Reconstruction of the Medial Patellofemoral Ligament

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Abstract: Patellar instability has been shown to be associated with different major factors. However, studies have demonstrated that soft tissue reconstructions are adequate enough to reestablish patellar constraint. In recent years, the medial patellofemoral ligament has been recognized as the primary passive restraint for lateral translation of the patella. Their reconstruction has gain popularity as the procedure is quite simple and fast. Although several surgical techniques have been described for their reconstruction, no clear consensus has been reached as to which is best. We present an implant-free, medial patellofemoral ligament reconstruction technique that uses a gracilis tendon autograft, 2 bone convergent tunnels at the original patellar attachment, and looping the graft around the adductor magnus tendon that is used as a pulley for femoral fixation.

Patellofemoral instability is a common knee problem that is frequently associated with pain, decreased activity, reduced quality of life, and long-term osteoarthritis.[1] With the aim of controlling patellar instability, several techniques have been described.[2] Although an "à la carte" plan based on reconstructing all anatomic disorders that may contribute to patellofemoral instability has been advocated, a standard surgical technique to treat this condition remains to be seen.[3]

The biomechanical and clinical importance of the medial patellofemoral ligament (MPFL) as the primary passive restraint in lateral patellar translation has been recently recognized. It constantly tears when the patella dislocates laterally[4] and so MPFL reconstruction has gained popularity as an effective procedure to stabilize the patella. Because of its simplicity and the excellent results, MPFL reconstruction is currently one of the most widely used surgical techniques for the treatment of chronic lateral patellar instability.[5]

Several methods of MPFL reconstruction have been described. They vary in terms of graft choice, patellar and femoral attachments, type of fixation, and graft tension at the time of fixation.[2,3,6-8] The graft attachments both at the patellar site and at the femoral site are one of the most discussed issues as they are probably the main causes of complications after MPFL reconstruction.[9] The aim of the current work is to present an implant-free, simple, and reproducible method for MPFL reconstruction technique that is not based on radiologic landmarks.

Surgical Technique

MPFL reconstruction is performed in patients with objective recurrent patellar instability. Patellar stability

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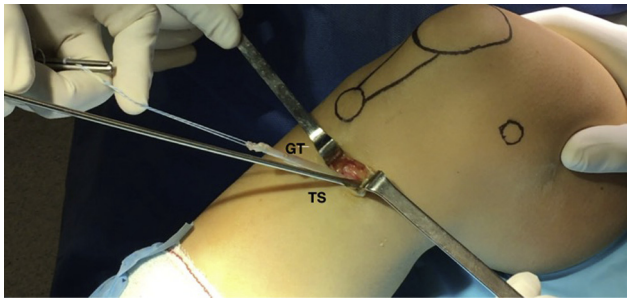

Fig 1. Right knee, anteromedial view. The patient is placed in a supine position on the operating table, with the knee at 90° of flexion. Anteromedial skin incision to harvest the gracilis tendon (GT) using closed tendon stripper (TS).

is evaluated under anesthesia, and the diagnosis of patellar instability requires that there be a soft endpoint or no endpoint in lateral patellar displacement either at full knee extension or at 30° flexion. Horizontal lateral mobility should not be larger than 1 to 2 quarters of patellar diameter. A tibial tuberosity–trochlear groove distance greater than 20 mm is the optimal indication for performing a distal realignment combined with the MPFL reconstruction.

Gracilis Tendon Harvest

The homolateral gracilis tendon (GT) autograft has always been preferred as the graft of choice. The skin incisions are shown in Figure 1. A 2-cm vertical skin incision was used to approach the GT. After exposing the sartorial fascia, it was horizontally incised in line with the palpable GT some 2 cm. It is important not to go deeper to prevent any injury to the underlying superficial medial collateral ligament (MCL). Both gracilis (proximal) and semitendinosus (distal) were identified and separated. After freeing the tibial attachment of the GT, a no. 2 high-strength suture (Hi-Fi, ConMed, Largo, FL) with a Krackow mattress was placed at its distal end. The GT was harvested using a closed tendon stripper and another similar suture was placed at the proximal end. The tendon was sized and stored wrapped in vancomycin soaked gauze.[10] The doubled graft should be at least 90 mm in length (total graft length 180 mm) to properly reconstruct the MPFL.

Patellar Exposure and Tunnels

A 2-cm vertical skin incision was then made over the medial border of the patella to expose its proximal third. The dissection is extended to the medial longitudinal retinaculum between layers 1 and 2. Two 4.5-mm convergent drill holes were performed in the proximal two-thirds of the medial patellar edge, leaving a cortical bone bridge of 10 mm between them to avoid a fracture. Then the edges of both drill holes and the inner angle of the obtained V-shaped tunnel were smoothed out so as to avoid any "killer turn" (Fig 2).

"Femoral" Attachment

Another 2- to 3-cm skin incision was made along the adductor magnus (AM) tendon slightly proximal to the medial femoral epicondyle. The approach was made in line with the medial intermuscular septum. After incising the adductor fascia, the AM tendon was easily identified by finger palpation. Anatomically, it sits flush to the posteromedial aspect of the femur and attaches to the adductor tubercle just proximal to the medial epicondyle. Once identified, the AM and its hiatus were dissected as distally as possible to approximate the anatomic femoral attachment of the graft to the original attachment point of the MPFL (Fig 3). A looped suture was placed around the AM to aid in graft passage (Fig 4).

Graft Pass and Suture

The graft was passed through the patellar tunnel and then through the interval between layers 2 and 3 of the medial retinaculum (Fig 5). The graft should not be deeper than layer 3 so that it remains extra-articular. Finally, it was looped around the AM tendon and back to the patella (Fig 6). Therefore, the AM hiatus was used as an elastic pulley for the graft. The knee was cycled several times through full range of motion while keeping the graft under a slight tension. Finally, both graft ends were sutured together at 30° of flexion with no. 0 high-resistance nonabsorbable sutures (Fig 7). Tension was calculated on the basis that the patella could still be manually lateralized some 10 mm to avoid overconstraint. At the end of the procedure, the lower

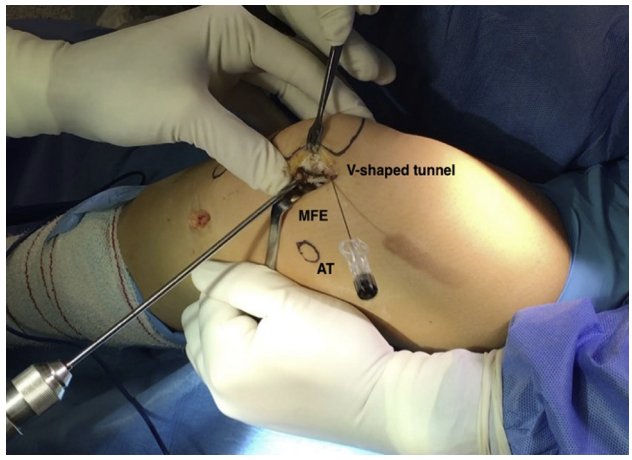

Fig 2. Right knee, medial view. A V-shaped tunnel is drilled in the medial aspect of the patella, using a 4.5-mm reamer, leaving a cortical bone bridge of 10 mm between them to avoid a fracture. The medial femoral epicondyle (MFE) and adductor tubercle (AT) are marked.

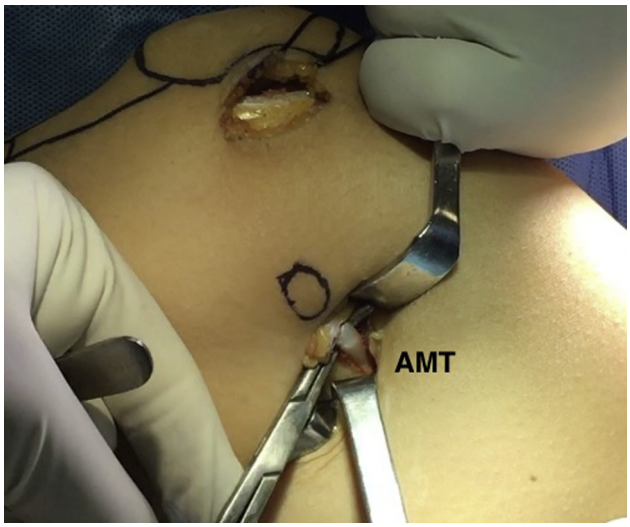

Fig 3. Right knee, medial view. Skin incision made along the adductor magnus tendon (AMT). The tendon is identified and dissected.

limb was immobilized in a brace locked in full extension (Video 1). A step-by-step summary of this technique is provided in Table 1.

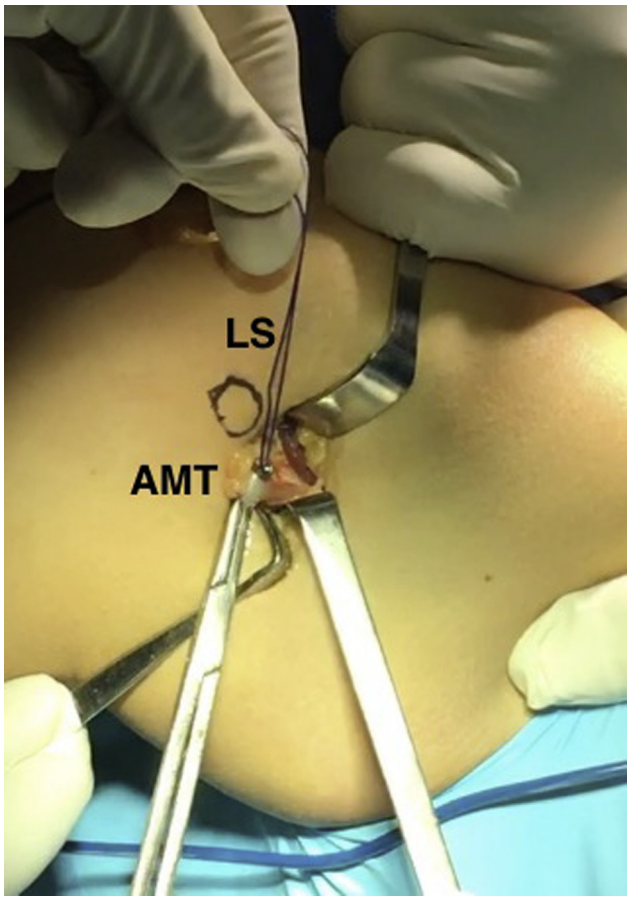

Fig 4. Right knee, medial view. Looped suture (LS) placed around the adductor magnus tendon (AMT) for graft passage.

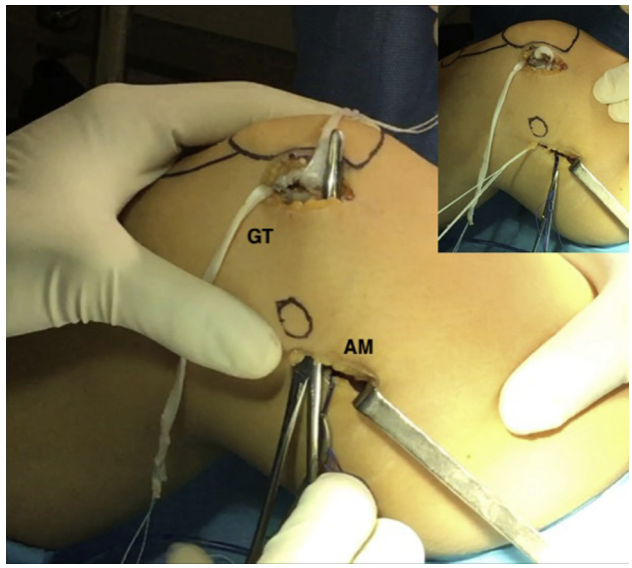

Fig 5. Right knee, medial view. The gracilis tendon (GT) is introduced in the patellar tunnel. Place the graft in the interval between layers 2 and 3 of the medial retinaculum. The graft should not be deeper than layer 3 so that it remains in the extra-articular environment.

Rehabilitation Protocol

Partial weight-bearing is allowed immediately after surgery as tolerated with a knee brace locked at full extension. Range-of-motion exercises were encouraged after 2 weeks and progressed to full range of motion by the sixth week. The brace was discarded at approximately 3 weeks depending on the quadriceps status. Pearls and pitfalls to performing this surgical procedure are listed in Table 2.

Discussion

The main objective of the current Technical Note was to present a simple, reproducible, implant-free MPFL

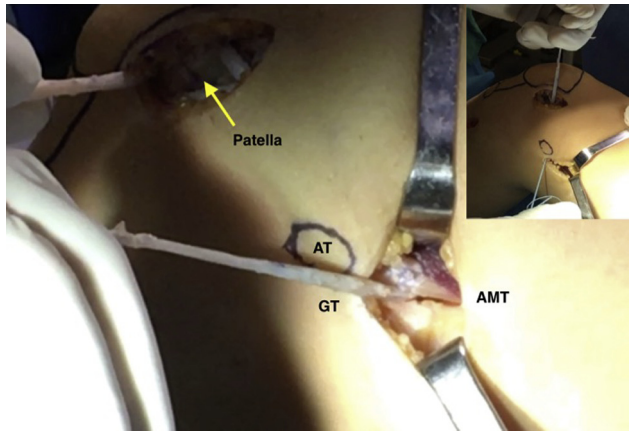

Fig 6. Right knee, closer medial view. Graft passed through the patellar V-shaped tunnel, between layers 2 and 3 of the medial retinaculum and looped around the AM tendon back to the patella.

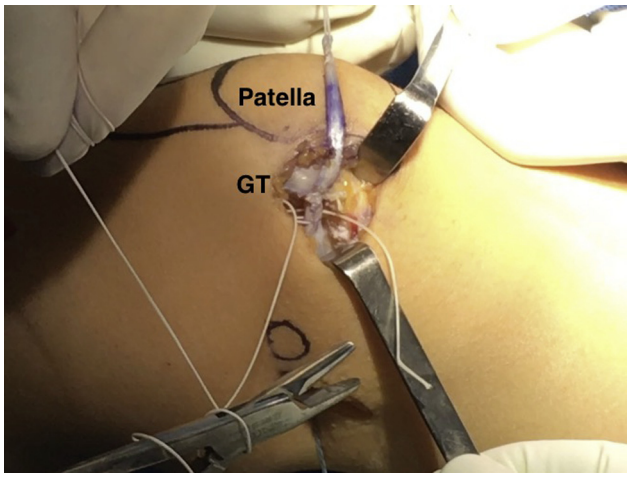

Fig 7. Both grafts were sutured together at 30° of flexion with no. 0 high-resistance nonabsorbable sutures. Tension was calculated on the basis that the patella could still be manually lateralized some 10 mm to avoid overconstraint.

reconstruction technique that does not need radiologic assistance. Despite the good results generally obtained with MPFL reconstruction to control lateral patellar instability, some surgical aspects are still controversial. In fact, the complications seen in recent years after the extensive use of MPFL reconstruction have raised concerns as to the best surgical technique.

Besides MPFL reconstruction failure due to an incorrect surgical indication, inappropriate surgical technique and/or patient selection, several biomechanical studies have demonstrated that the femoral graft/tunnel position is the most important factor affecting the isometric behavior of the MPFL graft.[7,9] Femoral tunnel malpositioning changes the isometry of the graft and increases patellofemoral contact pressures.[11] Conversely, a nonanatomic femoral attachment point in the adductor tubercle did not alter pressures on the patellofemoral joint in comparison to an anatomic attachment as seen in a biomechanical laboratory study using cadaver knees.[12] These nonanatomic reconstructions may exhibit quasi-isometric behavior that prevents overconstraint of the patellofemoral joint as suggested by Panagopoulos et al.[13] A possible explanation might be the very limited changes in length during knee flexion from 0° to 90° seen in the MPFL, which was calculated to be only 1.1 mm.[14]

Table 1. Step-by Step Implant-Free, Medial Patellofemoral Ligament Reconstruction Technique

Step	Description
1	The patient is placed in a supine position on the operating table. A well-padded high-thigh tourniquet is subsequently placed on the operative leg.
2	Standard anteromedial skin incision is performed to harvest the gracilis tendon using a closed tendon stripper.
3	A 2-cm vertical skin incision is then made over the superior medial border of the patella to expose its proximal third
4	In the proximal two-thirds of the medial aspect of the patella, a V-shaped tunnel is drilled using a 4.5-mm reamer, leaving a cortical bone bridge of 10 mm between them to avoid a fracture.
5	A 2- to 3-cm skin incision is made along the adductor magnus tendon. Once this tendon is identified, gently dissect around it.
6	Place a looped suture around the adductor tendon to aid graft passage.
7	Pass the graft through the patella and place it in the interval between layers 2 and 3 of the medial retinaculum. The graft should not be deeper than layer 3 so that it remains in the extra-articular environment.
8	Loop around the adductor magnus tendon back to the patella.
9	Both graft ends are sutured together at 30° of flexion with no. 0 high-resistance nonabsorbable sutures.

Table 2. Pearls, Pitfalls, and Risks

Pearls
The present patellofemoral ligament reconstruction technique is a simple soft tissue procedure in which the femoral physeal plate is not affected as no tunnel needs to be drilled and no hardware to fix the graft to the bone needs to be used.
Save the tendon in a gauze soaked in vancomycin to reduce the risk of infection.
The doubled gracilis graft should be at least 90 mm.
In the proximal two-thirds of the patella, drill 2 convergent holes avoiding inserting the graft distally to the native insertion of the MPFL to avoid constraint of the distal patellar pole.
Leave a cortical bone bridge of 10 mm between the tunnels to avoid a fracture.
Use a dissector-clamp for soften the "killer angle."
Once the adductor magnus tendon is identified, gently dissect around it, freeing all interdigitations of the tendon down to its insertion, as distal as possible, as it better approximates the anatomic femoral insertion point of the MPFL.
The graft is passed through the patella and placed in the interval between layers 2 and 3 of the medial retinaculum. Placing the graft between layers 2 and 3 is preferred for 2 reasons. First, the vastus medialis inserts superficially into the anterior 3 cm of the MPFL, so blind dissection superficial to the MPFL may cause unnecessary trauma to this insertion. Second, if the graft is placed deep into the MPFL, the native MPFL may be repaired to the graft during wound closure.
Tension was calculated on the basis that the patella could still be manually lateralized some 10 mm to avoid overconstraint. The lower limb was finally immobilized in a brace locked at full extension.
Pitfalls and Risks
Overtightening of the graft so that the graft is under tension when the patella is in contact with the medial trochlea facet will result in an overconstrained patella that is painful, and could lead to arthrosis as a result of increased medial facet forces.
Avoid fixing the graft distally to the native insertion of the MPFL to avoid constraint of the distal patellar pole.
During preparation of the 2 patellar tunnels, or during passage of an oversized tendon graft through a tight patellar tunnel, the bone bridge overlying the patellar tunnel may break.
Stiffness can occur if the patient is not able to follow the established rehabilitation protocol. Partial weight bearing with a knee brace lock at full extension is allowed immediately postoperation and progressed to full weight bearing without the brace at approximately 4 weeks. Passive unrestricted range of motion is allowed after 2 weeks.

MPFL, medial patellofemoral ligament.

Table 3. Advantages and Limitations

Advantages
Simple, safe, reproducible, and implant-free technique
Postoperative patellar instability was not observed
Safe and adequate for the treatment of recurrent patellar instability, including in adolescents with an open physis
No need to use intraoperative fluoroscopy
Does not interfere with subsequent MRI imaging and adds no additional costs
Limitations
Risk of patellar bone bridge fracture
Nonanatomic type of reconstruction

MRI, magnetic resonance imaging.

The MPFL is a nonisometric ligament intended to restrain lateral patellar mobility. In cases of patella supera, further anisometry of the MPFL can arise, as has been recently shown.[15] Shifting the femoral attachment site more proximally will increase the distance between the attachment points of the ligament during flexion and increases its tension and, theoretically, will increase the force and pressure applied to the medial aspect of the patellofemoral joint.

Furthermore, recent evidence has shown that using the AM tendon as femoral attachment, no clinical signs of patellofemoral overload, radiologic osteoarthritis, or recurrent patellar instability were observed during a short-term follow-up.[6]

The rationale for choosing the AM tendon insertion as a pulley to fixate the MPFL reconstruction was based on the good results obtained in a small series of pediatric patients with patellofemoral instability. The main reason was the close anatomic situation of the AM to the original MPFL attachment site at the medial femoral condyle. Although it is not completely anatomic, as the MPFL inserts 5 to 10 mm distally to the AM, it was assumed that the elastic nature of this attachment might compensate for any small length mismatching.[16] To establish an isometry similar to the anatomic, it is necessary to dissect the AM tendon as distal as possible to its insertion. Some late experiences seem to confirm this assumption.[17]

With regard to the graft, some authors have recommended the use of the semitendinosus to reconstruct the MPFL.[8] However, the GT was used instead in the current surgical technique. The native MPFL was found to have a mean tensile strength of 208 N. The mean maximum load for 1 strand of a GT was found to be 837 $\pm$ 138 N and 2 strands of the same tendon had approximately twice the strength and stiffness as 1 strand.[11] Therefore, the GT appears to be long enough and strong enough to duplicate MPFL function.

The surgical technique presented here showed some advantages. It is simple, safe, inexpensive, and reproducible. It turns into a simple soft tissue procedure in which the femoral physeal plate is not affected as no tunnel needs to be drilled and no hardware is needed to fix the graft to the femoral bone. A list of advantages and limitations of our procedure can be found on Table 3. Additionally, there is no need to use intraoperative fluoroscopy.

In conclusion, this easy-to-perform, safe, and inexpensive technique has proven to be an adequate treatment for recurrent patellar instability, particularly in children and adolescents with an open physis.

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