Technical Note

Medial Patellofemoral Ligament Reconstruction: A Surgical Technique to Dynamically Control Graft Tension

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Abstract: The medial patellofemoral ligament is an important patellar stabilizer and, when damaged, can lead to recurrent instability, cartilage injury, and debilitating pain among other conditions. In patients with continued patellar instability after failed nonoperative management, medial patellofemoral ligament reconstruction often is recommended. A key step of the procedure is appropriate graft tensioning. Previously described techniques can help guide the surgeon, but few allow for adjustable tensioning after dynamic examination of patellar tracking to avoid over tensioning. This technique offers the ability to dynamically control graft tension with 2 independent graft limbs while also using knotless onlay type fixation, therefore decreasing the risk of over- or undertensioning and the complications that come with it.

The medial patellofemoral ligament (MPFL) is a thin fascial band that connects the medial epicondyle of the femur to the proximal part of the medial border of the patella.[1] It accounts for approximately 50% to 60% of the total lateral restraint and is the primary stabilizer of the patella from 0 to 30°.[2]

After acute or chronic injuries with MPFL tear or insufficiency, patients usually present with patellar instability and can develop patellofemoral osteoarthritis, among other problems.[1] Reports have shown up to a 40% increased risk of recurrent dislocations, functional pain, and development of patellofemoral arthritis after MPFL injury.[3] Biomechanical studies show that transection results in increased lateral patellofemoral contact pressures and lateral patellar tracking during early knee flexion.[4] Therefore, to prevent recurrent instability, cartilage injury, and pain, surgical intervention often is recommended after a trial of nonoperative management fails.[5] Acute MPFL reconstruction is also indicated if risk or instability is high or if surgery is needed for removal of loose body.[6,7]

Optimal graft tension is the most important step in MPFL reconstruction, as overtensioning can lead to increased medial joint contact pressure, medial patellar tilt, medial patella translation, and ultimately graft failure.[4,8] We present a surgical technique that allows for patellar onlay fixation using knotless technology and allows independent adjustable tensioning of the patellar graft limbs. This technique provides the surgeon the ability to tighten or loosen the MPFL based on dynamic intraoperatively evaluation to prevent overtensioning while also minimizing prep time described with similar previous techniques.

Surgical Technique (With Video Illustration)

Indications

MPFL reconstruction often is recommended for patients with acute or recurrent instability after not responding to nonoperative management. The typical workup includes a radiograph and magnetic resonance imaging to evaluate both the bony and soft-tissue anatomy. Many patient factors must be considered before proceeding with an isolated MPFL reconstruction to prevent recurrent instability. Specifically, the surgeon must evaluate coronal plane alignment, patellar tracking (tibial tubercle to trochlear groove distance), patellar height, trochlear dysplasia, and

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The authors report that they have no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received July 7, 2022; accepted August 22, 2022.

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2212-6287/22876

https://doi.org/10.1016/j.eats.2022.08.023

rotational profile to determine whether concomitant procedures are needed.

Procedure

Equipment Needed

All equipment needed for this technique is listed in Table 1 and can be seen laid out in Fig 1.

Graft Preparation

Semitendinosus allograft, 240 mm in length with doubled diameter of 7 to 8 mm, is used and both free ends are whipstiched with a fiber loop (Fig 2A). The graft is then doubled over, and the central portion is fiber looped for 2 cm and size for tunnel preparation (ideally is between 7-8 mm) (Fig 2B). It can then be placed onto a graft tensioning device based on the surgeon's preference.

Patella Preparation

After examination under anesthesia, the patient is placed supine on the operating room table, ensuring the ability to obtain adequate imaging. A bump or foot bolster is placed to allow the knee to rest at 30° of flexion for graft fixation. The authors' preference is to perform free leg diagnostic arthroscopy with a lateral post as needed. A tourniquet is highly recommended to control blood loss and to obtain better visualization. The important landmarks are marked, including the patella and tibial tubercle. Before MPFL reconstruction, standard diagnostic arthroscopy is performed, and intra-articular pathology is addressed.

The 4-cm patellar incision is then created just medial to the patella starting 1 cm proximal to the superior pole. Skin and subcutaneous tissue are incised to expose the retinacular layer (Fig 3A), which is divided until the synovial layer is visualized (Fig 3B). The retinaculum is then elevated off the medial side of the patella and the bone is decorticated with a rongeur. Two parallel guide pins are placed into the medial patella. The proximal wire is placed 15 mm distal to the superior pole of the patella and the second guide pin is 15 to 20 mm distal. This is confirmed using radiographs to ensure central and parallel placement. It is key to avoid anterior cortical violation (can increase risk of fracture) as well as articular penetration. The 4.5 reamer is then placed over the guide pin and reamed to a depth of 20 mm. After reaming, two 4.75-mm Knotless SwiveLock anchors (Arthrex, Naples, FL) preloaded with a #2 FiberWire (Arthrex) are placed into the tunnels (Fig 4 A-C). The plane is then developed between the retinacular layer and the joint capsule toward the insertion of the MPFL on the femur.

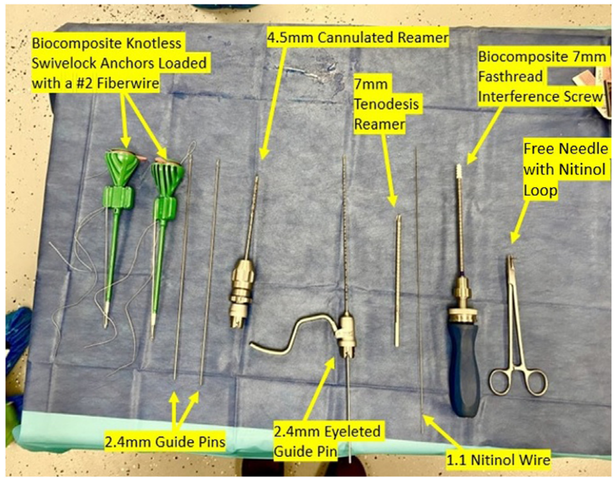

Fig 1. Back-table setup in the operating room. From right to left, two BioComposite Knotless SwiveLock Anchors loaded with a #2 FiberWire (Arthrex), two 2.4-mm guide pins, a 4.5-mm cannulated reamer, a 2.4-mm eyeleted guide pin, a 7-mm tenodesis reamer, a 1.1 nitinol wire, one BioComposite 7-mm FastThread interference screw (Arthrex), and a free needle.

Femur Preparation

Fluoroscopy is used to identify and mark Schöttle's point as previously described. The incision is carried through skin and subcutaneous tissue and the fascia is incised longitudinally (Fig 5A). The medial epicondyle and the adductor tubercle can be palpated for guidance; however, fluoroscopy is again used to confirm the location of Schöttle's point (Fig 5B). An eyeleted 2.4-mm guide pin is then placed bicortical exiting the skin on the lateral side (Fig 5C). The appropriate size reamer is then used over the guide pin based on graft size.

A passing suture is then placed through the femoral tunnel and a nitinol wire is placed into the closed socket (Fig 6A). The graft is fully seated into the femoral tunnel and secured with a bioabsorbable screw with line-to-line sizing (Fig 6B, 7 A and B). The 2 limbs of the graft are then passed between the retinacular and synovial layers for insertion into the patella (Fig 8 A-C).

MPFL Graft Tensionin

A Dynamic Process

There are 4 components to the knotless anchor in the patella. There is the repair stitch, the looped end of the

Table 1. Back Table Setup

Quantity	Instrument
2	BioComposite Knotless SwiveLock anchors loaded with a #2 FiberWire (Arthrex)
2	2.4-mm guide pins
1	4.5-mm cannulated reamer
1	2.4-mm eyeleted guide pin
1	7-mm tenodesis reamer
1	1.1 nitinol wire
1	BioComposite FastThread interference screw (Arthrex)
1	Free needle with nitinol loop

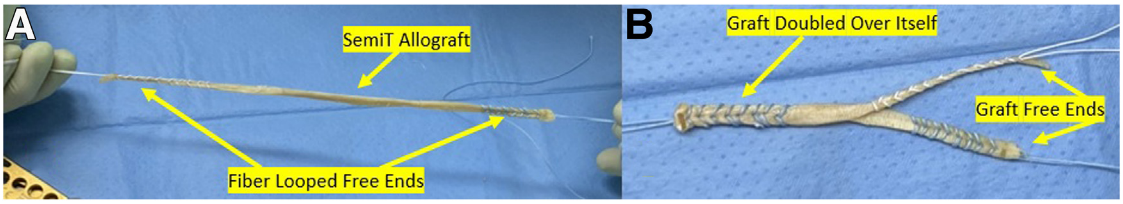

Fig 2. (A) The semitendinosus allograft is used and both free ends are whipstiched with a fiber loop. (B) The graft is then doubled over and the central portion is fiber looped for 2 cm and size for tunnel preparation.

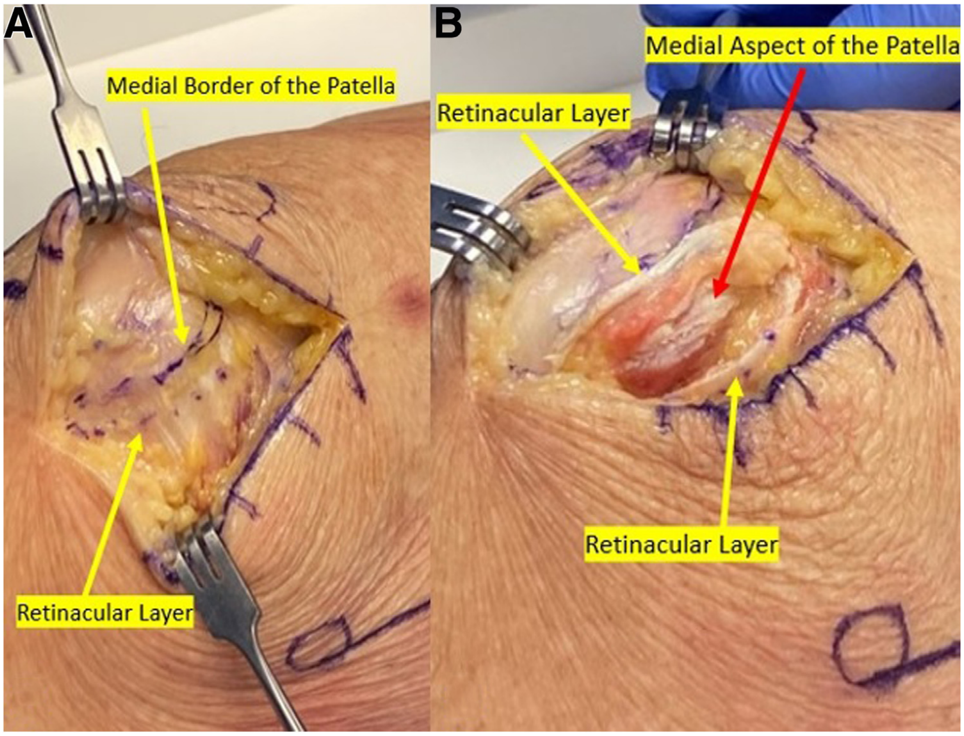

Fig 3. (A) Skin and fat are incised and the medial border of the patella exposed with an intact retinacular layer. (B) Retinacular layer is cut with exposed patella bone. Use a rongeur and decorticate the medial border of the patella. This is important for graft insertion.

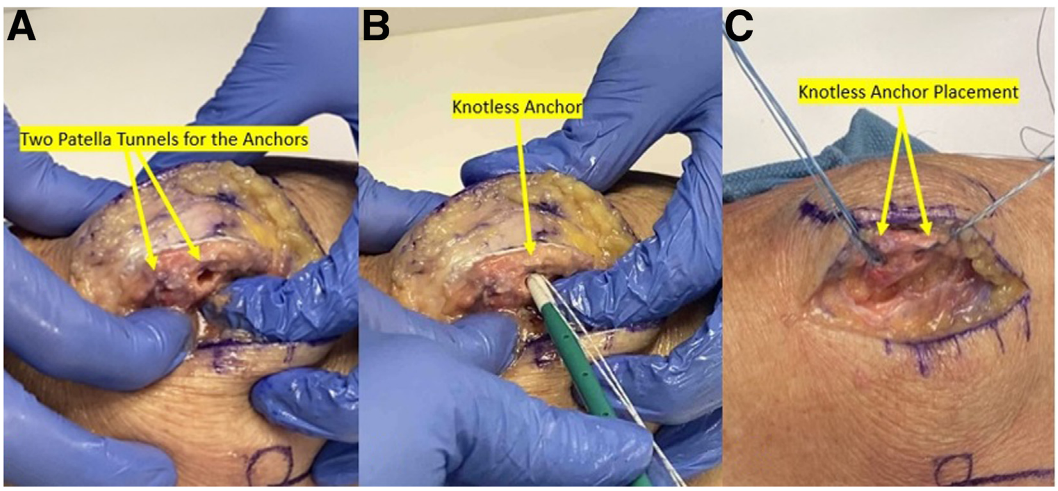

Fig 4. (A) Two tunnels are made within the medial border of the patella. (B) Insertion of the knotless anchor into the patella. (C) Final positioning of each anchor.

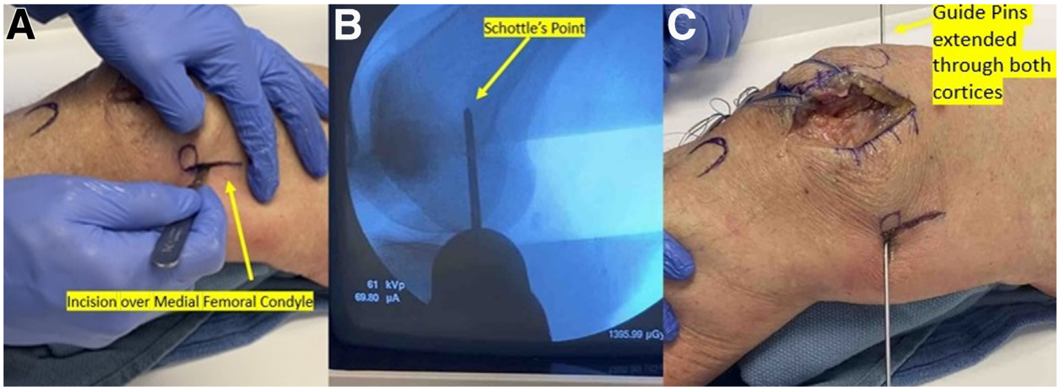

Fig 5. (A) Medial incision to get to Schöttle's point. (B) Fluoroscopy to identify Schöttle's point. (C) Guide pin through both cortices.

passing stitch, the flat "tail end" of the passing stich, and a #2 FiberWire, which was loaded into the eyelet before anchor insertion (Fig 9). Place one limb of the graft through the looped end of the passing stich (Fig 10A) and, using the tail end the passing stitch, tighten the loop over the graft (Fig 10B). During this process, the knee is flexed to 30° while centralizing the patella and holding appropriate tension on the graft. This is then secured by placing a hemostat on the looped stitch immediately adjacent to the graft (Fig 10C and Video 1). This is then repeated with the other end of the graft.

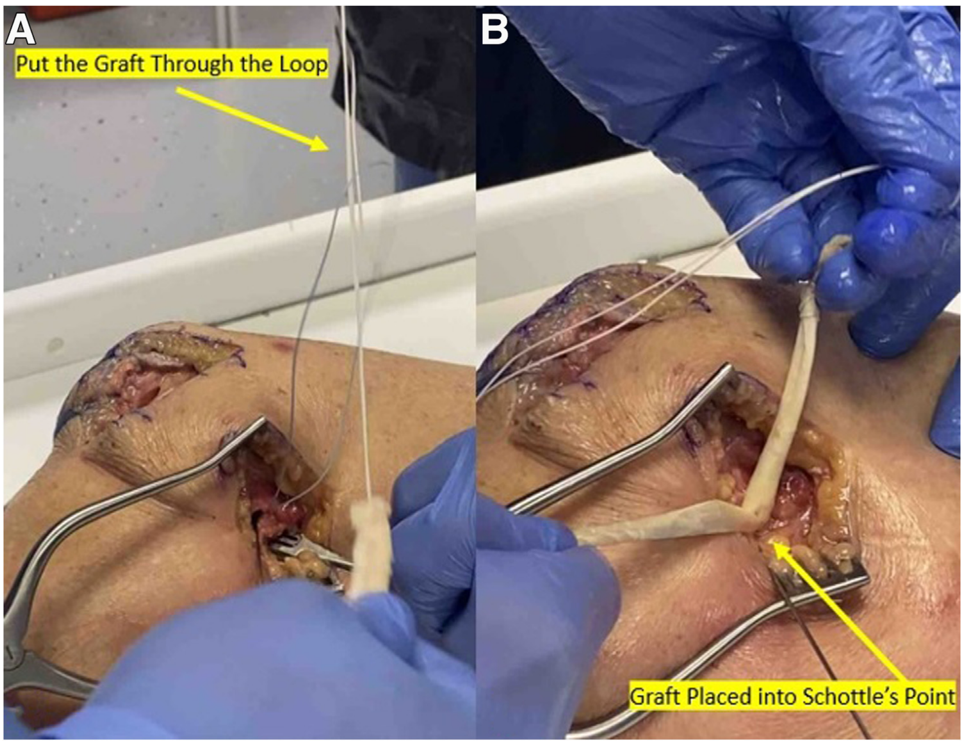

Fig 6. (A) Place the graft into the passing suture loop to pull through the femur. (B) Dock the allograft into the femoral tunnel. The 2 free ends of the graft should be exposed and free.

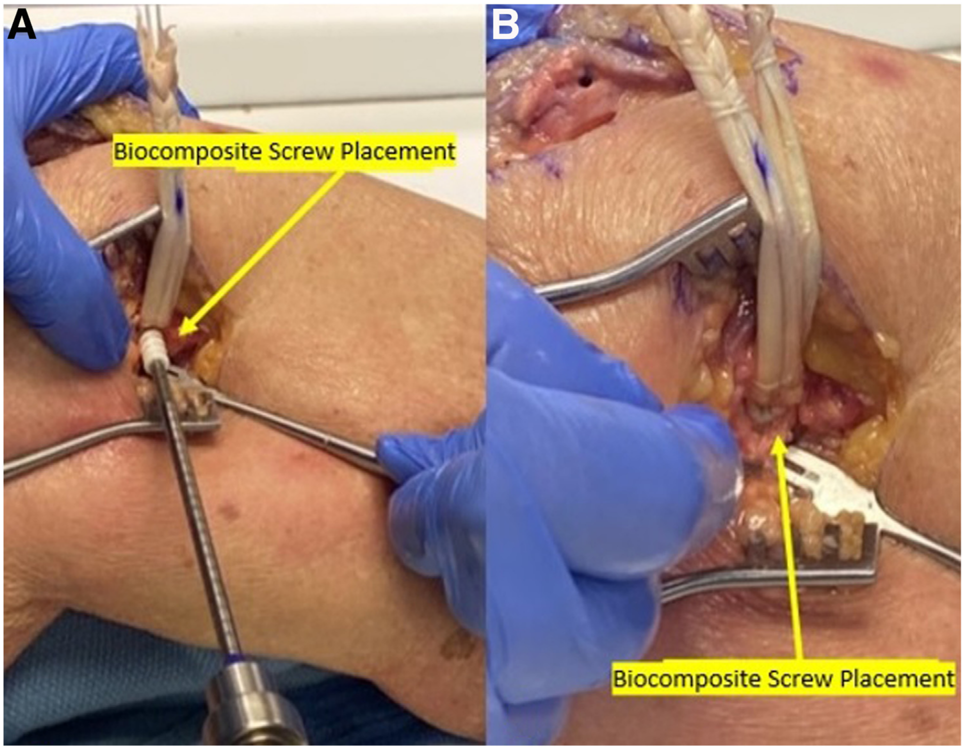

Fig 7. (A) Biocomposite screw placement over the graft into the femoral tunnel. (B) Final screw placement with the graft secure.

With both limbs of the graft temporarily secured, the knee can be taken through a range of motion and patellar tracking and translation can be assessed (Fig 11A). If the graft is too tight or loose, the hemostat can be removed, and the loop position adjusted on the graft. This can be repeated as many times as necessary and can be done independently on each limb.

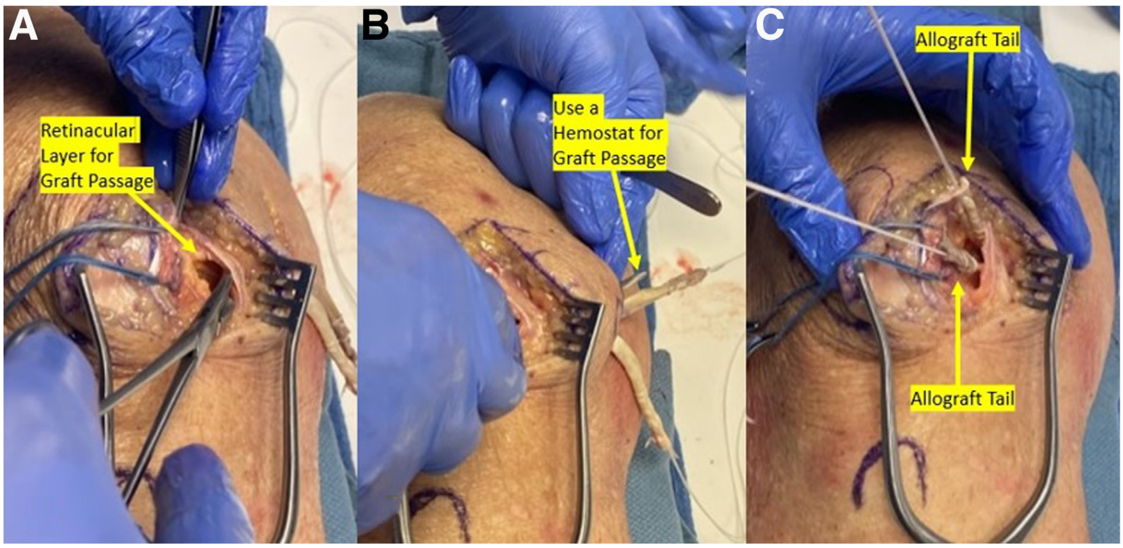

Fig 8. (A) Find the appropriate layer under the retinaculum and above the synovial layer as this is where the graft will be passed. Ensure you are not in the joint. (B) Use a hemostat to locate the graft. (C) Pull the medial patellofemoral ligament graft under the retinacular layer.

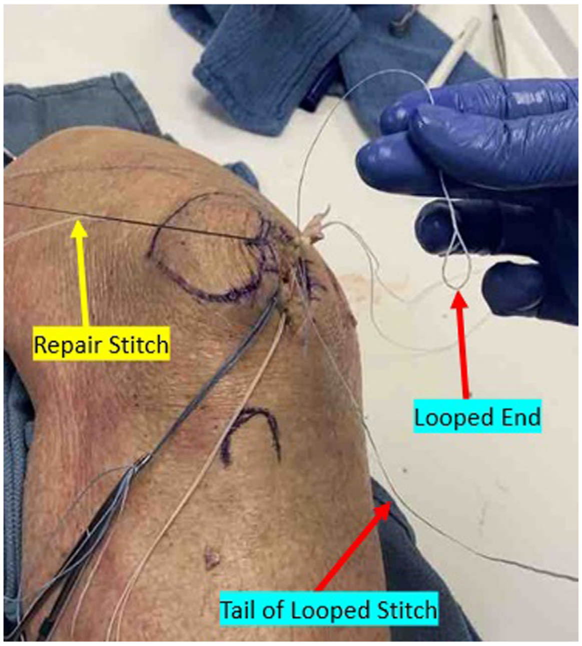

Fig 9. Suture management is a critical step. Find the loop/free end of the passing suture and the repair stitches. Both are these are part of the knotless mechanism.

When the tension is appropriate, a mark is placed on the graft at the location of the loop (Fig 11B). The marked section of the graft is where it will be secured to the patella in an onlay fashion.

Final Graft Fixation

After the tension is confirmed and the graft is marked, it's time to finalize the graft placement onto the patella. Starting with either limb, remove the loop

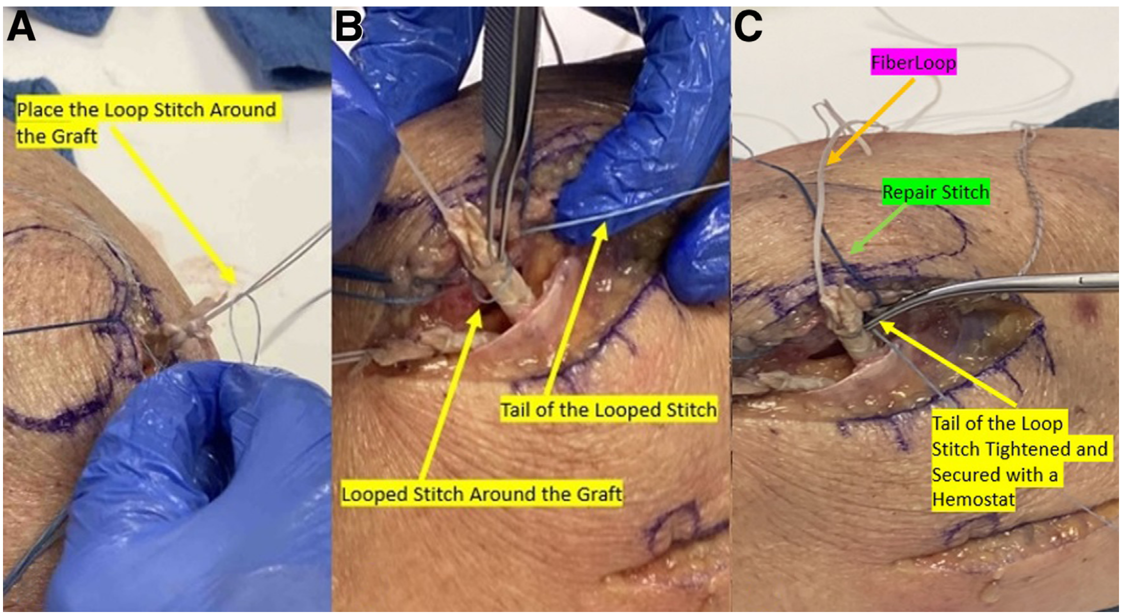

Fig 10. (A) Place the loop stitch around the graft. (B) Tighten the loop by pulling the free end of the passing suture. (C) Secure the graft tension with a hemostat.

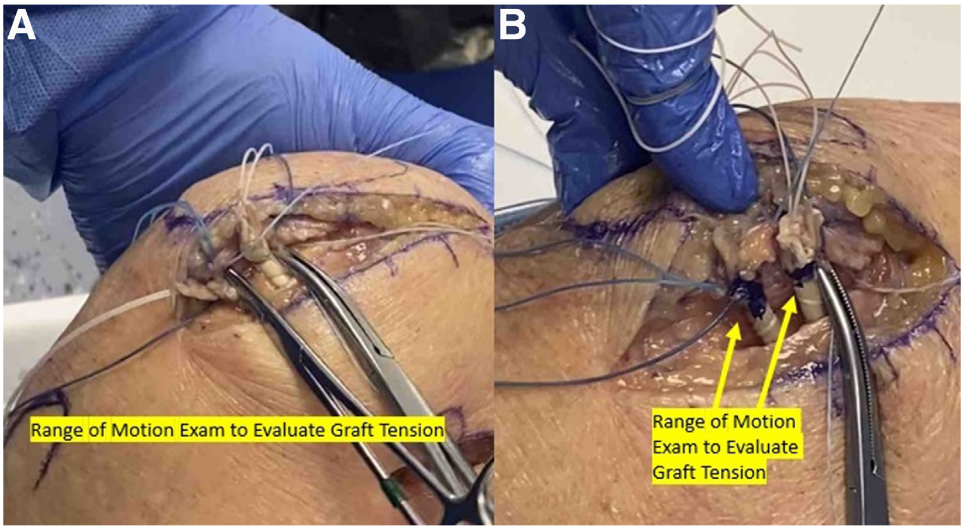

Fig 11. (A) Bring the knee through a range of motion examination to ensure the appropriate graft tension. This step is critical to assess the appropriate tension. (B) Use a marker to label where the graft tension should be placed.

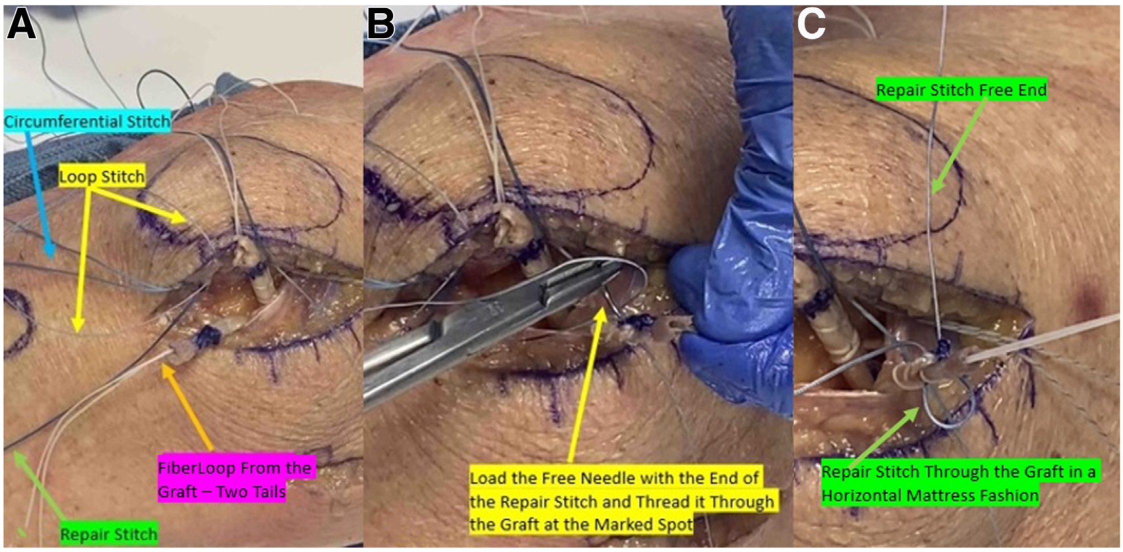

Fig 12. (A) Identify the repair stitch. (B) Load the repair stitch with a free needle. (C) Pass the repair stitch through the graft in an inverted mattress fashion.

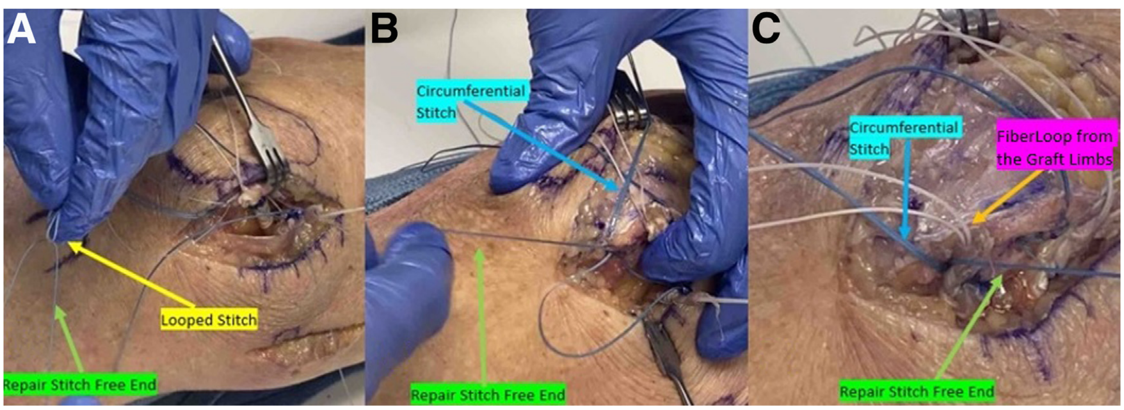

Fig 13. Place the free end of the repair stitch through the looped stitch. Pull the other end/tail of the loop stitch to tighten down the repair stitch in the anchor. The loop stitch can be discarded. Tighten down the repair stitch at this point for graft fixation. (A) Repair stitch through the loop. (B) Pulling the repair stitch. (C) Tightening down the repair stitch.

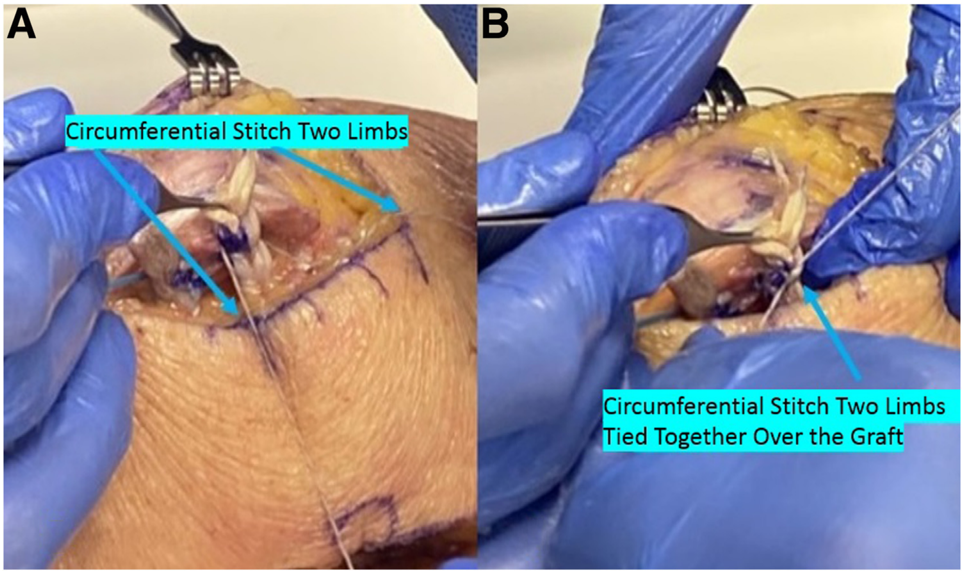

Fig 14. (A) Identify the 2 limbs of the circumferential suture. (B) Tie the circumferential stitch around the graft. This secures the graft to the patella.

off the graft (Fig 12A). Ensure that one limb of the #2 FiberWire is superior to the graft and one is inferior (these sutures will not slide). Next, place a free needle on the repair stitch and pass through the graft in an inverted mattress fashion at the marked location (Fig 12 B and C) . The repair stitch is then shuttled through the knotless fixation device per standard technique and the graft is secured to the medial side of the patella (Fig 13 A-C). The repair stitch can then be cut and the #2 FiberWire is tied over the top of the graft, providing additional circumferential fixation (Fig 14 A and B). The same technique will be performed on the second limb of the graft. Lastly, after the graft is secure and all sutures cut, the retinacular layer is

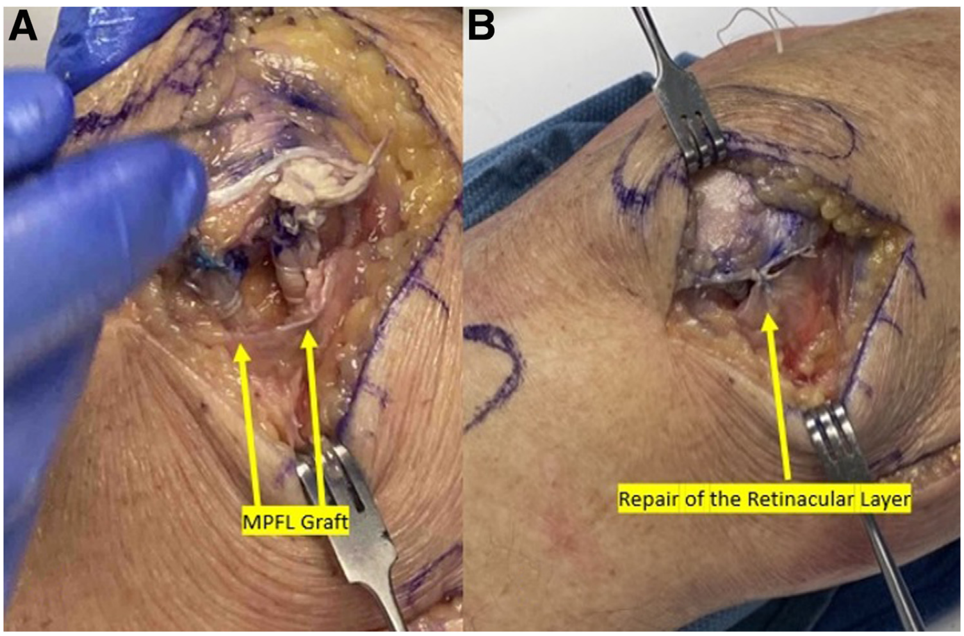

Fig 15. (A) Final graft positioning and tension. (B) Repair of the retinaculum after the graft is finalized.

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
Both limbs of the graft can be tensioned independently.	Due to the size of the anchors, there is a risk of fracture when placing the anchors within the patella.
Graft tension is assessed dynamically using an intraoperative range of motion examination under anesthesia.	
This technique uses knotless onlay fixation on the patella.	

Table 3. Pearls and Pitfalls

Pearls	Pitfalls
Use patella tracking to assess graft tension during the intraoperative knee range of motion examination. Tighten and loosen the graft as needed based on tracking.	When placing anchors, ensure they do not penetrate the cortex and damage the patella cartilage. Use radiographs if needed for assistance.
Tension each of the 2 limbs of the MPFL graft independently. Use the hemostat clamp to adjust the tension based on range of motion examination.	When passing the MPFL graft, ensure it is beneath the retinaculum and above the capsule layer.

MPFL, medial patellofemoral ligament

closed after irrigation of the wound in a standard fashion (Fig 15 A and B).

Discussion

Graft tension is the most critical aspect of the MPFL reconstruction.[8] Excessive graft tension can lead to medial patella cartilage pressure and wear, and medial patellar instability.[9] Conversely, undertensioning can lead to recurrent lateral patellar instability.[9] Using biomechanical studies, some authors note the graft should be tensioned at 2N, whereas others state 10N, leading to the current state of ambiguity regarding appropriate tension and graft failure.[9] Clinically, in the operating room, most authors note the graft should be tensioned while the knee is in 30° of knee flexion with the patella centralized because the graft is the longest in this position, but again there is significant debate about this recommendation.[4]

Obtaining appropriate graft tension is already a difficult task, and currently there is no ideal system that allows the surgeon to assess it in the operating room. Previous techniques with adjustable loop fixation allow for sequential tensioning of the femoral side of the graft, however once tensioned it is not reversible. Traditionally, this technique requires fixation of the patellar limbs into bony tunnels and has been associated with patellar fractures due to large tunnel size.[10,11]

Other authors have also described an adjustable "reverse loop" technique where a double loaded anchor is unloaded, and a loop is created which the patellar side of the graft can be passed through and re-tensioned as needed after evaluation of patellar tracking and graft tension.[12] However, this requires anchor preparation before implantation, potentially increasing operative time.

This technique has many advantages (Table 2). Both limbs of the graft can be tensioned independently and adjusted based on intraoperative evaluation prior to final fixation. It's important to tension both grafts based on the clinical examination intraoperatively (Table 3). This allows the surgeon to dynamically control the tension based on examination and adjust appropriately. Another is the benefits of knotless onlay fixation on the patella.

A disadvantage in using this technique is that placing two 4.75-mm Knotless SwiveLock anchors within the patella does have the theoretical risk of fracture. If the market offers smaller-sized anchors moving forward, one may consider using them to minimize the risk of fracture. Further biomechanical and clinical studies are needed to evaluate clinical outcomes compared with previously described surgical techniques but provides surgeons with the ability to use knotless fixation while also adjusting graft tension.

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