Technical Note

Double-Bundle Technique for the Reconstruction of the Proximal Medial Patellofemoral Complex, Using the First Layer of the Quadriceps Tendon as a Graft

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Abstract: The proximal medial femoral patellar complex is the main medial stabilizer of the patella. It is formed by the medial patellofemoral ligament and medial quadriceps tendon-femoral ligament. We present a double-bundle medial patellofemoral complex reconstruction technique using a graft from the first layer of the quadriceps tendon, which enables fixation at different degrees of knee flexion and therefore also different lengths of the reconstructed medial patellofemoral ligament and medial quadriceps tendon-femoral ligament, imitating the native anatomy and biomechanics of the medial femoral patellar complex with a single incision that allows harvesting of the graft and its fixation in the patella and the quadriceps tendon.

The proximal medial femoral patellar complex (MPFC) is the main medial stabilizer of the patella. It is formed by the medial patellofemoral ligament (MPFL) and medial quadriceps tendon-femoral ligament (MQTFL).[1] In recent years, numerous surgical techniques have been described to reconstruct the MPFL, and, more recently, a smaller number of surgical techniques have been described for both the reconstruction of the isolated MQTFL and for the MPFL and the MQTFL in a combined manner.[2] Biomechanical investigations have shown that the medial patellofemoral complex is a nonisometric structure that presents the greatest change in length in the proximal part of it as the degrees of knee flexion increase.[3] This is a key aspect that should be considered in the reconstruction of the medial femoropatella complex.

Surgical Technique

A 5-cm incision is made starting at the proximal pole of the patella and continuing in a proximal direction. A surgical plane between the tendon and the subcutaneous tissue is created, starting at the proximal surface of the patella until the proximal part of the quadriceps tendon is reached. To obtain the rectus femoris graft, 2 incisions are made on the tendon parallel to each other and 1 cm apart. The incision at the tendon begins at approximately 5 cm from the patellar eminence line, which is defined as a straight line between the medial and lateral patellar eminences.[3] At this distance, there is an anatomical division of the first layer and second layer of the quadriceps tendon; this is where the quadriceps tendon divides between the rectus femoris and the vastus intermedius. A thin layer of fat tissue can be found at this level, which will help in locating the site at which to create the plane between the first and second layer of the quadriceps tendon (Fig 1). To create the plane between the rectus femoris and the vastus intermedius, a curved clamp can be used.By introducing it through the layer of fatty tissue and opening, it will expand the plane. Next, with the help of scissors, we harvest the rectus femoris in a proximal direction until we reach approximately 8 cm of graft length counting from the proximal pole of the patella.

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The next step is to obtain the graft from the distal part of the quadriceps tendon. At this stage of the procedure, the surgeon must keep in mind that the first and second layer of the quadriceps are fused and there is no anatomical plane. The use of a scalpel is needed to maintain the thickness of the graft similar to the thickness of the proximal part of the rectus femoris. The graft should be widened progressively as the distance to patella becomes closer so that approximately 3 cm in width is obtained at the time of detachment of the tendon from the patella (Fig 2). In this fashion, a graft of 8 cm in length and 3 cm wide is obtained in the part of the patella and 1 cm wide in the proximal part of the tendon.

The graft is then prepared. Once obtained, the graft is prepared on the worktable. The single side of the graft will be sutured with a Krackow stich and fixed at the femur with a Knotless type implant, then we prepare the portion of the graft that we will fix in the extensor apparatus, which we divide with the help of a scalpel into 2 equal symmetrical parts, each 1.5 cm wide (Fig 3).

In the same the surgical field that was created for graft harvesting, an incision is made between the quadriceps tendon and the vastus medialis up to the patella on its medial side, which will be the insertion areas of the graft at extensor mechanism of the MPFC. For the femoral fixation of the graft, a 3-cm skin incision is made centered on the adductor tubercle. Once the fascia is incised, the adductor tubercle is identified and used as the anatomical reference. The femoral MPFL attachment site is located approximately one centimeter distal to the tip of the adductor tubercle.

Fig 1. The graft is harvested in a Supine position, with the knee positioned at 90° of flexion. Once the incision is made starting proximal to the patella the rectus femoris is located at a distance of 5 cm from the patellar eminence where there is an anatomical division between the rectus femoris and the vastus intermedius. With the help of a curved forceps, we can separate the plane and dissect the rectus femoris.

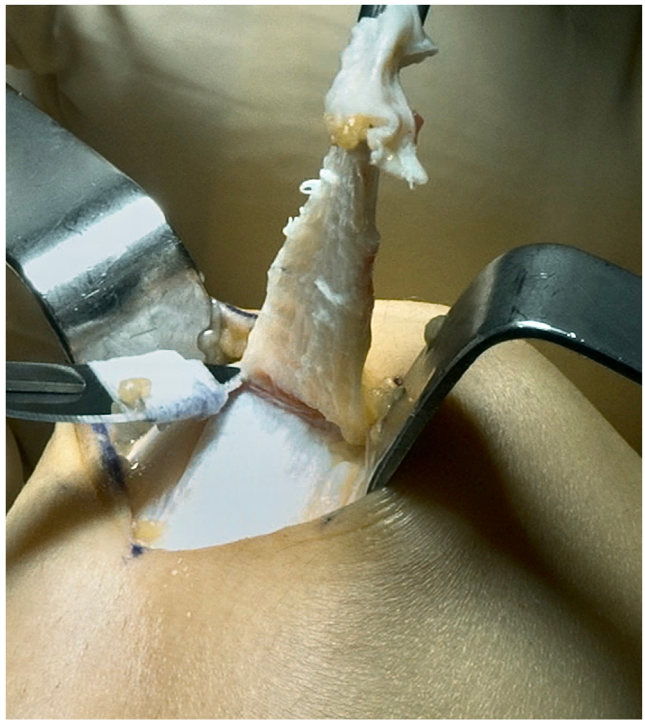

Fig 2. Supine, 90° flexion. The graft is widened progressively from proximal to distal. The goal is to obtain a 3-cm wide graft at the level of the patella. Detachment of the graft from the patella is achieved with a scalpel.

Therefore, 3-dimensional computed tomography can help in locating the femoral attachment point. We can translate the femoral attachment point from a 3-dimensional to 2-dimensional image. The image intensifier is used to check the femoral attachment point.[4] With the help of a clamp, a shuttle suture will connect the extensor mechanism and femoral insertion site, in the appropriate plane between layers 2 and 3. The graft is passed until its single bundle part appears at the level of the adductor tubercle. At 1 cm distal to the adductor tubercle, a 3.5-mm drill is used to create a tunnel and the single-bundle part of the graft is fixed a with a 4.5-mm knotless implant (HEALICOIL KNOTLESS; Smith & Nephew) (Fig 4).

Next, the graft is fixed in the extensor mechanism. The more distal bundle is fixed at the patella using 2 all-suture implants (Q-FIX all-suture anchor; Smith & Nephew), which requires the use of only a 1.8-mm drill, reducing the risk of patella fracture that has been described with the use of thicker implants or tunnels (Fig 5). The location of the most proximal implant coincides with the Tanaka point[5] at 1.5 cm distal to the proximal pole of the patella, which can be located with an intravenous needle by palpating the bone in the proximal patella at the level of the insertion of the

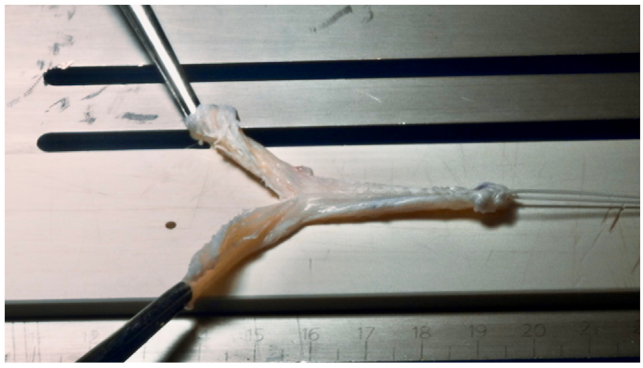

Fig 3. During the preparation of the graft, we divide the wide part of it into 2 bundles and the other end is sutured using the Krackow technique.

quadriceps. The other implant is placed distal to the first one at a distance of approximately 1.5 cm, depending on the thickness of the graft that was previously measured. It must be taken into account that there is an excess length of the graft in this more distal bundle since this bundle is used for reconstruction of the MPFL, which has a length of approximately 5.5 cm; at any rate, it can be trimmed at the time of preparation of the graft or once fixed in the patella (Fig 6).

Once the corresponding MPFL part of the MPFC has been fixed to the patella, we proceed to fix the proximal bundle of the graft in the medial and posterior part of the quadriceps tendon, reproducing the anatomy of the MQTFL. The behavior of this unfixed bundle is observed throughout the range of motion of the knee to verify at what degree of knee flexion the maximum length of the graft occurs. At that, said flexion fixation is performed with a No. 0 nonabsorbable suture until the entire graft is attached to the posterior and medial part of the quadriceps tendon; usually 4 sutures is enough (Fig 7).

Once the MQTFL part of the MPFC has also been fixed, we check the adequate tension of both bundles in extension and flexion. We observe how the MPFL

Fig 4. For the femoral insertion, we use the adductor tubercle as the anatomic reference. We perform the fixation with a knotless-type implant in which the graft sutures are loaded.

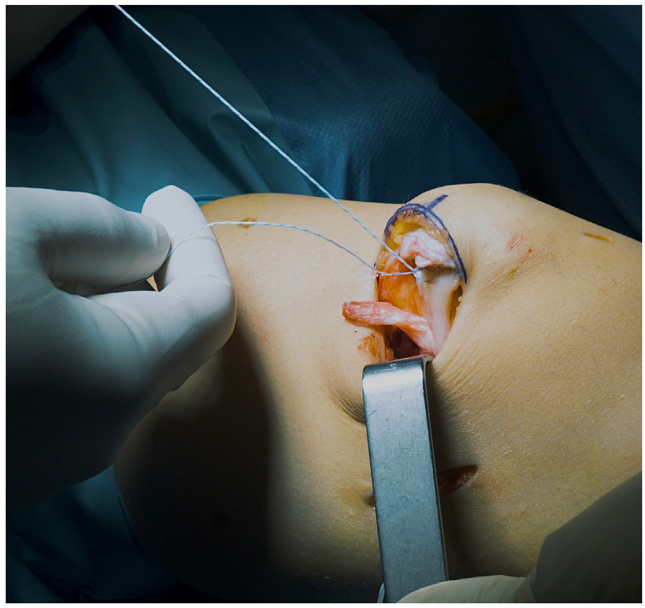

Fig 5. Supine, full knee extension. Fixation at the patella is made using 2 all-suture implants. A transfixing suture is performed with one of the threads of the implant whereas a simple suture is performed with the other thread. When you pull the latter, the graft automatically sticks to the patella that has previously been prepared with a small bur or rasp to obtain bleeding bone. To the left of the bundle that is being fixed, you can see the fascicle with which the medial quadriceps tendon-femoral ligament will be reconstructed.

tenses at approximation 30° of flexion whereas at said flexion the MQTL is lax and how at flexions greater than 90° the MPFL relaxes and on the contrary the MQTFL becomes tighter (Figs 8 and 9). Finally, after washing the surgical field, we proceed to closure by planes.

Discussion

The recent interest in MPFC has led to the description of new surgical techniques; however, there are still some key aspects that we do not know, such as the surgical indication or what is the most appropriate way to perform its reconstruction. Likewise, with anatomical reconstruction of a ligament, the reconstruction of the MPFC should have as its objectives the most similar reproduction possible not only of the anatomical insertion sites but also of the functional behavior and biomechanics of the MPFC.

It should be taken into account that the behavior of the MPFL and the MQTFL in the range of flexion-extension of the joint is different in terms of length and isometry.[6] The importance of this fact is that a reconstruction of the MPFC that does not take this aspect into account could alter the biomechanics of the MPFC, which in turn could potentially lead to pain,

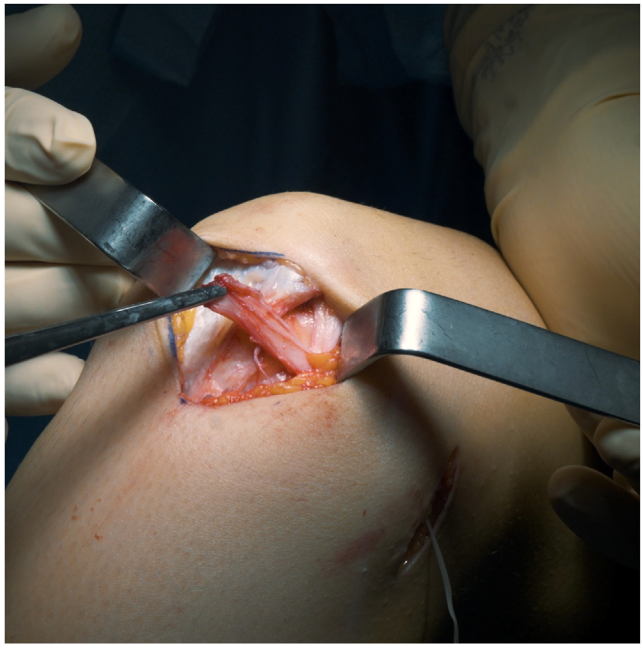

Fig 6. A full range of mobility of the knee is performed and it is verified at what degrees of flexion the maximum length of the proximal bundle of the graft occurs. In this image, it can also be seen the bundle with which we have reconstructed the medial patellofemoral ligament already fixed to the patella.

limitation of the range of motion, and alterations in cartilage pressure.

This technique includes a double-bundle reconstruction that reproduces the anatomical insertion sites and imitates the native biomechanical behavior of the MPFC so that the proximal and distal part of complex have different lengths and tension peaks in different ranges of motion. Furthermore, we believe that the technique has another advantage because the same incision allows harvesting of the graft and its fixation in the patella and the quadriceps tendon. The use of a

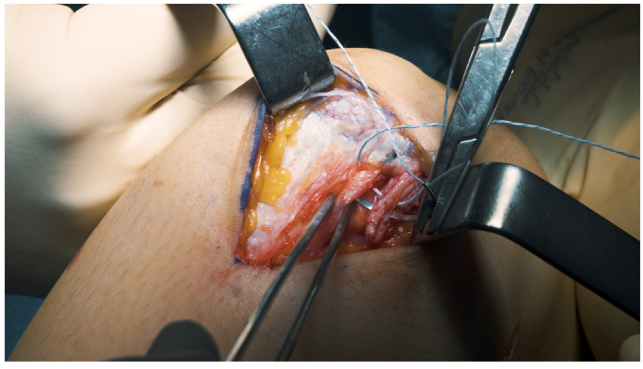

Fig 7. The proximal bundle of the graft is fixed to quadriceps tendon with simple stitches and a nonabsorbable thread. The sutures emerge from the posterior surface of the quadriceps tendon to replicate the anatomy of the medial quadriceps tendon-femoral ligament.

Fig 8. Once the fixation is completed we can check how the tension of both fascicles is different depending on knee flexion. At about 90° of flexion, the medial patellofemoral ligament is loose.

partial-thickness quadriceps tendon allows an excellent graft option for MPFL reconstruction, which has been previously described.[7] The rectus femoris biomechanical values of load to failure, stiffness, and length are better than the native values of the MFPL.

However, the morbidity associated with the graft harvesting could be a concern, especially in the setting after surgery for patellofemoral instability; nevertheless, the rate of anterior knee pain and the strength recovery

Fig 9. Once the fixation is completed we can check how the tension of both fascicles is different depending on knee flexion. At about 90° of flexion, the medial quadriceps tendon-femoral ligament is tight.

Table 1. Advantages and Disadvantages

Advantages	Disadvantages
An autologous graft achieves the anisometry and length changes that characterize the MPFC	Quadriceps weakness in the first weeks after surgery
By adding the reconstruction of the MQTFL, we achieve ligamentous tension in flexion, whereas with the isolated reconstruction of the MPFL, only the initial 60° of knee flexion guarantees it.	Obtaining the graft from the first layer of the quadriceps can be technically demanding
Same incision is used to obtain the graft and fix it to the patella and quadriceps tendon	Although the incision in the proximal part of the patella is only 5 cm long, it may have an unsightly or hypertrophic result
The bone tunnels of the patella are only 1.8 mm thick, thus reducing the risk of fracture	

MPFC, medial femoral patellar complex; MPFL, medial patellofemoral ligament; MQTFL, medial quadriceps tendon-femoral ligament.

measured by an isokinetic dynamometer are excellent after the harvesting of the quadriceps tendon.[8] Therefore, the use of the first layer of the quadriceps tendon provides us with an ideal graft for the reconstruction of the MPFC (Table 1).

Disclosures

All authors (J.L.M-A., R.d.M.N., J.M.F-D., P.N.H., J.L.M-G., V.S-A.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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