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Operative Techniques in

Sports Medicine

Medial Patellofemoral Ligament Reconstruction

Vicente Sanchis-Alfonso, MD, PhD,* and Joan Carles Monllau, MD, PhD†

Medial patellofemoral ligament reconstruction (MPFLr) is the most frequent surgical procedure performed in patients with chronic lateral patellar instability (CLPI). Depending on the fixation technique used, there are 2 types of MPFLr: the static and the dynamic. The current trend is to perform a static MPFLr with an anatomic femoral bone attachment and a patellar bone attachment. However, dynamic MPFLr using the adductor magnus tendon as a pulley could be a good option in children in order to avoid the risk of an injury to the distal femur growth plate with the subsequent risk of developing a deformity of the knee. MPFLr has proven to be a safe, reliable and reproducible technique for the treatment of CLPI. The paramount requirement for a successful MPFLr is the proper patient selection as well as correct presurgical planning and a meticulous surgical technique.

KEYWORDS Chronic lateral patellar instability, Recurrent lateral patellar dislocation, Medial patellofemoral ligament reconstruction

Introduction

Chronic lateral patellar instability (CLPI) is a common finding in the orthopaedic knee surgeon's daily clinical practice. Although its etiology is multifactorial, medial patellofemoral ligament (MPFL) deficiency is the most important factor.[1,2] Therefore, restoration of MPFL is the cornerstone of surgical treatment. Consequently, MPFL reconstruction (MPFLr) is the most frequent surgical procedure performed in patients with CLPI.[1-3] MPFLr can be performed as an isolated technique or combined with other surgical techniques such as an anteromedialization of the tibial tubercle and/or trochleoplasty.[4-6] Many MPFLr surgical techniques have been described using different types of grafts (autografts, allografts, or synthetic) and fixation techniques.[1] Depending on the fixation technique used, there are 2 types of MPFLr: The static and the dynamic. The current trend is to perform a static MPFLr with an anatomic femoral bone attachment and a patellar bone attachment. However, the first author relies on the dynamic MPFLr using the adductor magnus tendon (AMT) as a pulley in children.[7] With this technique we avoid the risk of an injury to the distal femur growth plate with the subsequent risk of developing a deformity of the knee.[8] The objective of this paper is to describe in detail both surgical techniques as well as the protocol used in patients with CLPI.

Relevant Anatomy and Biomechanics Applied to Surgery

The most important issue for a successful static MPFLr is an adequate location for the femoral attachment point of the ligament. It must be anatomic. An anatomic femoral fixation point is a relatively easy and reproducible way to obtain the optimal length-change behavior of the graft during knee flexion-extension, and therefore, a satisfactory long-term clinical result.[9] The problem is that the femoral origin of the MPFL has highly individual anatomic variations. Fluoroscopy, the commonly used method to locate the femoral attachment point, is extremely variable and prone to errors.[10] Therefore, it is easy to be misled using the radiographic

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method alone. With this method, C-arm identification of the femoral graft placement site is an approximation and should not be the sole basis for femoral attachment location. The final placement must be based on a thorough understanding of the relevant anatomy. Therefore, we recommend an incision that is large enough to permit identification of the AMT leading to the apex of the adductor tubercle (AT), which is the most important anatomic landmark for locating the femoral attachment point during MPFLr surgery. The femoral insertion of the MPFL is distal to the AT and proximal-posterior from the medial femoral epicondyle (MFE). The center of the femoral attachment of the MPFL is in a groove midway between the MFE and the AT.[11,12] Most authors recommend the use of the AT as a landmark for MPFLr because the distances between the AT and the femoral attachment of the MPFL are uniform, approximately 10 mm distally.[13-16]

The MPFL is more a check-rein than a constraint. Therefore, the concept of "tensioning" the MPFL graft is not correct from a conceptual point of view given that it is not under constant tension in its native state. It only comes under tension when a lateral or medial force acts on the patella, displacing it laterally or medially. We can compare the MPFL to a dog leash as described by Philip Schottle. The leash (that is, the MPFL) is loose most of the time. However, when the dog (that is, the patella) wants to run away (that is, dislocates) the leash tightens. After that the leash loosens again. If the leash were tight all the time, it would choke the dog. Following the simile, if the graft were tight all the time, it would provoke a high patellofemoral pressure that could lead to patellofemoral osteoarthritis.

Lateral retinaculum release (LRR) or lengthening has no role in primary lateral patellar instability surgery. Biomechanical studies by Amis and Merican[17] have shown that the lateral retinaculum (LR) contributes to resisting lateral patellar displacement — it is a restraint to lateral patellar displacement. Therefore, CLPI will increase after LRR. Moreover, to guide the patella towards the trochlear sulcus during the first degrees of knee flexion, both the MPFL and the LR must interplay in a harmonious way. Christian Lattermann has described both ligaments to behave similarly to the reins of a horse. Both reins must have some degree of tension. They are neither too tense nor too loose. If one of the reins is completely loose the horse is drawn towards the opposite direction, as occurs in the patella. This will provoke a patellofemoral imbalance that may be responsible for iatrogenic anterior knee pain (AKP).

Indications

The paramount requirement for a successful MPFLr is the proper selection of the patient. The ideal indication for an isolated MPFLr would be a CLPI with at least 2 documented episodes of dislocation in a patient with a TT-TG distance of less than 20 mm, a positive apprehension test up to 30° of knee flexion, a patellar Caton-Deschamps index of less than 1.2 and grade A trochlear dysplasia.[1] It is of utmost importance to confirm patellar dislocation with physical examination (Fig. 1). In some cases, it may be necessary for it to be carried out under anesthesia to confirm lateral patellar dislocation objectively.

An isolated MPFLr is not indicated to correct patellofemoral maltracking. Its only aim is to stabilize the patella once patellofemoral tracking has been corrected. Neither should it be performed in a fixed lateral patellar instability in flexion. In that case, the main problem is retraction of the extensor mechanism of the knee and a flat lateral condyle, factors that contribute to secondary MPFL insufficiency. Therefore, the correct treatment for these cases would be lengthening of the extensor mechanism. If needed, the lateral condyle may be raised. Then, an MPFL reconstruction may be performed as the final surgical step.

Operative Technique — Surgical Options

Static Anatomic MPFL Reconstruction

The usual surgical technique performed by the first author (V.S-A) is an anatomic double bundle static MPFLr using semitendinosus autograft. Kang et al[18] have shown that the double bundle procedure for isolated MPFLr has similar outcomes to the single bundle technique relative to an improvement in knee function, recurrent dislocation, and complications.

The patient is placed in the supine position on a standard table. After induction of anesthesia, lateral patellar dislocation must be confirmed (Fig. 1). Prepare and drape the limb in the standard fashion and inflate the tourniquet. A sterile bump is placed under the knee to keep the knee slightly flexed. First, an arthroscopic examination of the knee is carried out to evaluate the state of the cartilage of the patellofemoral joint and rule out intra-articular pathology (Fig. 2). After that, the semitendinosus tendon is harvested. That is the graft that the first author uses in most of his cases. The graft is prepared and then it is immersed in a tray with a solution of 100 mL of sterile saline mixed with 500 mg of vancomycin powder. It is then wrapped in a gauze compress that has been soaked in the solution. This last step is suggested to avoid graft-related intraoperative microbiological contamination, as previously described.[19]

Next, we make an incision in the anterior aspect of the knee centered over the junction of the medial and middle thirds of the patella. The medial third of the patella is

Figure 1 It is of utmost importance to confirm patellar dislocation with physical examination. (Color version of figure is available online.)

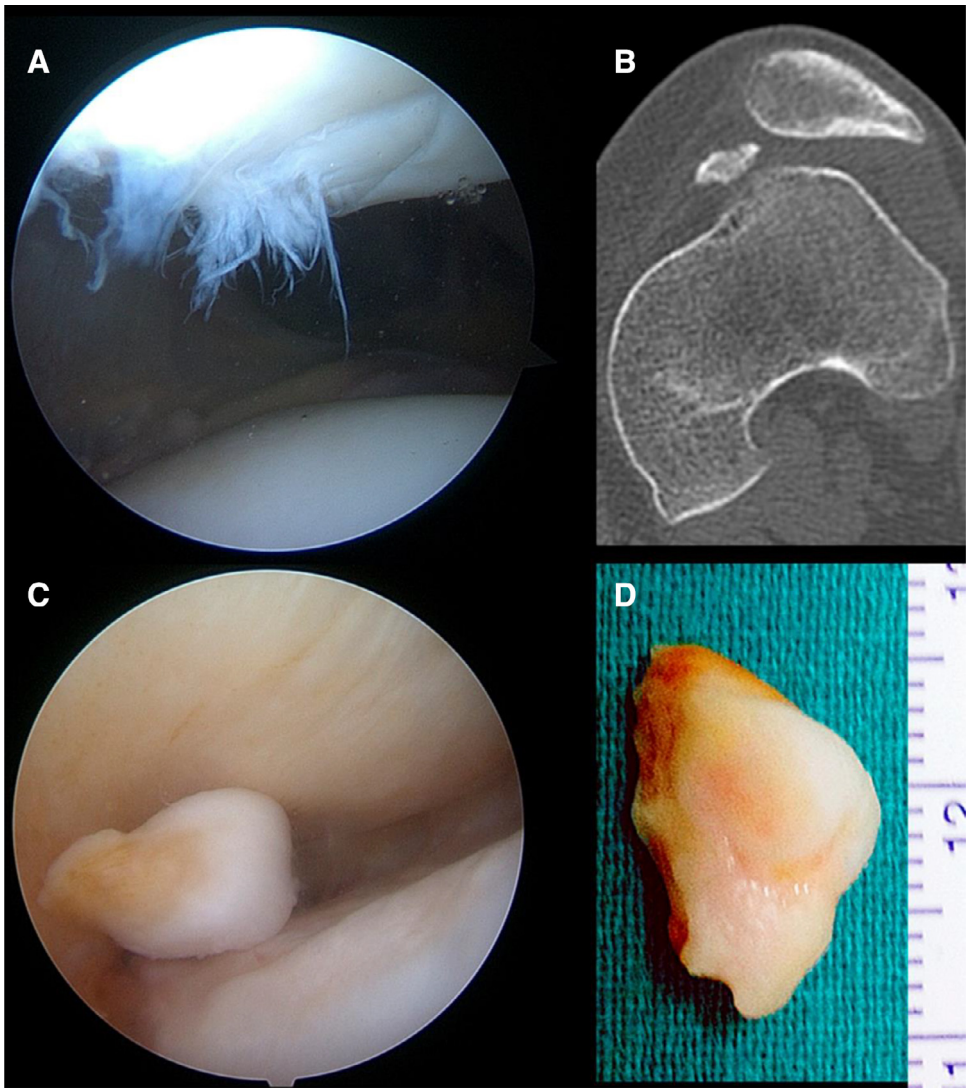

Figure 2 **(A)** Typical lesion of the patellar cartilage located in the medial facet of the patella in a patient with CLPI. **(B** to **D)** Loose body in a patient with CLPI. (Color version of figure is available online.)

exposed by subperiosteal dissection with a scalpel (Fig. 3A). The dissection is prolonged medially between the layers 2 and 3 described by Warren. We open 2 tunnels in the medial aspect of the patella from dorsal to posterior in V-shape using a 4.5 mm drill (Fig. 3B). When drilling the patellar tunnels, we must avoid penetrating the subchondral bone and damaging the articular cartilage. We do not use any fixation system in the patella.

Then, an incision is made in the medial aspect of the knee to locate the femoral fixation point. Locating the femoral attachment point is one of the most crucial steps in MPFLr.[9] Poor graft placement can cause severe complications and disability.[9] An incision that is large enough to facilitate in identifying the AMT that leads to the apex of the AT is recommended.[1] The femoral insertion of the MPFL is located between the AT and the MFE. An attractive option to perform small-incision surgery would be to use the 3D-CT technology to locate the anatomic femoral attachment point.[10] 3D-CT allows us to locate the femoral attachment point of the MPFL based on the location of the AT. By means of a computer program, we can translate the point calculated in the 3D-CT to the 2D image. Therefore, we can check that the femoral attachment point is the one that the radiologist has located in the 3D CT, 10 mm distal to the AT, under fluoroscopic control in the operating room. It makes for a tailor-made surgical procedure. Once we have determined the anatomic femoral attachment point the normal length changes will be obtained automatically. The MPFL is isometric in 80% of the cases, from 0 to 60°.[9] In 20% of the cases, it is isometric from 0 to 30°.[9] Beyond this latter degree range, it loosens. Graft fixation on the femoral side can be done with bioabsorbable interference screws or suture anchors. In most of our cases we use suture anchors. After that, we connect the medial patellar and medial femoral incisions by blunt dissection using a hemostat. Firstly, we pass the graft through the tunnels opened in the patella (Figs. 3C and D and Fig. 4) and then pass the graft between layers 2 and 3 until the femoral attachment point is reached.

Setting correct ligament length is crucial to the success of MPFLr surgery. Generally, an overly tight graft causes more

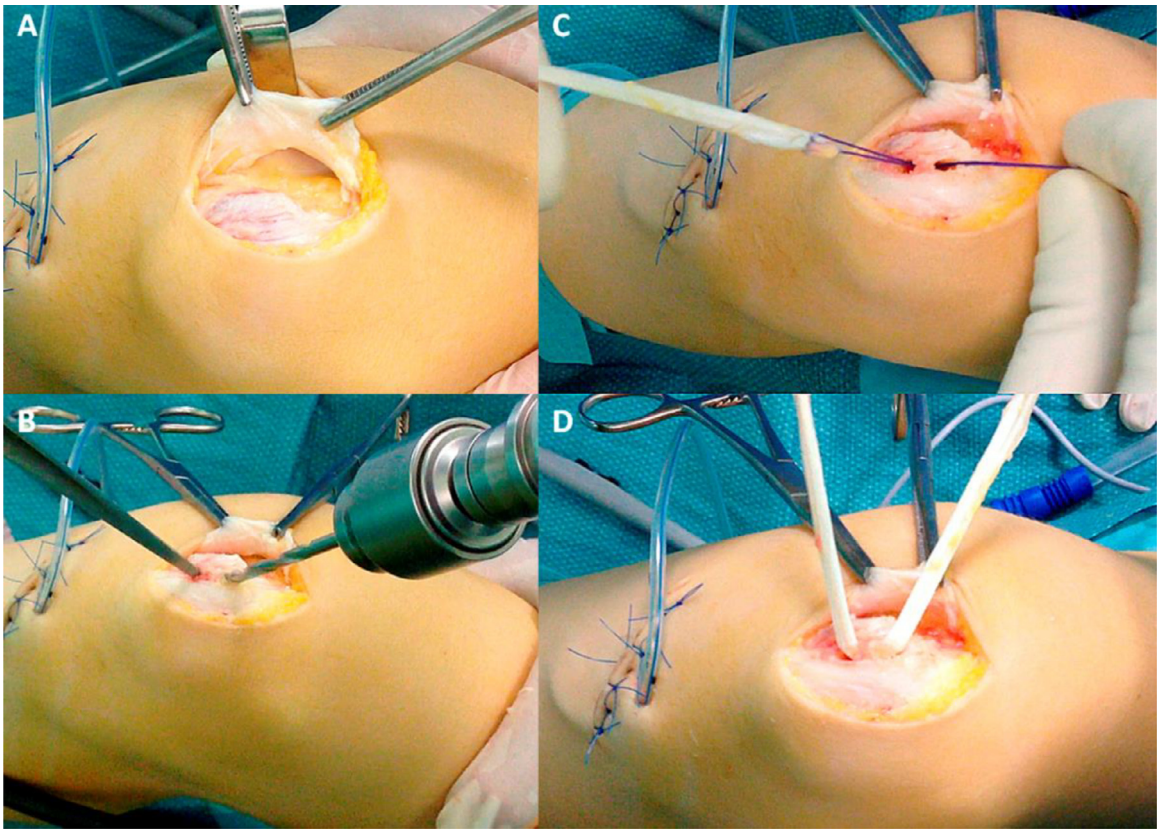

Figure 3 **(A)** The medial third of the patella is exposed by subperiosteal dissection with a scalpel. **(B)** We make 2 tunnels from dorsal to posterior in V-shape using a 4.5 mm drill bit. **(C)** The graft is passed through the patellar tunnels. **(D)** Aspect once the graft has been passed. (Color version of figure is available online.)

Figure 4 Aspect once the graft has been passed. (Color version of figure is available online.)

problems than one that is too slack as this can lead to medial patellofemoral chondrosis. Do not pull the graft tight at the time of fixation. If done so, it leads to elevated medial contact pressures and medial patellar tracking. To avoid excessive tension on the graft when we perform an anatomic MPFLr, we recommend fixing the graft at 30° of knee flexion as it is at this angle that the distance between the femoral and patellar attachments points is greatest in most knees.[9]

We never perform an LRR associated with a reconstruction surgery of the MPFL. This agrees with the findings of Malatray et al[20] who stated that there is no indication for a systematic LRR in association with MPFLr in the treatment of CLPI.

MPFL Reconstruction With an Implant-Free Technique and Elastic Femoral Fixation

For the present technique, the homolateral gracilis tendon (GT) autograft is the suggested graft of choice. A standard harvesting technique should be used through a 2 cm length vertical skin incision centered on the tibial insertion of hamstring tendons (Fig. 5A). After releasing the distal attachment of the hamstring, care should be taken so as not to pre-cut the tendon. The doubled graft must be at least 90 mm in length (total graft length 180 mm) to properly reconstruct the MPFL. We suggest preparing the 2 ends of the tendon with Krackow mattress fashion stitching with a high-strength #2 sutures (Fig. 5B). The tendon is sized and kept wrapped in vancomycin-soaked gauze.

In the experience of the second author (J.C.M), the GT is enough in terms of both length and strength to reconstruct the MPFL given that the native ligament was found to have a mean tensile strength of 208N and the mean maximum load for 1 strand of a GT was found to be 837 ± 138N.[21,22]

A second 2 cm vertical skin approach is then made over the superior medial border of the patella to expose its proximal third where the anatomical footprint of the

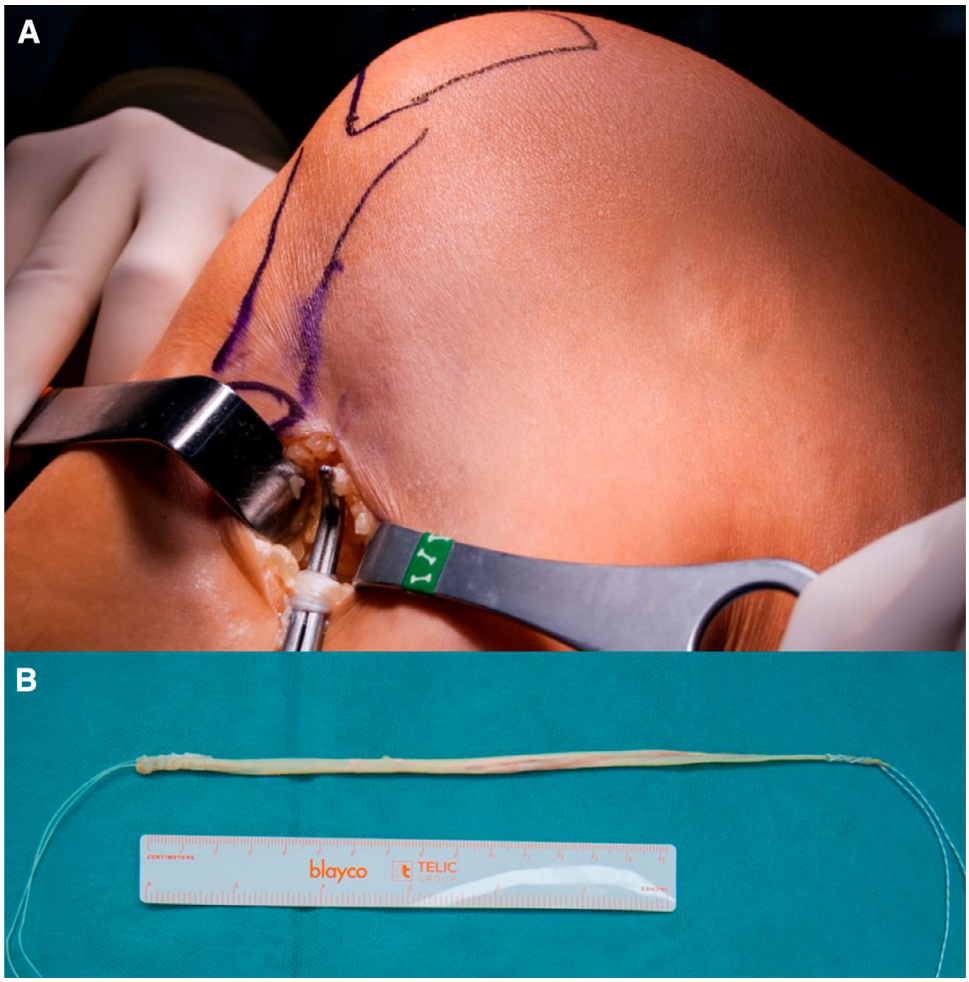

Figure 5 **(A)** Gracilis tendon autograft harvesting. **(B)** Preparation of the 2 ends of the tendon with Krackow mattress fashion stitching with a high-strength #2 sutures. (Color version of figure is available online.)

MPFL is located. The latter is roughly identified and 2 convergent 4.5 mm holes are drilled at the edges of the footprint. The tunnels are made in a convergent V-shape from the cortex to the cancellous bone of the patella (Fig. 6). Attention should be paid to leaving at least 15 mm of bone bridge between the starting points of the tunnels to avoid intraoperative fractures or a stress fracture could be produced postoperatively. The edges of both drill holes and the inner angle of the V-shaped tunnels obtained are smoothed out to avoid any "killer turn".

A third 2 cm skin incision is then made slightly proximal to the MFE along the AMT. The approach is deepened in line with the medial intermuscular septum and the AMT is easily identified, by means of finger palpation under its fascia. Anatomically, it runs flush to the posteromedial aspect of the femur and attaches to the AT just proximal to the MFE. Attention should be given to dissecting it from the surrounding fat pad, which is always present at this level, and to coagulate any vessels at this point to prevent postoperative bleeding. The AMT is carefully dissected as distally as

Figure 6 Patellar tunnels are made in a convergent V-shape from the cortex to the cancellous bone. (Color version of figure is available online.)

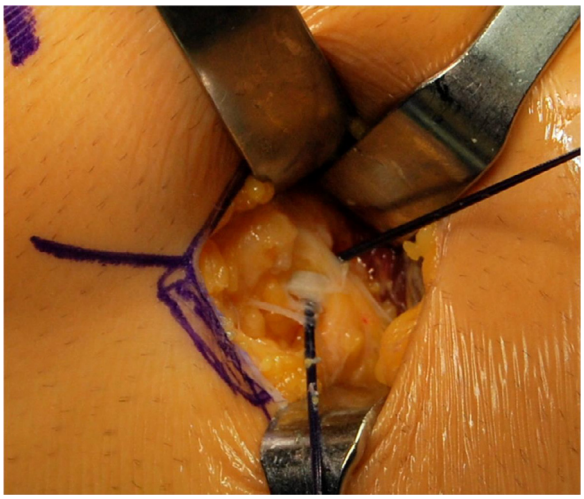

Figure 7 The AMT is carefully dissected as distally as possible in order to reach the closest point possible to the native MPFL footprint. (Color version of figure is available online.)

possible in order to reach the closest point possible to the native MPFL footprint (Fig. 7). A looped suture is placed around the AMT to aid in graft passage. The same suture helps in a proper distal dissection of the AMT by a pulling and "sawing" movement toward the femoral insertion. This kind of insertion of the MPFL reconstruction at the femoral side permits fixing the graft with some advantages: (1) Without hardware, 2) without any bone drilling, and (3) with an elastic tensioning of the new ligament. The first should be considered for economic reasons. The second makes for approaching patellofemoral instability safely in skeletally immature patients. Finally, elastic fixation may reduce the possibility of developing medial patellofemoral pain due to the overconstraint that is eventually produced by static femoral fixation.[7,11,23] In addition to these advantages, there is no need to use an image intensifier. Although the AMT femoral insertion is not completely anatomic, as the MPFL inserts 10 mm distally to the AT, it is assumed that this kind of elastic attachment might compensate for the mismatching.

The graft is finally passed through the patellar tunnels and then through the interval between layers 2 and 3 described by Warren (Fig. 8). When the MPFL is reconstructed in combination with other intra-articular procedures, attention should be paid to carefully closing the synovial and capsular layers and not situating the MPFL intra-articularly. Finally, the graft is looped around the AMT used like a pulley and back to the patella (Fig. 8). While maintaining the graft under a slight tension, the knee is cycled several times to find the correct physiometry and check patellofemoral tracking. Before proceeding to the last step, it is important to verify that the patella can still be manually lateralized some 10 mm to avoid any overconstraint. Lastly, both graft ends are tied together at 30° of flexion with high-resistance #2 sutures (Fig. 8). If the remaining tendon is long enough, it can also be tied under the prepatellar periosteum.

Treatment of Concomitant Pathology and Anatomic Factors Predisposing to Patellar Dislocation

Patellar condropathy is very common in cases of CLPI (Fig. 2A). We only remove unstable cartilage flaps, but other cartilage lesions are not addressed. Patellar chondropathy could be responsible for AKP in the patient with CLPI. However, once the patella has been stabilized, the pain typically resolves even though the chondral lesion is left alone. Loose bodies are removed (Fig. 2B to D).

Several authors have traditionally recommended medialization of the tibial tuberosity (TT) when the TT-TG distance is more than 20 mm. However, there is no evidence in the medical literature to support that recommendation.[2] TT-TG distance depends on knee flexion, weightbearing, tibiofemoral rotation, and joint size.[2] What is more, the intra- and interobserver reliability for TT-TG distance measurements is less in patients with severe trochlear dysplasia compared to low-grade trochlear dysplasia.[2] Moreover, some authors have demonstrated that there are no differences in TT-TG distance between the stable and the unstable knee in patients with unilateral patellar instability.[24] Furthermore, some authors have not found differences in the outcomes of isolated MPFL reconstructions in the setting of a TT-TG index >20 mm compared to those with a TT-TG distance <20 mm.[25]

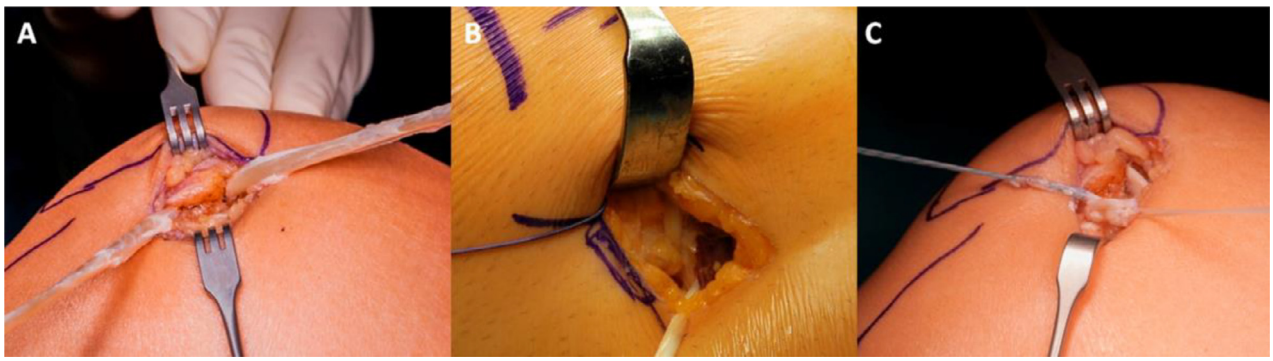

Figure 8 The graft is passed through the patellar tunnels, then it is passed between layers 2 and 3 and then looped around the AMT and back to the patella. (Color version of figure is available online.)

Therefore, TT-TG can be used as a guide but the key is the history and the physical examination. We must consider whether the dislocation is traumatic or atraumatic, bilateral or unilateral as well as the activity level of the patient and the patient expectations. Moreover, we must take the presence or absence of patellofemoral maltracking into consideration. In conclusion, we must consider TT osteotomy in extremely selected cases when a less invasive alternative is insufficient.

According to several authors we must perform a distalization of the TT when the Caton-Deschamps (CD) index is more than 1.2. However, there is no strong evidence in the medical literature to support this recommendation.[2] Moreover, TT distalization is not a panacea. Furthermore, distalization is risky in patients with chondral lesions of the distal pole of the patella because it causes an overload of this area in initial flexion. Bartsch et al[26] have shown that TT distalization is not mandatory in patients with mild *patella alta* (CD Index 1.2-1.4). Once again, we must not to use imaging numbers to treat a patient.

Regarding sulcus deepening trochleoplasty, it is not a routine surgical procedure. It is a valuable tool only in a small subset of patients mostly in revision surgeries. They include severe trochlear dysplasia, when the patella dislocates not only during the first 30° of knee flexion but also at high degrees of knee flexion, and when there is a patellofemoral maltracking.

Postoperative Course

To control the pain, after a surgery, we perform a femoral nerve block and use oral analgesics. A knee range of motion brace is used for 4 weeks until the recovery of quadriceps that is when straight leg raising is possible. Immediate full weight bearing, as tolerated, is allowed with 2 crutches for 4 weeks. The principles of rehabilitation after MPFLr are like those after anterior cruciate ligament reconstruction, emphasizing early complete range of motion (ROM), with the emphasis on extension to prevent scar formation and capsular retractions, quadriceps strengthening and proximal control of the lower limb (hip abductors and external rotators strengthening). Most patients can play competitive sports after 6 months.

Outcomes

MPFLr for recurrent patellar dislocation results in a significant improvement in Kujala scores (a mean of 51.6 in the preop vs 87.7 in the postop) and a low redislocation rate (2.4%).[27] In a systematic review in 2016, Schneider et al[28] showed with meta-analysis that a high percentage of patients (84%) return to sports activities after isolated MPFLr for CLPI. Additionally, there is a low incidence of recurrent instability (1.2%), positive apprehension sign (3.6%), and reoperation risk (3.1%).

Conclusion

MPFLr has proven to be a safe, reliable, and reproducible technique for the treatment of CLPI. The paramount requirement for a successful MPFLr is the proper selection of the patient as well as correct presurgical planning and a meticulous surgical technique. An MPFL reconstruction should not be performed if the patella cannot be laterally dislocated.

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