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Authors

Su, Favian

Hartwell, Matthew

Zhang, Alan

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Minimally Invasive Medial Patellofemoral Ligament Reconstruction With Patellar-Sided Tensioning Using All-Suture Anchors



Favian Su, M.D., Matthew J. Hartwell, M.D., and Alan L. Zhang, M.D.

Abstract: Medial patellofemoral ligament (MPFL) reconstruction is a commonly performed procedure to reestablish the checkrein to the lateral patellar translation in patients with recurrent patellofemoral instability. Graft tensioning is one of the most critical aspects of the procedure. Most surgical methods for MPFL reconstruction involve tensioning and securing the graft on the femoral side. In this article, we describe a technique for patellar-sided tensioning of the graft using all-suture anchors, which provides the surgeon with the ability to finely control graft tension with two independent graft limbs, while preserving patellar bone stock.

Patellofemoral instability is a common injury among young athletes, accounting for 3% to 7% of all acute knee injuries.¹ The medial patellofemoral ligament (MPFL) is a biomechanically important restraint to lateral patellar dislocation and provides 50% to 60% of the patellar stability during the first 30° of knee flexion.² MPFL rupture occurs with almost all patellar dislocations, and the resultant patholaxity is a frequent contributor to recurrent dislocations, chondral injuries, and long-term functional limitations.³

Although nonoperative treatment of a first-time patellar dislocation is often successful, surgery is recommended for patients with recurrent instability or patients with persistent symptoms despite conservative treatment.^{4,5} Several reconstruction techniques have been described for the treatment of MPFL rupture.⁶⁻⁸ These techniques vary in the choice of graft, method of patellar and femoral fixation, as well as the side of graft tensioning.⁹⁻¹¹ Excellent results with high patient-reported outcomes and low recurrence rates

have been reported with a variety of techniques.¹²⁻¹⁴ As such, there is currently no consensus on the optimal method for MPFL reconstruction.

This article describes a minimally invasive approach to MPFL reconstruction using all-suture anchor fixation and tensioning on the patellar side. This technique allows fine adjustments to the intraoperative tension of the MPFL and minimizes the risk of patellar fracture.

Surgical Technique

Video 1 demonstrates our technique for MPFL reconstruction. The procedure begins by placing the patient supine on a regular operating table. A foot and lateral thigh post is used to help position the leg at 90° of knee flexion (**Fig 1**). A large fluoroscopic C-arm machine is positioned on the contralateral side.

A standard anterolateral portal is made to assess chondral damage and loose bodies. During this time, an assistant can prepare a semitendinosus allograft by whipstitching both ends of the graft with a #2 nonabsorbable suture. The graft is doubled over and sized to a diameter of 7 mm. A minimum doubled graft length of 9 cm is recommended to ensure that the graft can reach from the proximal superomedial patella to Schöttle's point on the femur. The graft is then covered in a wet gauze sponge to prevent desiccation.

After the graft has been prepared, a 3-cm incision is made along the superomedial border of the patella. Dissection is carried along the bone down to the level of the capsule (**Fig 2**). The proximal half of the patella

Department of Orthopaedic Surgery, University of California San Francisco, San Francisco, California, U.S.A.

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Address correspondence to Favian Su, M.D., 500 Parnassus Ave., MU-320W, San Francisco, CA, 94143, U.S.A. E-mail: favian.su@ucsf.edu

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Fig 1. Positioning of the right knee in the supine position on a regular operating room table with a foot (*) and lateral thigh (triangle) post (underneath drapes). The C-arm fluoroscope is placed on the patient's contralateral side.

is prepared with a rongeur to remove any remaining soft tissue. A 1.6-mm Kirschner wire is inserted into the patella under lateral fluoroscopic guidance to ensure that the wire is located at the midpoint of the patella in the anteroposterior direction (Fig 3A). The drill guide for a 2.3-mm suture anchor is then placed over the wire. The wire is subsequently removed while holding the drill guide steady. A 2.3-mm, double-loaded, all-suture anchor (Iconix; Stryker, Kalamazoo, MI) is then inserted after drilling through the drill guide. A second all-suture anchor is then placed approximately 10 mm proximal to the first anchor (Fig 3B). The suture limbs from each anchor are clamped with a separate hemostat to keep the sutures from becoming intertwined.

Next, a 2.4-mm Beath pin is then positioned at Schöttle's point on the medial femur with lateral fluoroscopic guidance (Fig 4). It is crucial that the pin is positioned on a true lateral fluoroscopic view where the posterior femoral condyles overlap, as slight malrotation will lead to graft malposition. The pin is then aimed slightly proximal and anterior and drilled out the lateral femoral cortex and skin. A 3-cm incision is then made centered around the

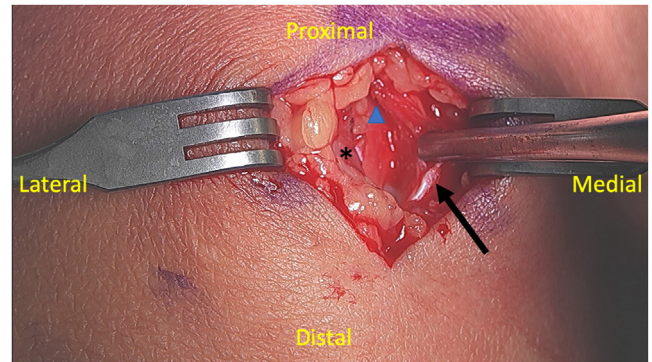
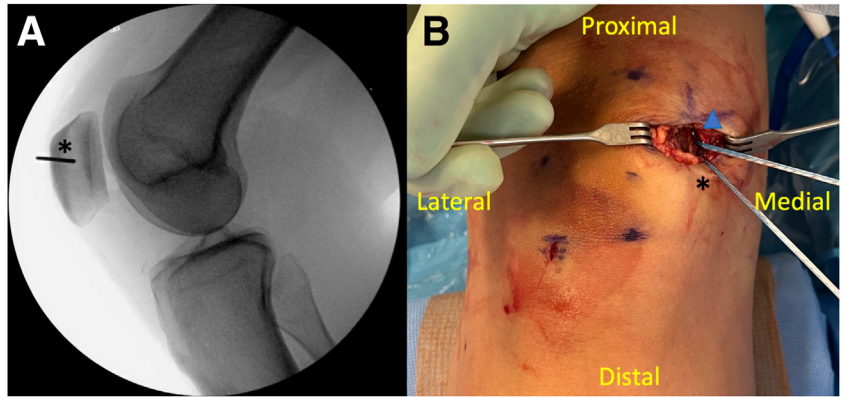


Fig 2. A 3-cm incision over the superomedial aspect of the patella (*) is sharply made down to the knee capsule (triangle). A forceps is holding onto the medial patellofemoral ligament remnant and medial retinaculum (arrow).

Beath pin and carried down to bone. An acorn reamer with a diameter equal to the diameter of the graft (7 mm) is then inserted over the pin and drilled down to a depth of 25 mm. The graft is then folded in half over a no. 2 nonabsorbable passing suture. The free ends of this passing suture are placed in the Beath pin until the graft was ~1 cm away from the pin (Fig 5A). This ensures that the passing suture ends do not get lost in the femoral tunnel. The pin is subsequently pulled out of the lateral thigh along with the passing suture. The passing suture ends are then pulled tight to bring the doubled-over graft into the blind femoral tunnel. With maximal tension placed on both suture ends, a polypropylene sheath followed by a 7-mm screw (Intrafix Advance PP Sheath and PEEK Screw; DePuy Mitek, Raynham, MA) is inserted into the anterior aspect of the femoral tunnel to fix the graft to the femur (Fig 5B). The passing suture is removed by pulling on one limb or by cutting it flush with the skin.

At this point, a Kelly clamp is passed just superficial to the capsule from the patellar incision to the femoral incision (Fig 6). The clamp is opened to create a soft tissue tunnel. The sutures whipstitched to the ends of the graft are grasped, and the graft is passed through the soft tissue tunnel and out the patellar incision. The knee is then placed in 30° of flexion with a towel bump. An assistant can then hold the ends of the graft taut along the medial patellar border (Fig 7A). The patella should be held firmly in the center of the trochlear groove with neutral tilt. A free needle with a suture limb from the inferior anchor is used to pass 3 Krakow stitches through the graft at the level where the graft meets the anchor. It is critical not to pass these stitches too far from the anchor, as it could

Fig 3. Patellar fixation of the 2.3-mm, all-suture anchors. (A) Anchor placement of the patella is confirmed under lateral fluoroscopic guidance. The first anchor (*) should be placed in the superior half of the patella and in the center of the patella in the anteroposterior direction. (B) A second anchor (triangle) is deployed ~1 cm proximal to the first anchor.



overtension or undertension the graft. The suture post of the corresponding color is then passed once through the graft. The other 2 suture limbs from the anchor are passed in a simple fashion through the same end of the graft. This process is repeated for the superior anchor suture limbs and the other end of the graft (Fig 7B). After all the sutures are passed, the post of the sutures used for the running Krakow from each anchor are pulled to reduce the graft to the patella at the desired tension. The 4 sets of sutures are then tied (Fig 8). Patellar stability is confirmed by

having a firm endpoint to lateral translation of the patella at 30° of flexion and normal tracking through the entire range of motion. Excess graft is then trimmed.

Advantages and disadvantages (Table 1), as well as pearls and potential pitfalls (Table 2), of this technique are summarized.

Postoperative Rehabilitation

After surgery, the patient is allowed to weight bear as tolerated with a hinged knee brace locked in extension. The brace can be unlocked from 0° to 40° flexion for range of motion exercises during the first 2 weeks. Subsequently, knee flexion can be increased by 10° each week with a goal of reaching 90° flexion by 6 weeks after surgery. At this phase, the knee brace and crutches are weaned. Range of motion is further increased to full extension and flexion between 6 to 12 weeks. After 3 months, the patient can advance to strengthening exercises and low-impact exercise. After 6 months, the patient can return to sport.

Discussion

Over the last decade, there have been multiple techniques described to reconstruct the MPFL. Most techniques utilize femoral-sided tensioning, in which the graft is secured on the femoral side with the use of an interference screw, button, or anchor.^{9,10,15} Determining the appropriate graft tension at the time of femoral fixation is difficult, as insertion of an interference screw or anchor can advance the graft into the tunnel and increase tension.¹⁶ Other techniques with adjustable loop button fixation allow for sequential tensioning of the femoral side of the graft, but is not reversible once the tension is applied.¹⁷ Femoral-sided tensioning is further complicated by

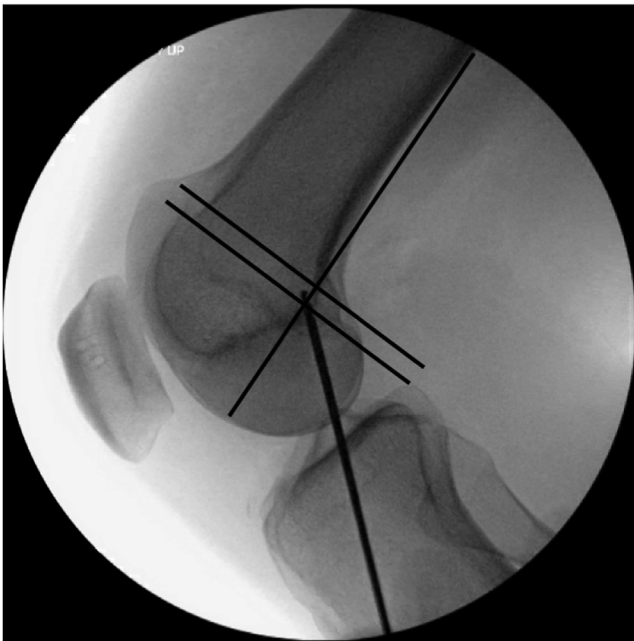


Fig 4. Confirmation of the femoral insertion of the MPFL. A 2.4-mm Beath pin is placed on Schöttle's point using a true lateral fluoroscopic view of the femur.

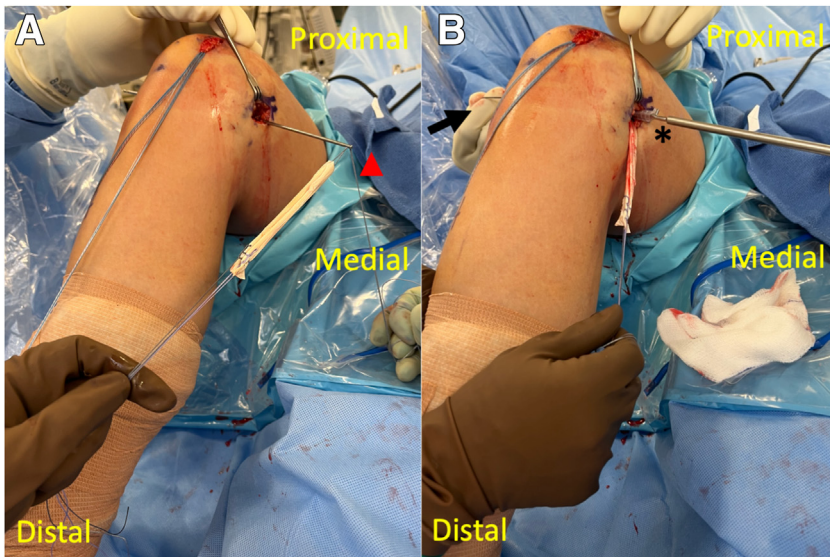


Fig 5. After a 7-mm cannulated reamer is used to drill a 25-mm femoral tunnel over the Beath pin. (A) The passing suture (triangle) of a doubled-over semitendinosus graft is placed into the Beath pin eyelet until the graft is ~1 cm away from the pin. (B) Tension is applied to the passing suture (arrow), while an Intrafix Advance PP Sheath (*) and PEEK screw (not shown) are inserted to secure the graft (DePuy Mitek, Raynham, MA).

the fact that both graft limbs are secured at the same time, limiting the surgeon's ability to make fine adjustments to graft tension with each individual limb.

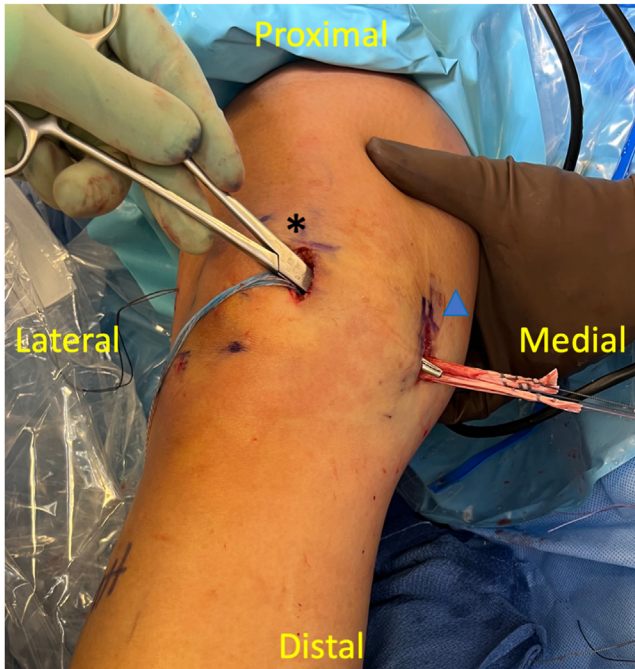


Fig 6. A large Kelly clamp is passed from the patellar incision (*) between capsule and medial retinaculum layers to grasp the semitendinosus graft from the femoral incision (triangle).

In contrast to these described techniques, our current method of patellar-sided tensioning allows the surgeon to finely calibrate the amount of tension by passing sutures into the graft at the desired level. This allows both limbs of the graft to be tensioned independently and adjusted on the basis of patellar tracking and lateral translation intraoperatively. We believe this method minimizes the technical errors of undertightening and overtightening the graft, which can lead to recurrent lateral patellar instability and the development of stiffness and patellofemoral arthrosis, respectively.^{18,19}

In our review of the literature, there were previously described MPFL reconstruction techniques utilizing a patellar-sided tensioning method.^{11,20} However, the strategies for surgical exposure and graft fixation varied substantially from the technique presented here. In our current technique, the MPFL origin and insertion are exposed using small incisions, which improves cosmesis and limits the amount of soft tissue dissection. Moreover, femoral fixation was obtained using a sheath-and-screw construct, which has been demonstrated to have higher yield strength and lower cyclical displacement for soft tissue graft fixation compared to the interference screws used in the other techniques.²¹ Finally, our use of 2.3-mm all-suture anchors obtains strong initial fixation and preserves bone stock, which may potentially minimize the risk of patellar fractures. Satalich et al. described a patellar-sided tensioning technique that utilizes 4.75-mm knotless SwiveLock anchors (Arthrex,

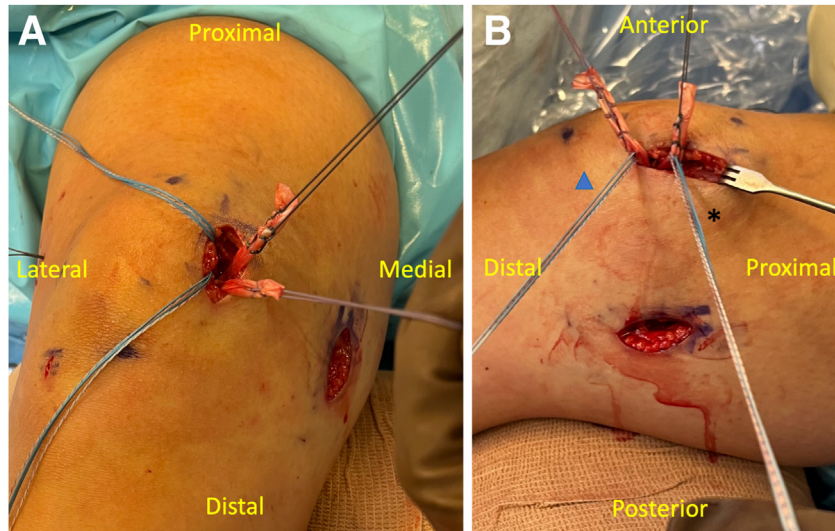


Fig 7. (A) The graft limbs are held taut by an assistant next to the suture anchors. The knee is held in 30° flexion using a bump. (B) Sutures from the proximal anchor (*) are passed through the superior graft limb using a free needle, while sutures from the distal anchor (triangle) are passed through the inferior graft limb.

Naples, FL) for patellar fixation.²⁰ In a recent systematic review of MPFL patellar fixation techniques, no patellar fractures were observed when sockets were less than 4 mm.²²

In conclusion, we present a minimally invasive MPFL reconstruction technique with patellar-sided tensioning. This simplified technique improves

surgeon flexibility by allowing for fine adjustments to the tension of each graft limb. Further biomechanical and clinical studies are warranted to evaluate the outcomes of MPFL reconstruction with patellar-sided tensioning compared to femoral-sided tensioning.

Disclosures

The authors report the following potential conflicts of interest or sources of funding: A.Z. reports consulting fees from Stryker Corporation and DePuy Mitek, outside the submitted work. Full ICMJE author disclosure forms are available for this article online, as [supplementary material](#).

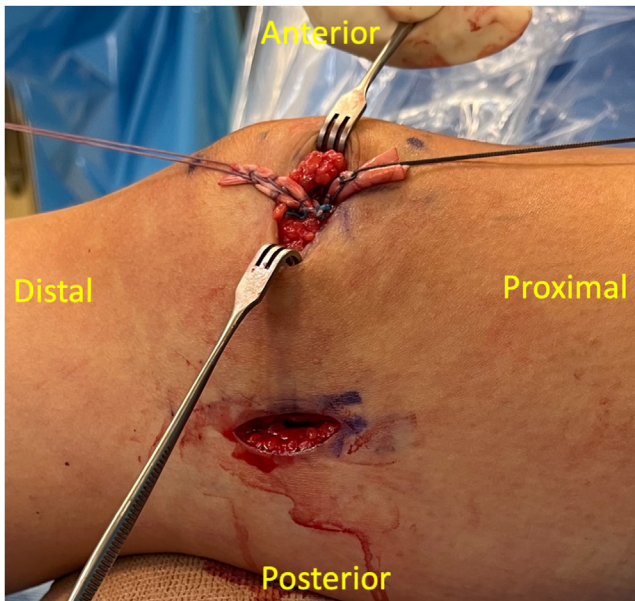


Fig 8. The graft is brought down to the patella and secured. Patellar stability was assessed by confirming a firm endpoint to lateral translation at 30° flexion and normal tracking through the entire range of motion. Excess graft was then trimmed (not shown).

Table 1. Advantages and Disadvantages

Advantages	Disadvantages
<ul style="list-style-type: none"> • Small incisions • Patellar-sided tensioning allows for fine adjustment of graft tension. • All-suture anchors are small and minimize risk of patella fracture without compromising fixation strength. • Femoral fixation with sheath-and-screw construct allows for strong initial fixation for soft tissue grafts • Allograft eliminates donor site morbidity and surgical time, while allowing for selection for a larger diameter graft. 	<ul style="list-style-type: none"> • Lack of biomechanical and clinical studies to support patellar-sided tensioning over femoral-sided tensioning • Unknown clinical implication of perianchor cyst formation associated with all-suture anchors in the patella • Asymmetric tensioning of the two graft limbs may cause medial-lateral motion of the patella with knee range of motion.

Table 2. Pearls and Pitfalls

Pearls	Pitfalls
<ul style="list-style-type: none"> • Use fluoroscopy to ensure that the anchors are in the superior half of the patella and in the midpoint of the patella in the anteroposterior direction to minimize the risk of fracture. • Pass the sutures from the anchors into the graft at the level of the anchor with the patella held in the center of the trochlear groove and in neutral tilt. • Tension the inferior graft limb first and assess patellar translation and tracking. Fine adjustments to the tension of the superior graft limb can be made based on the assessment. 	<ul style="list-style-type: none"> • Avoid passing the sutures from the anchors into the graft too far from the anchor to avoid undertightening and overtightening the graft. • Asymmetric graft limb length at the time of femoral fixation may result in one limb being too short to reach MPFL attachment on patella. A graft length of 18 cm is recommended. • Drilling the two suture anchors in a convergent fashion may result in breakage of the bone bridge between the two anchors. Fluoroscopic guidance is recommended to ensure the anchors are parallel.

MPFL, medial patellofemoral ligament.

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