest form while the knee is flexed 30°-40°.[6]

Fig 7. Left knee is seen from accessory superolateral portal. Extracapsullary reconstructed MPFL graft's fold is seen. F, femur; MPFL, medial patellofemoral ligament; P, patella.

Therefore, double-bundle MPFL reconstruction surgeries are performed to mimic the native MPFL. When double-bundle and single-bundle MPFL reconstructions were compared, more force was needed to translate the patella 10 mm laterally while the knee was positioned at 15° of flexion in the double-bundle group.[7] Zhang et al. reported that there was no significant difference in terms of redislocation in the postoperative follow-up of patients who underwent double-bundle and single-bundle MPFL reconstruction, and also stated that the clinical outcomes of the patients who underwent double bundle MPFL reconstruction were better.[8] On the other hand, there are studies reporting that the risk of iatrogenic patella fracture increases by opening two tunnels in the patella during double-bundle MPFL reconstruction.[9] In a meta-analysis comparing the anchor and bone tunnels in the fixation of the graft in the patella, it was reported that there was no difference between the two groups regarding the risk of postoperative redislocation, but the clinical results of the patients fixed with anchors were better.[10] In another study, it was reported that patellar fixation performed with anchor fails easier than the patellar bone tunnel.[11] Zanon et al. reported a surgical technique in double-bundle MPFL reconstruction using a single patellar tunnel directed toward the cranial direction.[3] In the technique reported by the authors, the lateral end of the patellar tunnel is opened to the superior pole, where the weaker bone is located. With the theory that this method may cause an iatrogenic patella fracture and patellofemoral joint penetration, the patellar tunnel in our surgical technique was directed to the equator of the patella in the lateral, where the stronger bone was located. In our surgical technique, double-bundle MPFL reconstruction is performed with a graft passed through a single patellar tunnel positioned obliquely toward the caudal, and we believe that the risk of iatrogenic patellar fracture is low, since extra fixation is not required in the patella.

Medial patellofemoral ligament reconstruction is known as a successful surgery that provides good-to-excellent patient results postoperatively and after which 84% of the patients can return to sports.[12] In addition, the risk of postoperative failure has been reported to be less than 10%, and these failures are known to occur because of preoperative patella alta, J sign, or errors made with the intraoperative positioning of the graft or with the adjustment of the graft tension.[13] As a result of the study comparing the soft tissue fixation methods and bone fixation methods at the femoral attachment site of the graft in MPFL reconstruction, it was reported that there was no difference between the two groups in terms of redislocation and postoperative clinical outcomes.[14] In addition, Tscholl et al. reported that during MPFL reconstruction, the risk of redislocation increased in the graft location with an incorrect femoral attachment site, but there was no change in clinical results.[13]

In their study on adjusting the graft tension, which is another cause of postoperative poor clinical outcomes, Stephen et al. reported that when the traction force of 10 Newtons (N) applied to the graph was increased to 30 N, the contact pressure in the patellofemoral joint increased, and excessive traction on the graft should be avoided.[15]

Although there is no consensus on the angle of the knee at which the graft fixation should be performed, it is known that when the knee is at 30°-40° flexion, that is the angle range when the native MPFL is the most tense.[16] In the surgical method we present, femoral tunnel placement is determined with a perfect lateral knee fluoroscopy image, while an arthroscope placed from the lateral portal during graft fixation allows the visualization of the reduced patella, and the procedure is performed without excessive traction.

We believe that our double-bundle MPFL reconstruction surgical technique, which is performed through a single incision with a single oblique patellar tunnel that fills the native MPFL footprint in the patella, does not require fixation material in the patella, has a lower patellar fracture risk, and is an easily applicable and interesting technique for orthopedic surgeons.

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