Technical Note

Anatomical Double-Bundle Medial Patellofemoral Ligament Reconstruction With Autologous Semitendinosus, a Single Patellar Tunnel Technique

Pratchaya Manop, M.D., and Adinun Apivatgaroon, M.D.

Abstract: Patellofemoral instability is one of the knee problems that can be found in up to 3% of knee injuries, especially in younger aged females. Recent biomechanical studies showed that the main soft tissue stabilizer for patellofemoral stability is the medial patellofemoral ligament (MPFL). More than 200 articles on MPFL reconstruction have been published. Some surgical techniques create multiple holes in the patellar area that may increase the risk of patellar fractures. This technique that we present here attempts to reduce the chance of patella-related complications, while maintaining stability of the reconstructed construct, reducing the use of a lengthy tendon graft within the patella and covering the footprint at the border of the patella closed to the native anatomy of the MPFL.

Introduction

Patellofemoral instability is one of the knee complications that can be found in up to 3% of knee injuries, especially with younger patients and female patients.1-3 After the initial dislocation, in as many as 96% of cases, patients will have a medial patellofemoral ligament (MPFL) injury. The etiology of the instability is multifactorial. Soft tissue and bone are the main stabilizers of physiological patellar tracking. Recent biomechanical studies showed that the main soft tissue stabilizer for patellofemoral stability is the MPFL.4-6

Recent studies have shown indications for MPFL reconstruction, and they are noted in Table 1.8 However, there is some concern regarding underlying conditions that make simple reconstruction not sufficient, and additional procedures are required to create a more successful outcome.8,9

Restoration of the MPFL to prevent lateral patellar dislocation has become more popular.10 There are many techniques of MPFL reconstruction.11,12 However, there are no gold standards for techniques, choices for graft reconstruction and fixation options.13

We propose a feasible option for MPFL reconstruction that is reproducible, may reduce complications, and shortens operative time. This technical note shows an anatomic double-bundle MPFL reconstruction with a hamstring autograft, a single tunnel through the patella without fixation that requires just one interference screw at femoral insertion.

Technical Note

A demonstration of the anatomical double-bundle medial patellofemoral ligament reconstruction with autologous semitendinosus, a single patellar tunnel technique is available in Video 1. Advantages, disadvantages, and technical pearls and pitfalls are summarized in Tables 2 and 3.

Table 1. Indications for MPFL Reconstruction

- Failed conservative treatment
- Recurrent patellar instability
- Patellar subluxation/dislocations
  - With ongoing instability, pain, or symptoms
  - Associated osteochondral fracture
- Loose osteochondral fracture
- Active sports participation

Department of Orthopaedics, Faculty of Medicine, Thammasat University, Thailand

Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received July 29, 2021; accepted August 17, 2021.

Address correspondence to Adinun Apivatgaroon, M.D., Department of Orthopaedics, Faculty of Medicine, Thammasat University, Thailand 12120.

E-mail: adino_hall@yahoo.com

© 2021 by the Arthroscopy Association of North America. Published by Elsevier. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

2212-6287/21/$ - see front matter

https://doi.org/10.1016/j.eats.2021.08.028
**Patient Positioning**

A supine position on a radiolucent table is preferred for examination of the knee under anesthesia to evaluate patellar tracking. We also do an arthroscopic examination to evaluate and correct the intraarticular pathology.

This position is considered as the preferred position for reconstructing the MPFL, as fluoroscopy can easily access the proper landmark for femoral insertion.

**Graft Harvesting**

An oblique incision is made on the medial aspect of the tibial tuberosity, approximately 3 fingerbreadths from the joint line. The sartorial fascia is incised, and then, the semitendinosus tendon is identified and stripped with use of a tendon stripper (Fig 1). The muscle tissue is cleared from the tendon. The two ends of the graft are whipstitched using nonabsorbable suture, No.2 Ultrabraid suture (Smith & Nephew, Andover, MA) (Fig 2).

The graft for the double-bundle technique needs to be a minimum of 150-200 mm of a single strand at total length and ~5-6 mm in diameter at the femoral fixation (conjoint of the double strand).

**Arthroscopic Examination**

The diagnostic arthroscopy is performed before MPFL reconstruction to evaluate patellar tracking and the intraarticular pathology. All intra-articular compartments are accessed, and removal of particulates and loose bodies and debridement or chondroplasty are performed.

**Patellar Tunnel Preparation**

A longitudinal incision is made along the medial border of the patella, ~1-2 cm. from the lower one-third of the patella. An incision is made to the superficial fascia, and the second layer of the medial patellofemoral complex and the native insertion of the MPFL is identified. A 2.0-mm Kirschner wire (K-wire) is used to drill the femoral footprint. It requires a true lateral view of the knee to obtain the Schöttle’s point. So as not to overtension the graft, always maintain knee flexion at 45-60°. Constantly recheck the patellar tracking. If lateral tightness is present, a lateral release can be performed.

**Table 2. Advantages and Disadvantages**

| Advantages                                      | Disadvantages                                      |
|------------------------------------------------|---------------------------------------------------|
| Small incision                                  | Donor-site morbidity                              |
| Reduces the chance of patellar fractures         | Necessity for drilling of the patella              |
| Large and strong tendon graft                   |                                                   |
| Covering the footprint at the border of the patella |                                                   |
| Reduces foreign-body reaction                   |                                                   |
| Reproducible technique                          |                                                   |
| Lower cost                                      |                                                   |
| Shortened operative time                        |                                                   |

**Table 3. Technical Pearls and Pitfalls**

| Pearls                                                                 | Pitfall                                                                 |
|-----------------------------------------------------------------------|------------------------------------------------------------------------|
| Create a proper landmark before drilling.                              | Inadequate exposure prior to drilling can set the wrong position for reconstruction. |
| Perform a suture augmentation at the border of the patellar to create a fan shape. | Multiple drilling at the patella may cause iatrogenic fractures.       |
| Use a curved clamp to create a space for graft placement.             | Overtensioning the graft may cause excessive medial restraint.         |
| Pass that graft between the medial retinaculum and the medial joint capsule. |                                                                       |
| Avoid penetrating the joint capsule                                   |                                                                       |
| It requires a true lateral view of the knee to obtain the Schöttle’s point for a femoral footprint. |                                                                       |
| So as not to overtension the graft, always maintain knee position in flexion at 45-60°. |                                                                       |
| Constantly recheck the patellar tracking.                             |                                                                       |
| If lateral tightness is present, a lateral release can be performed.  |                                                                       |
is inserted at the midpoint of the medial border of the patella through the center of the patella (Fig 3).

The single tunnel is created with a 4.5-mm EndoButton reamer (Smith & Nephew, Andover, MA) (Fig 4), and then a suture loop is passed through the tunnel (Fig 5).

The semitendinosus graft is passed through the tunnel by suture loop (Fig 6). The upper limb of graft is redirected to the upper part of patella by suture hang with the medial retinaculum and separating the graft to the upper and lower limbs.

Secure the graft to the patella by suturing with the medial retinaculum and patella with no. 1 absorbable suture (no.1 Vicryl, Ethicon, Johnson & Johnson, Blue Ash, OH) (Fig 7).

**Femoral Tunnel Preparation**

A 2-cm skin incision is performed at the posteromedial of the knee. In order to avoid neurovascular injury, the medial epicondyle and adductor tubercle need to be identified. Fluoroscopy is then used to identify an anatomical landmark. We use the radiographic method to create the proper landmark for MPFL insertion with Schöttle’s point and a 2.0-mm K-wire is drilled into this point (Fig 8), perpendicular to the medial aspect of the knee, throughout the lateral cortex.

Then, a 4.5-mm EndoButton reamer is used and reamed through the lateral cortex. Then, the Beath pin is inserted into the EndoButton hole, and drilling is performed with a reamer until the tunnel reaches a maximum of 3-5 cm depth and a diameter of 5.0-6.0 mm, depending on the double-bundle graft length and diameter.

**Graft Placement and Fixation**

The space for graft placement is created between the medial retinaculum and medial joint capsule by carefully dissecting the plane above the medial joint capsule. The graft is then passed from the anteromedial to the medial side and shuttled with the suture loop. The two ends of the tendons are passed through the
lateral cortex following the guidewire (Fig 9). After applying guidewire, an interference screw, 6 mm in width and 25 mm in length, (Biosure HA, Smith & nephew, Andover, MA, USA.) is inserted with the proper tension at a knee flexion of 45-60° (Fig 10).

Postoperative Rehabilitation

Following MPFL reconstruction surgery, patients are required to wear a knee brace to prevent the recurrence of dislocation and aid in the healing of ligaments. The rehabilitation protocol is shown in Table 4.

Discussion

MPFL reconstruction surgery is an effective operation that prevents recurrent dislocation. More than 200 publications on MPFL reconstruction have been published since 2014.

Fig 7. External photograph of the left knee. The upper limb of the graft is redirected to the upper part of the patella by a suture hang with the medial retinaculum and separating graft to the upper and lower limbs (white arrow). Secure the graft to the patella by suturing with the medial retinaculum and patella with a no. 1 absorbable suture (black arrow).

Fig 8. The method of Schöttle et al. creates an anatomical femoral MPFL insertion via fluoroscopy in a lateral view of the left knee. Line 1: Straight line along posterior cortex of the femur. Line 2: Perpendicular to Line 1 passing through the origin of the medial femoral condyle. Line 3: Parallel to Line 2 passing through the posterior aspect of the Blumensaat line. The landmark is anterior to Line 1 and between Lines 2 and 3 (white circle).
Some surgical techniques that create multiple holes in the patellar area may increase the risk of patellar fractures; thus, we use an alternative technique that creates a single hole and inserts the tendon graft. The tendons are passed through the front of the patella to reduce the chance of fractures. Then, the suture augmentation is performed on the edges of the patella to primarily cover the footprint at the border increasing the strength of the tendons. This is in accordance to the technique of using a double-bundle span inserted in a fan shape closer to the native anatomy of the MPFL.

The MPFL is located at the femur in the second layer of tissues at the medial side of the knee.15-17 A study of human bones, according to research by Schöttle et al.,7 shows that at the femoral insertion of the MPFL, a radiographic image with a true lateral view of the knee is used to identify the landmarks (Fig 9).

There have been numerous studies regarding the selection of graft choice in replacing the original MPFL.18 For example, synthetic graft, allograft,3 quadriceps tendon,19 and hamstring grafts,20 including semitendinosus, gracilis, or a combination of semitendinosus and gracilis.6,21 However, there is no research comparing the pros and cons for each graft choice. In the usage of a hamstring graft, the semitendinosus is better than the gracilis, as it is larger, longer, and more suitable for the double-bundle techniques.

It can be seen that MPFL reconstruction surgery with this technique has several advantages. It reduces the chance of patellar fractures, creates larger and stronger tendons, and covers the footprint at the border of the patella close to the native anatomy of the MPFL. The surgical procedure is not very complicated, and results are reproducible. At the femur insertion area, we use only one interference screw for fixation.

**Conclusion**

This presented technique attempts to reduce the chances of patella-related complications, while preserving good stability of the reconstruction, reduces the use of the length of the tendon graft within the
Table 4. The rehabilitation protocol following isolated MPFL reconstruction

| At Time Period | Rehab Protocol                      |
|---------------|-------------------------------------|
| 1-4 Weeks     | • On knee brace                     |
|               | • Limit knee flexion 0-30°          |
|               | • Full weight bearing as tolerated  |
|               | • Isometric quadriceps exercises    |
| 4-6 Weeks     | • Removable brace                   |
|               | • Limit knee flexion 0-90°          |
|               | • Semi-squat exercise with knee flexion at 45° |
| 6-12 weeks    | • Promote to full knee flexion as possible |
|               | • Semi-squat exercise               |
|               | • Open kinetic chain quadriceps exercise |
| 12-16 weeks   | • Return to light sports especially cycling, jogging, and swimming |
| After 16 weeks | • Return to sports                  |

The rehabilitation protocol following isolated MPFL reconstruction includes the following:

- **1-4 Weeks**: On knee brace, limit knee flexion 0-30°, full weight bearing as tolerated, isometric quadriceps exercises.
- **4-6 Weeks**: Removable brace, limit knee flexion 0-90°, semi-squat exercise with knee flexion at 45°.
- **6-12 weeks**: Promote to full knee flexion as possible, semi-squat exercise, open kinetic chain quadriceps exercise.
- **12-16 weeks**: Return to light sports especially cycling, jogging, and swimming.
- **After 16 weeks**: Return to sports.

Acknowledgment

We wish to thank the Department of Orthopaedics, Faculty of Medicine, Thammasat University and Thammasat University Hospital for the kindly support.

References

1. Reagan J, Kullar R, Burks R. MPFL reconstruction: Technique and results. *Orthop Clin North Am* 2015;46:159-169. doi: 10.1016/j.ocl.2014.09.012.
2. Smith MK, Werner BC, Diduch DR. Avoiding complications with MPFL reconstruction. *Curr Rev Musculoskelet Med* 2018;11:241-252. doi: 10.1007/s12178-018-9479-y.
3. Rosinski A, Chakrabarti M, Gwodsiz J, McGahan PJ, Chen JL. Double-bundle medial patellofemoral ligament reconstruction with allograft. *Arthrosc Tech* 2019;8:e513-e520. doi: 10.1016/j.eats.2019.01.011.
4. Conlan TG, WP Jr, Lemons JE. Evaluation of the medial soft-tissue restraints of the extensor mechanism of the knee. *J Bone Joint Surg* 1993;75:682-693.
5. 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. doi: 10.1177/0363546598026012701.
6. Deie M, Ochi M, Sumen Y, Adachi N, Kobayashi K, Yasumoto M. A long-term follow-up study after medial patellofemoral ligament reconstruction using the transferred semitendinosus tendon for patellar dislocation. *Knee Surg Sports Traumatol Arthrosc* 2005;13:522-528. doi: 10.1007/s00167-005-0641-x.
7. Schöttle PB, Schmeling A, Rosenstiel N, Weiller A. Radiographic landmarks for femoral tunnel placement in medial patellofemoral ligament reconstruction. *Am J Sports Med* 2007;35:801-804. doi: 10.1177/0363546506296415.
8. Dall’Oca C, Elena N, Lunardelli E, Ulgelmo M, Magnan B. MPFL reconstruction: Indications and results. *Acta Biomed* 2020;91:128-135. doi: 10.23750/abm.v91i4-S.9669.
9. Thaunat M, Erasmus PJ. The favourable anisometry: An original concept for medial patellofemoral ligament reconstruction. *Knee* 2007;14:424-428. doi: 10.1016/j.knee.2007.08.008.
10. Migliorini F, Oliva F, Maffulli GD, et al. Isolated medial patellofemoral ligament reconstruction for recurrent patellofemoral instability: Analysis of outcomes and risk factors. *J Orthop Surg Res* 2021;16:239. doi: 10.1186/s13018-021-02383-9.
11. Sadigursky D, de Melo Laranjeira MS, Nunes M, Caneiro RJ, Colavolpe PO. Reconstruction of the medial patellofemoral ligament by means of the anatomical double-bundle technique using metal anchors. *Rev Bras Ortop* 2016;51:290-297. doi: 10.1016/j.rboe.2015.07.011.
12. Moran TE, Burke JF, Diduch DR. Small (3.2-mm), short oblique patellar tunnels for patellar fixation in MPFL reconstruction. *Arthrosc Tech* 2020;9:e1613-e1617. doi: 10.1016/j.eats.2020.07.001.
13. Migliorini F, Driessen A, Quack V, Schenker H, Tingart M, Eschweiler J. Patellar fixation graft via suture anchors versus tunnel techniques during isolated MPFL reconstruction for recurrent patellofemoral instability: A systematic review of the literature. *Arch Orthop Trauma Surg* 2020;140:1201-1210. doi: 10.1007/s00402-020-03420-8.
14. McNellian RJ, Everhart JS, Mescher PK, Abouljoud M, Magnussen RA, Flanigan DC. Graft choice in isolated medial patellofemoral ligament reconstruction: A systematic review with meta-analysis of rates of recurrent instability and patient-reported outcomes for autograft, allograft, and synthetic options. *Arthroscopy* 2018;34:1340-1354. doi: 10.1016/j.arthro.2017.11.027.
15. Baldwin JL. The anatomy of the medial patellofemoral ligament. *Am J Sports Med* 2009;37:2355-2361. doi: 10.1177/0363546509339909.
16. 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. doi: 10.1007/s00167-010-1090-8.
17. 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. doi: 10.1007/s00167-012-1993-7.
18. Haupert A, Lorbach O. Anatomic reconstruction of the medial patellofemoral ligament using the fascia lata as an autograft. *Arthrosc Tech* 2015;4:e57-e63. doi: 10.1016/j.eats.2014.11.005.
19. Goyal D. "The superficial quad technique" for medial patellofemoral ligament reconstruction: The surgical video technique. *Arthrosc Tech* 2015;4:e569-e575. doi: 10.1016/j.eats.2015.06.003.
20. Vasso M, Corona K, Toro G, Rossini M, Schiavone Panni A. Anatomic double-bundle medial patellofemoral ligament reconstruction with autologous semitendinosus: Aperture fixation both at the femur and the patella. *Joints* 2017;5:256-260. doi: 10.1055/s-0037-1607192.
21. Nomura E, Inoue M. Hybrid medial patellofemoral ligament reconstruction using the semitendinosus tendon for
recurrent patellar dislocation: Minimum 3 years’ follow-up. *Arthroscopy* 2006;22:787-793. doi: 10.1016/j.arthro.2006.04.078.

22. Migliorini F, Maffulli N, Eschweiler J, Quack V, Tingart M, Driessen A. Lateral retinacular release combined with MPFL reconstruction for patellofemoral instability: A systematic review. *Arch Orthop Trauma Surg* 2021;141:283-292. doi: 10.1007/s00402-020-03689-9.

23. Bollier M, Fulkerson J, Cosgarea A, Tanaka M. Technical failure of medial patellofemoral ligament reconstruction. *Arthroscopy* 2011;27:1153-1159. doi: 10.1016/j.arthro.2011.02.014.