Double-Bundle Medial Patellofemoral Ligament Reconstruction With a Single Patellar Tunnel

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Abstract: Medial patellofemoral ligament (MPFL) reconstruction is an established method to prevent patellofemoral instability. Nevertheless, the anatomy and the biomechanical behavior of native MPFL are still under investigation, but in recent years they have become more defined. We propose a technique for MPFL reconstruction based on the results of recent anatomic studies regarding the patellar insertion of the MPFL. A double-bundle MPFL is reconstructed by use of the semitendinosus tendon passed through a single patellar tunnel, which crosses the patella from the midpoint of its medial border until its superolateral corner is reached. This method permits a strong patellar fixation, potentially reducing the risk of patellar fracture compared with double—patellar tunnel techniques. Moreover, it requires no fixation devices at the patella and only a single interference screw on the femoral side.

The medial patellofemoral ligament (MPFL) is the primary passive restraint to lateral patellar translation, especially during the first 30° of flexion, the angle at which lateral patellar dislocation most often occurs.[1] Its lesion is labeled as essential for acute and chronic cases of patellar dislocation, and MPFL reconstruction has become an accepted surgical technique to restore patellofemoral stability.[2]

Several techniques have been proposed, but there is no clear consensus on a single surgical technique, graft option, or fixation method.

This technical note presents a technique for anatomic double-bundle MPFL reconstruction using the semitendinosus tendon and a single patellar tunnel and requiring only an interference screw for fixation on the femoral side.

Technical Note

Graft Harvesting

The semitendinosus tendon is harvested through a 3-cm oblique incision over its tibial insertion, finishing 0.5 to 1 cm distal to the tibial tuberosity. After exposure of the pes anserinus, the sartorius fascia is incised and the semitendinosus is harvested with a tendon stripper. The tendon is then cleaned of muscle tissue; the usable part of the tendon should be at least 18 to 20 cm long. The 2 ends of the graft are armed with absorbable No. 2 Vicryl sutures (Ethicon, Somerville, NJ).

Preparing Patellar Insertion Site

A 3-cm skin incision is performed over the superomedial border of the patella. After the superficial fascia is opened, the second layer of the medial patellofemoral complex is exposed and the insertion of the native MPFL is found.

A single tunnel is prepared: a 1.7-mm guidewire (Arthrex, Naples, FL) is passed, starting from the midpoint of the medial border until the superolateral corner of the patella is reached, with care taken to avoid breaching either the chondral surface or the anterior cortex. A single pass with a cannulated 5-mm drill (Synthes AG, Oberdorf, Switzerland) is performed.

Because the MPFL is situated in the second layer of the medial patellofemoral complex, the vastus medialis obliquus (VMO) is gently detached with scissors from the joint capsule down to the femoral insertion side. Care has to be taken not to open the capsule. This leads to placement of the neo-MPFL between the second and third fascial layers in its native position, under the VMO.

Preparing Femoral Insertion Site

The adductor tubercle and the medial epicondyle are palpated with the knee in 30° of flexion, the position at

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Fig 1. The method of Schöttle et al.[3] used to obtain the anatomic femoral MPFL attachment, as shown on a radiograph in a left knee. A straight lateral view of the knee is obtained intraoperatively with an image intensifier. The radiographic landmark of the femoral attachment is determined by 3 lines: an elongation of the posterior femoral cortex (line x) and 2 lines perpendicular to line x, 1 passing the origin of the medial condyle (line y) and 1 passing the most posterior aspect of the Blumensaat line (line z). The landmark is anterior to line x and between lines y and z (asterisk).

which the graft finally will be fixed. A curved clamp is brought through the patellar incision into the space created between the VMO and the joint capsule, with its tip directed toward the skin over the adductor tubercle. A 3-cm longitudinal skin incision is performed over the tubercle.

The medial epicondyle and the adductor tubercle are recognized. One should take care to perform an accurate dissection to avoid risk of injury to the medial infrapatellar branch of the saphenous nerve.

To obtain the correct femoral MPFL insertion, we use the radiographic method described by Schöttle et al.[3] This method requires a straight lateral view, obtained intraoperatively with an image intensifier. On this view, the landmark of the femoral MPFL insertion is located slightly anterior to an elongation of the posterior femoral cortex between the proximal origin of the medial condyle and the most posterior point of the Blumensaat line (Fig 1). A 1.7-mm guidewire with an eyelet (Arthrex) is drilled on this landmark, perpendicular to the medial aspect of the knee. The guidewire

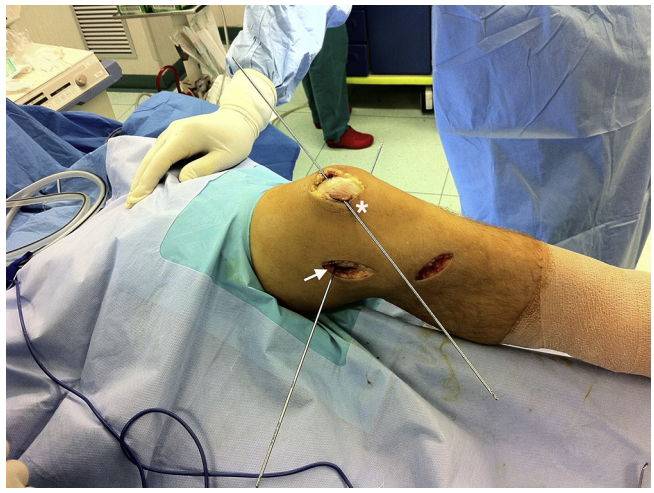

Fig 2. Guidewire position. The patient is supine, with the head on the left and the feet on the right; a left knee is shown. The patellar guidewire (Arthrex) has been drilled from the midpoint of the medial patellar aspect to the superolateral corner of the patella (asterisk). The tip of the femoral guidewire has been located in the anatomic insertion of the MPFL on the medial aspect of the knee (arrow). After position control under fluoroscopic guidance using the method described by Schöttle et al.,[3] the guidewire has been drilled perpendicular to the femoral cortex outside the lateral aspect of the knee.

is pushed outside the lateral side of the knee (Fig 2). Then, a 5-cm-long half-tunnel with a diameter 1 mm larger than that of the 2 free graft ends together is created with a cannulated drill (Synthes AG).

Graft Placement and Fixation

A first suture loop is inserted in the patellar tunnel and then between the second and third layer of the medial aspect of the knee, with the loop toward the femur. This suture loop is used to pull the graft from the femoral side to the patella and then into the patellar tunnel. The graft, which emerges from the superolateral corner of the patella, is then turned back over the quadriceps tendon until the medial aspect of the patella is reached.

A second suture loop is inserted again between the second and third layer, but with the loop toward the patellar side. The free end of the graft that emerges from the superolateral corner of the patella is then pulled between the second and third layer until the femoral side is reached (Fig 3). Here, the 2 free graft ends are fixed to the eyelet of the femoral guidewire and pulled laterally in the half-tunnel while equal tension is maintained on both bundles.

Several flexion-extension cycles are performed to pre-tension the graft and to reconfirm its isometry. The graft is then fixed with the knee in 30° of flexion with a 7-mm-diameter bioabsorbable interference screw 30 mm long (Arthrex) (Fig 4); during this procedure, the

Fig 3. The same left knee and orientation shown in Figs 1 and 2. The graft is placed inside the patellar tunnel and then pulled between the second and third layer of the medial side of the knee. The armed graft ends are pulled outside the femoral incision and equally tensioned.

lateral patellar edge has to be positioned in line with the lateral femoral trochlear border to avoid overtightening (Video 1). Tips, pearls, indications, contraindications, and pitfalls are shown in Table 1.

Postoperative Treatment

Rehabilitation starts with continuous passive motion from 0° to 30° in a hinged brace and isometric strengthening exercises for the first 2 weeks; then, the brace is unblocked to reach 0° to 90° at 4 weeks after surgery. Partial weight bearing is recommended for the first 3 weeks. After 4 weeks, strengthening exercises in a closed kinetic chain are commenced. After 6 weeks, cycling is allowed, and after 8 weeks, gentle jogging is allowed. Full activity is permitted 4 months after surgery.

Discussion

MPFL reconstruction is established as an effective option for the treatment of recurrent patellar instability.[2] Over the past decade, many techniques have been described, but considerable controversies exist on the optimal method.

Fig 4. Graft fixation in the same left knee and orientation shown in Figs 1 and 2. The incision performed over the medial epicondyle is shown. After the 2 graft ends in the femoral half-tunnel have been pulled with the guidewire, the graft is fixed with a 7-mm-diameter, 30-mm-long bioabsorbable screw (Arthrex). During this maneuver, the knee is maintained in 30° of knee flexion.

The native MPFL is a thin fascial band with a femoral insertion area between the adductor tubercle and the medial epicondyle at the femur[1]; the MPFL fans out from the femur to the patella, where it extends from the proximal-medial corner of the patella over approximately half of the length of the medial patellar aspect.[1]

Recently, Mochizuki et al.[4] performed an anatomic study to investigate the relation between the MPFL and the quadriceps complex; they showed that the proximal fibers of the MPFL are mainly attached to the vastus intermedius tendon. Even if the MPFL is a single intact structure, it has thicker concentrated bands running along its proximal and inferior edges: an inferior straight bundle and a superior oblique bundle.[1] Because the goal of a surgical intervention must be an anatomic reconstruction, we believe that a double-bundle reconstruction at the patellar side is reasonable to restore native ligamentous morphologic and biomechanical properties.[5] We also believe that the proximal bundle of the reconstructed MPFL should be proximal to the patella, according to the study performed by Mochizuki et al. but in contrast with previous anatomic studies.[1]

Several grafts have been used for MPFL reconstruction: synthetic grafts, semitendinosus graft, gracilis graft, combined semitendinosus and gracilis graft, and graft comprising the central portion of the quadriceps tendon and the lateral third of the patellar tendon. We use the semitendinosus tendon for reconstruction because we wanted to ensure a graft of appropriate length. Its disadvantage is the need to make a 5.0-mm-wide patellar tunnel. Gracilis graft could permit a smaller bony tunnel, but semitendinosus graft is stiffer and has a higher ultimate load than gracilis graft,[6] which may make it more suitable in patients with associated abnormalities.

We preferred not to perform tendon flips; if a patellar or quadriceps tendon is transferred, not only is the extensor apparatus of the knee weakened but the patellar insertion cannot be reconstructed at its anatomic position and the MPFL reconstruction would be a single-bundle technique.[7] This also includes a single point of fixation on the patellar side, not limiting the rotational moment of the patella during its movement.

We use a single patellar tunnel positioned at 45° on the coronal plane, from the middle of the medial aspect to the superolateral corner of the patella. This permits the restoration of a double-bundle MPFL without placing 2 patellar tunnels; because bone tunnels might act as stress risers, a single patellar tunnel potentially reduces the risk of patellar fracture. With the techniques that use the passage of a tendon graft through 2 tunnels at the patella, a non-negligible risk of patellar fracture has been documented, and transverse drill holes would result in serious fracture with articular

Table 1. Tips, Pearls, Indication, Contraindications, and Pitfalls

Tips and pearls
- Expose the whole medial border of the patella to recognize its midpoint.
- During drilling of the patellar tunnel, expose both the medial border and the superior border of the patella to have continuous control of the trajectory.
- Perform a single pass with a cannulated 5-mm drill. Overdrilling elevates the risk of cortical breaching. The aim of this technique is to avoid patellar fracture.
- Create space for the new MPFL with a curved clamp brought through the patellar incision between the VMO and the joint capsule; the tip of the clamp must be directed toward the skin over the adductor tubercle.
- Use the radiographic method described by Schöttle et al.[3] to recognize the femoral insertion of the MPFL, but do not forget the anatomy. Palpate the adductor tubercle and the medial epicondyle before making the femoral tunnel. The radiographic landmark should be halfway between them.
- Maintain the knee in 30° of flexion when performing the femoral incision. This will be helpful to have an invariable view of the anatomy of the medial side of the knee, even during fixation of the graft.
- Place suture loops in the femoral tunnel and in the space created in the medial soft tissues to pull the graft easily in the desired location.
- Lateral release must not be used systematically but must be used selectively. Remember that over-release is an error.

Indication
- History of lateral patellar dislocation with abnormal patellar tilt and trochlea dysplasia
- Associated abnormal patellar height or tibial tubercle—trochlear groove distance must be corrected first.

Contraindications
- Patellar pain or subluxation without report of patellar dislocation
- Do not perform MPFL reconstruction alone if there is also an abnormal tibial tubercle—trochlear groove distance and/or abnormal patellar height. These abnormalities must be corrected first by use of tibial tubercle transfer.
- In severe trochlear dysplasia, MPFL reconstruction alone might fail; consider trochleoplasty as an associated surgical procedure.

Pitfalls
- Inadequate exposure of medial and superior patellar border
- Failure to correct underlying malalignment or abnormal patellar height
- Excessive lateral release: Lateral stability is also important.
- Overtensioning graft: During graft fixation, the lateral patellar edge has to be positioned in line with the lateral femoral trochlear border to avoid overtightening.

surface involvement and cortical disruption.[8] Nevertheless, even our technique requires careful placement of the drill hole in the patella to avoid cortical weakening and subsequent patellar fracture.

Making a patellar tunnel permits us not to use fixation devices on the patella and results in a quick replacement of the anatomic patellar attachment. In our opinion, having a bone tunnel provides a higher load to failure than a soft-tissue fixation, in which the graft is sutured to a tendon, the subcutaneous soft tissue, or the periosteum.

The use of only 1 interference screw is an advantage because it reduces the amount of hardware capable of promoting foreign-body reactions. It is also advantageous from the economic point of view.

In conclusion, the described technique is a method to achieve an anatomic double-bundle MPFL reconstruction with a single patellar tunnel and a simplified femoral fixation. The use of only 1 implant is advantageous from the biological and economic points of view.

References

1. Baldwin J. The anatomy of the medial patellofemoral ligament. *Am J Sports Med* 2009;37:2355-2361.
2. Feller JA, Amis AA, Andrish JT, Arendt EA, Erasmus PJ, Powers CM. Surgical biomechanics of the patellofemoral joint. *Arthroscopy* 2007;23:542-553.
3. Schöttle PB, Schmeling A, Rosenstiel N, Weiler A. Radiographic landmarks for femoral tunnel placement in medial patellofemoral ligament reconstruction. *Am J Sports Med* 2007;35:801-804.
4. 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.
5. Kang HJ, Wang F, Chen BC, Su YL, Zhang ZC, Yan CB. Functional bundles of the medial patellofemoral ligament. *Knee Surg Sports Traumatol Arthrosc* 2010;18:1511-1516.
6. Christiansen SE, Jacobsen BW, Lund B, Lind M. Reconstruction of the medial patellofemoral ligament with gracilis tendon autograft in transverse patellar drill holes. *Arthroscopy* 2008;24:82-87.
7. Steensen RN, Dopirak RM, Maurus PB. A simple technique for reconstruction of the medial patellofemoral ligament using a quadriceps tendon graft. *Arthroscopy* 2005;21:365-370.
8. Bollier M, Fulkerson J, Cosgarea A, Tanaka M. Technical failure of MPFL reconstruction. *Arthroscopy* 2011;27:1153-1159.