Technical Note

Medial Collateral Ligament Reconstruction With Dual Adjustable-Loop Suspensory Fixation: A Technique Guide

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Abstract: The purpose of this technique paper is to outline a minimally invasive technique using dual suspensory fixation with adjustable-loop devices for reconstruction of the superficial medial collateral ligament. The femoral fixation is performed through a limited approach at the anatomic origin of the medial collateral ligament, a socket is prepared, and the graft is docked using the adjustable-loop suspensory fixation. The tibial socket is prepared through a separate incision just distal to the pes anserine tendons and drilled medially to laterally perpendicular to the tibial shaft. The graft is tunneled and docked into the tibial tunnel using adjustable-loop cortical suspensory fixation on the far cortex. The knee is cycled through a full arc of motion and stressed in valgus to take initial creep out of the construct. The knee is placed in 30° of flexion and slight varus and final tension is applied to both the femoral and tibial side. With this technique, fixation can be completed with a minimally invasive incision and it allows the ability to tension the graft both on the femoral and tibial side to the desired level, providing a significant advantage over previously used interference screw techniques.

The medial collateral ligament (MCL) is the most commonly injured ligament of the knee, and high-grade tears are often accompanied by other pathology including anterior cruciate ligament and meniscal injuries. Surgical reconstruction is often indicated with grade 3 injuries, chronic tears with valgus instability, or in multiligamentous knee injuries.[1-6] Traditional MCL reconstruction techniques describe an extensile medial approach and interference screw fixation of the graft. Several newer techniques have been described over the past 10 years using anatomic principles and suspensory loop fixation.[5-9]

This report describes a minimally invasive technique that provides an outstanding method for tensioning using adjustable-loop suspensory fixation devices for both femoral and tibial fixation of the superficial MCL (Video 1, Tables 1-3).

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Surgical Technique

Patients are positioned in the supine position after the induction of general anesthesia. Examination under anesthesia is performed taking careful attention to document valgus instability in flexion and extension, recurvatum, and any posteromedial rotation indicating a posterior oblique ligament injury. Stress radiographs are taken in valgus at 0 and 30° of flexion to document medial instability and gapping of the joint line (Fig 1).

Diagnostic knee arthroscopy is performed to address intra-articular pathology. Cruciate ligaments are reconstructed, and meniscal pathology is addressed appropriately at this point.

Autograft or allograft is acceptable for MCL reconstruction depending on surgeon and patient preference. We typically prefer allograft due to size, predictability, and lack of donor site morbidity. Graft preparation—preferably using tibialis anterior or Achilles allograft—is completed sterilely on the back table by the assistant during the diagnostic arthroscopy. A minimum graft length of 150 mm is taken to ensure adequate

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Table 1. Surgical Steps for Medial Collateral Ligament Reconstruction Using Dual Suspensory-Loop Fixation

Step	Description	Key Points
Setup	Supine position with thigh tourniquet and lateral thigh post.	Have preoperative imaging available intraoperatively.
Examination under anesthesia	Assess medial opening to valgus stress in extension and 30° of flexion; assess collateral ligament stability.	Use fluoroscopy to compare pre- and postoperative medial opening with valgus stress.
Arthroscopy	Perform full examination and address intra-articular injuries and cruciate ligament reconstructions prior to MCL reconstruction.	The assistant should begin graft preparation here to save intraoperative time. If combined with ACL reconstruction, do not fully tension ACL prior to MCL reconstruction.
Graft preparation	Prepare preselected Achilles or tibialis anterior allograft with suspensory-loop at both terminal ends, pretension graft, and measure length and end diameters.	Goal size: >150 mm in length; 6-7 mm tibial and 7-8 mm femoral diameters.
Femoral preparation	Identify isometric point on tibia. Drill spade-tip guide pin from isometric point out the lateral femoral cortex, aiming proximally and anteriorly. Ream desired diameter socket depth to 50-65 mm and place passing suture.	Do not breach lateral cortex with the larger sized reamer.
Tibial preparation	Identify MCL insertion on tibia (6-7 mm distal to joint line). Drill spade-tip guide pin perpendicular to the tibial shaft, aiming slightly anterior to exit through anterior compartment. Ream socket to graft diameter and place passing suture.	Do not breach lateral cortex with larger sized reamer.
Graft placement	Pass graft into femoral socket, flip button on lateral cortex, and bring ~15 mm of graft into the femoral socket. Pass graft underneath the skin, along the medial joint, and underneath the pes anserine to the tibial socket. The button is flipped on the lateral cortex of the tibia and the graft is then brought into the tibial socket.	Use fluoroscopy to confirm button is flipped on lateral cortex of femur and tibia with no soft tissue interposition.
Tensioning the graft	Remove slack by tensioning both sides back and forth. Cycle the knee through flexion and extension with a gentle valgus stress. Re-tension both sides of the graft at 30° of flexion and slight varus.	Take final fluoroscopic stress views.

ACL, anterior cruciate ligament; MCL, medial collateral ligament.

extraosseous length, which is typically 100 to 110 mm. Graft diameter depends on the allograft but is generally 7 to 9 mm on the femur and 6 to 7 mm on the tibia (Fig 2). An ACL TightRope (Arthrex) is applied to both terminal ends of the graft using a FiberTag (Arthrex) technique. The graft is pretensioned after button assembly and measured for length and end diameters, noting the length of the suture on either end to reference how much graft is in each socket on tensioning. In addition to the lead suture, which allows for pulling the button through the tunnel, a separate suture is placed in the trail end of the button to facilitate button flipping on the outside of the cortex. The adjustable-loop construct is lengthened to allow for adequate length for button passage across the tunnel prior to the graft entering the tunnel.

We begin the procedure by identifying the MCL isometric point on the femur fluoroscopically using the intersection of a line drawn from the posterior cortex of the distal femur as it intersects the Blumensaat line, as previously described by Wijdicks et al.[7] (Fig 3A). A small incision is made, and dissection is carried down to

Table 2. Surgical Pearls and Pitfalls of Dual Suspensory Fixation for Superficial Medial Collateral Ligament Reconstruction

Pearls
Use preoperative imaging to determine other intraarticular pathology and plan to address these pathologies in conjunction with sMCL reconstruction.
Confirm there is no medial rotatory component that may require a reconstruction of the posteromedial corner, not just the sMCL.
Use a spade-tip guide pin, which prepares the far cortex for passage of the button.
Ream the femoral socket to a depth of 50-65 mm. This will keep the graft from bottoming out during the tensioning process and will allow room to fully tighten the construct.
Cycle the knee through flexion and extension and stress with valgus to remove creep from the construct. Then re-tension both sides in 20° to 30° of flexion and slight varus until adequate tension is achieved.
Pitfalls
Overtensioning the sMCL in a combined lateral-sided ligamentous injury. This can place the patient in varus.
Breaching the lateral cortex of the femur or tibia when reaming sockets.
Not providing adequate socket depth to allow for complete tensioning of the graft.

sMCL, superficial medial collateral ligament.

Table 3. Advantages and Disadvantages of Dual Suspensory Fixation for Superficial Medial Collateral Ligament Reconstruction

Advantages
Minimally invasive technique.
Suspensory adjustable-loop fixation allows for tensioning on both sides of the joint and adjustment of the graft amount in each socket.
Ability to re-tension the graft after initial fixation to remove creep.
Disadvantages
Does not address the deep medial collateral ligament or posterior oblique ligament in the setting of more severe injuries.

the medial epicondyle (Fig 3B). A 4-mm spade-tip guide pin is placed at the isometric point of the femur and advanced out the lateral aspect of the femur. In most circumstances, this procedure is done in conjunction with other ligament reconstructions, so we have found it advantageous to aim the trajectory of the pin proximally and anteriorly to avoid other reconstruction tunnels. A 2.4-mm pin can be used, but the surgeon must remember to over-ream with a 4-mm reamer to allow passage of the button. Based on the size of the graft, the socket is created by using standard tenodesis reamers to the desired diameter and depth (Fig 4A). When possible, we recommend drilling up to but not through the far cortex to allow adequate room for graft tensioning and docking. Careful attention to not breach the lateral cortex with the larger reamer is recommended to allow an adequate bridge for the cortical suspensory device (Fig 4B). After preparing the socket, a passing suture is placed in the femur (Fig 4C).

The tibial socket is prepared in a similar fashion. A longitudinal incision over the pes anserine and just distal is made. The insertion of the semitendinosus is identified, and blunt dissection is carried out to create a path for the graft underneath the pes tendons (Fig 5A). A 4-mm spade-tip guide pin is drilled perpendicular to the tibial shaft, starting just distal to the insertion of the

Fig 1. Intraoperative fluoroscopic anteroposterior valgus-stress view of the right knee showing medial joint line gapping indicating medial collateral ligament incompetence during preincision examination under anesthesia.

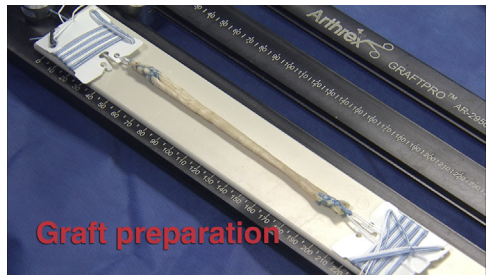

Fig 2. Prepared allograft tendon measured at approximately 150 mm for reconstruction of the superficial medial collateral ligament using a minimally invasive technique.

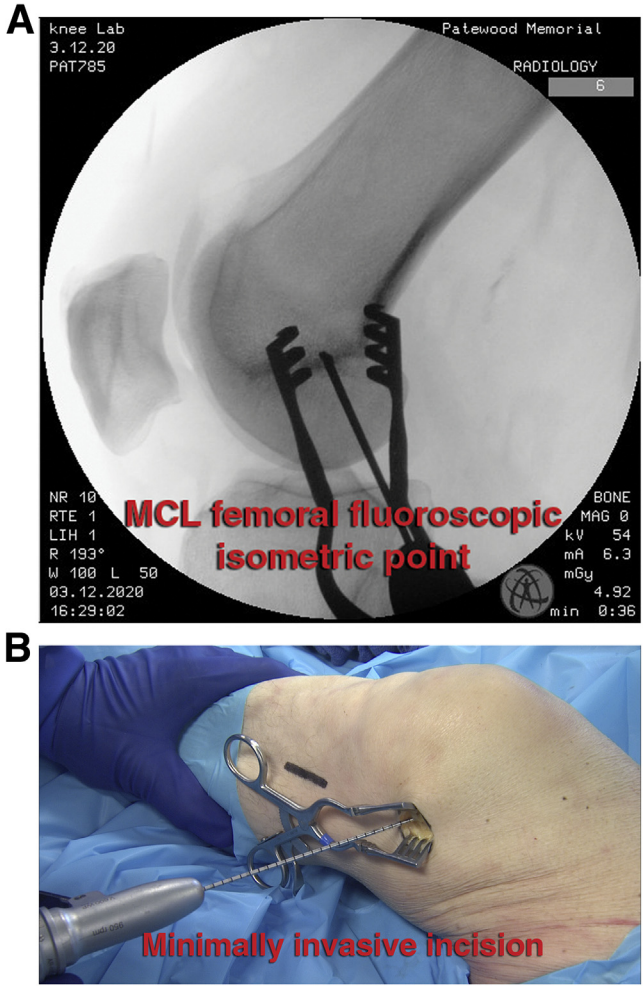

Fig 3. (A) Fluoroscopic lateral view of the right knee identifying the isometric point of the femur at the intersection of the posterior cortex of the femur and the Blumensaat line. This will be the starting point for the femoral socket. (B) Intraoperative photograph of the right knee showing the minimally invasive incision for the femoral tunnel of the medial collateral ligament (MCL) reconstruction.

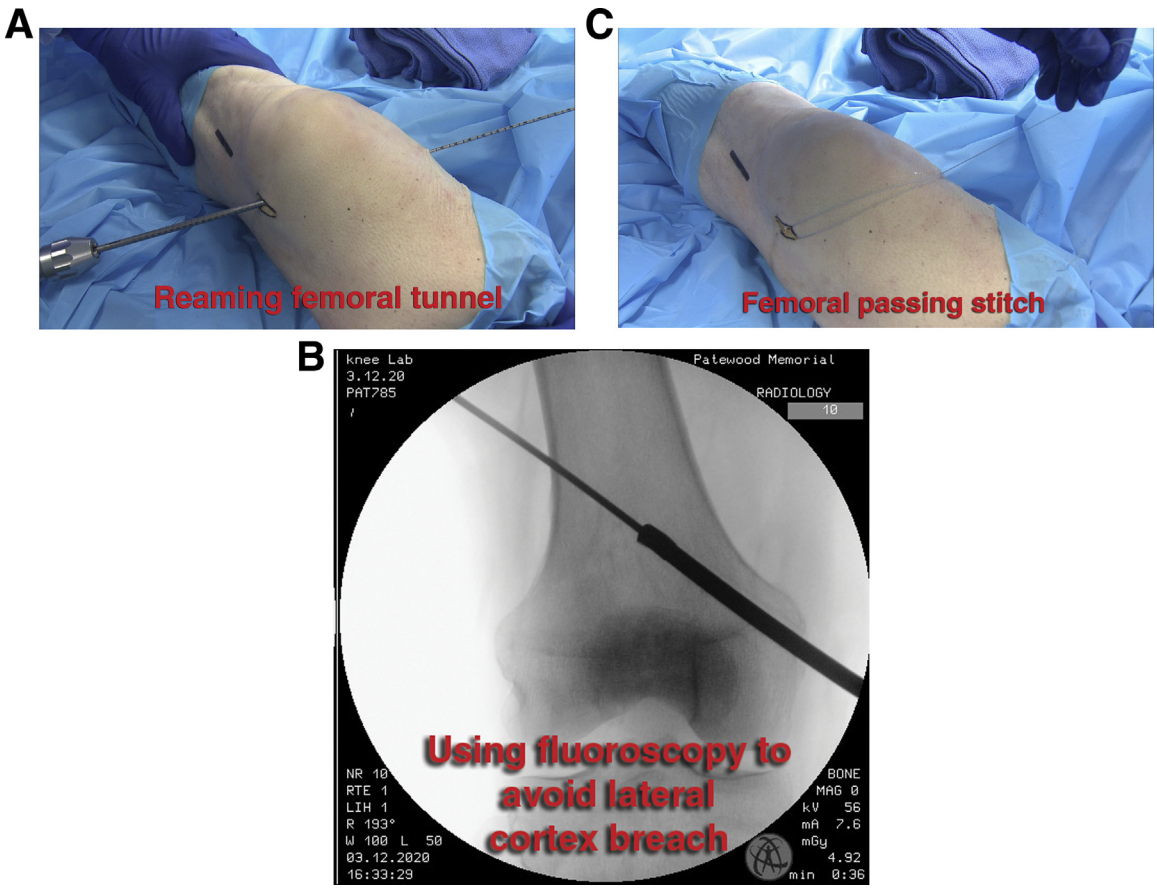

Fig 4. (A) Intraoperative photograph of the right knee showing the reamer passing over the spade-tip guide pin starting at the isometric point of the femur and aiming proximally and anteriorly to avoid concomitant reconstruction tunnels. (B) Anteroposterior fluoroscopic view of the right knee showing the reaming trajectory over the spade-tip guide pin of the femoral socket, taking care not to breach the lateral cortex. (C) Intraoperative photograph of the passing stitch placed through the femoral tunnel to allow for passing of the graft later in the technique.

semitendinosus in the center of the superficial MCL footprint, typically 6 to 7 cm distal to the joint line. The guide pin exits the anterior compartment and through the skin, taking care to keep this pin anterior to avoid injury to the peroneal nerve laterally. The medial cortex is reamed to the desired diameter with a tenodesis reamer, reaming to but not through the far cortex to allow adequate cortical fixation for the button and a socket length to dock the graft to the desired tension (Fig 5 B and C).

A passing suture is placed, and the graft is brought into the femoral socket (Fig 6A). Fluoroscopy is used to confirm the button is flipped on the lateral cortex of the femur (Fig 6B). As mentioned previously, the addition of a suture placed in the trailing end of the button aids in the flipping of the button on the far cortex and is tensioned once the button exits the tunnel on the far cortex. Using the adjustable loop, approximately 15 to 20 mm of the graft is brought into the femoral socket initially, using the suture construct on the graft as a depth guide.

Blunt dissection is carried out extracapsular along the medial femoral condyle, medial tibia, and underneath the pes anserine tendons between the 2 incisions. A retrograde passing suture is passed from the tibial to the femoral incision and is used to pass the graft into the tibial tunnel site, passing underneath the pes tendons (Fig 7A). Using the tibial socket passing suture, the graft and button are shuttled into the tibial socket and flipped on the lateral cortex, again using the trail suture as needed (Fig 7B). This is confirmed fluoroscopically to ensure it is flush with the lateral cortex (Fig 7C). Care is taken to keep some tension on the graft medially to keep the button flush with the cortex on both the femoral and tibial sides while tensioning.

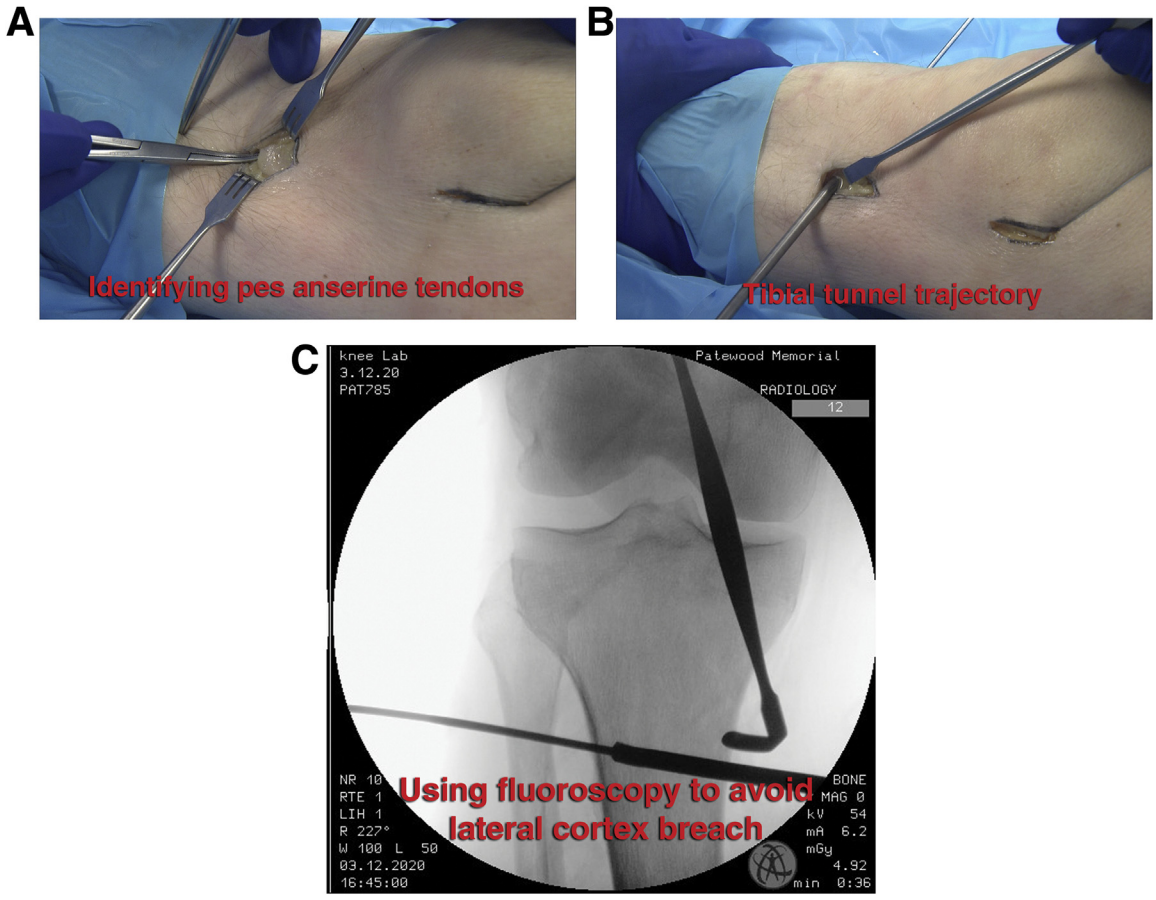

Fig 5. (A) Intraoperative photograph showing the minimally invasive tibial tunnel incision and identifying the pes anserine tendons, under which the tunnel will be drilled. (B) Intraoperative photograph showing the reamer passing over the spade-tip guide pin. (C) Anteroposterior fluoroscopic view of the right knee showing the spade-tip guide pin and reamer trajectory of the tibial socket, aiming anteriorly from medial to lateral perpendicular to the tibial shaft, taking care not to breach the lateral cortex.

For initial tensioning, the knee is placed in approximately 30° of flexion with slight varus force. Slack is removed from the system by tensioning both sides back and forth with a goal of at least 20 mm of graft in both sockets initially. The femoral socket is typically deeper and can accommodate more graft if needed for tensioning. The knee is cycled through flexion and extension and stressed multiple times with valgus to remove creep from the construct. Both sides are then re-tensioned in 20° to 30° of flexion and slight varus until adequate tension is achieved and final fluoroscopic stress images are taken (Fig 8 A and B). Wounds are irrigated and closed in standard fashion. Surgical steps for this technique can be found in Table 1.

Postoperative precautions vary based on concomitant pathology. For isolated MCL reconstruction using this technique, patients are placed into a hinged knee brace with partial weight-bearing restrictions while locked in extension and range of motion as tolerated. By 6 weeks, patients should be ambulating with at least 0 to 90° knee range of motion and depending on concomitant injuries may be able to return to most activities by 4 to 6 months.

Discussion

This technique uses the same anatomic principles as the LaPrade and Wijdicks[6] and Deo and Getgood[7] techniques, but with dual suspensory fixation for improved tensioning and fixation. The ability to re-tension the graft after cycling from both the femoral and tibial side allows creep removal and the ability to add more tension without screw pullout, resulting in a theoretically more secure final construct against stress in comparison to the Deo described technique.[6] Compared with interference screw constructs, we have been very pleased with the initial tension of this construct. Pearls and pitfalls of this technique can be found in Table 2.

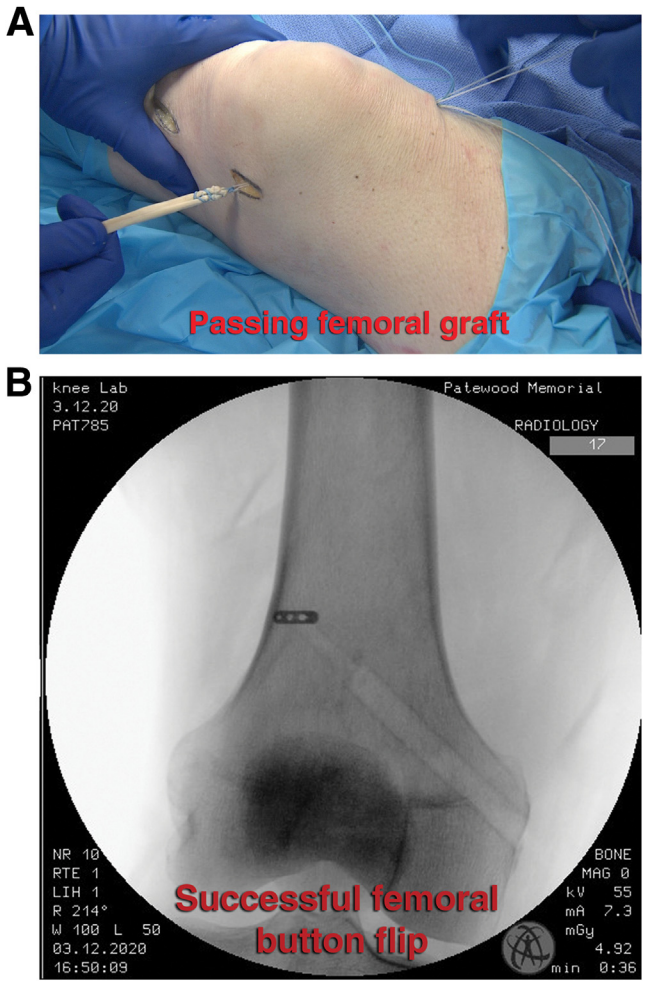

Fig 6. (A) Intraoperative photograph shows passing the graft into the femoral tunnel using the passing stitch placed in (C). (B) Anteroposterior fluoroscopic view of the right knee showing the successfully flipped cortical button of the medial collateral ligament reconstruction graft on the anterolateral femoral cortex.

Potential complications include cortical breach when reaming, the button not being flush with the cortex, or poor tension if there is graft tunnel length mismatch. Furthermore, with tibial suspensory fixation, there is a concern of iatrogenic nerve injury from drilling the tibia from medial to lateral. We have used this technique in over 25 patients and have not observed this complication. Advantages and disadvantages of this technique can be found in Table 3.

In conclusion, this technique of dual adjustable-loop cortical suspensory fixation uses anatomic principles for minimally invasive graft placement and allows for excellent tensioning of the graft intraoperatively without evidence of significant complications or failures in early follow-up.

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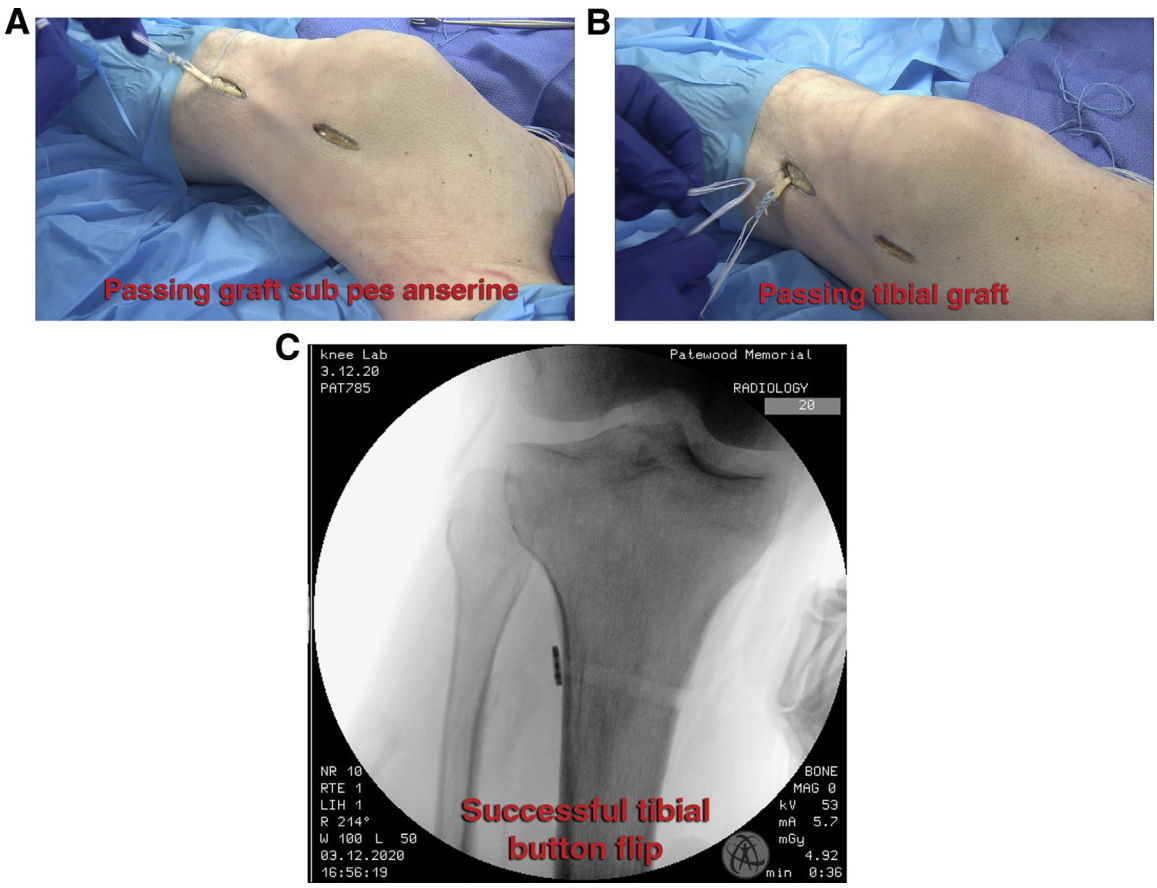

Fig 7. (A) Intraoperative photograph showing successful passing of the medial collateral ligament (MCL) graft from the femoral tunnel to the tibial incision, underneath the pes anserine tendons. (B) Intraoperative photograph shows passing the tibial portion of the MCL graft through the tibial socket using a previously placed passing stitch. (C) Anteroposterior fluoroscopic view of the right knee showing the successfully flipped cortical button of the MCL reconstruction graft on the anterolateral tibial cortex.

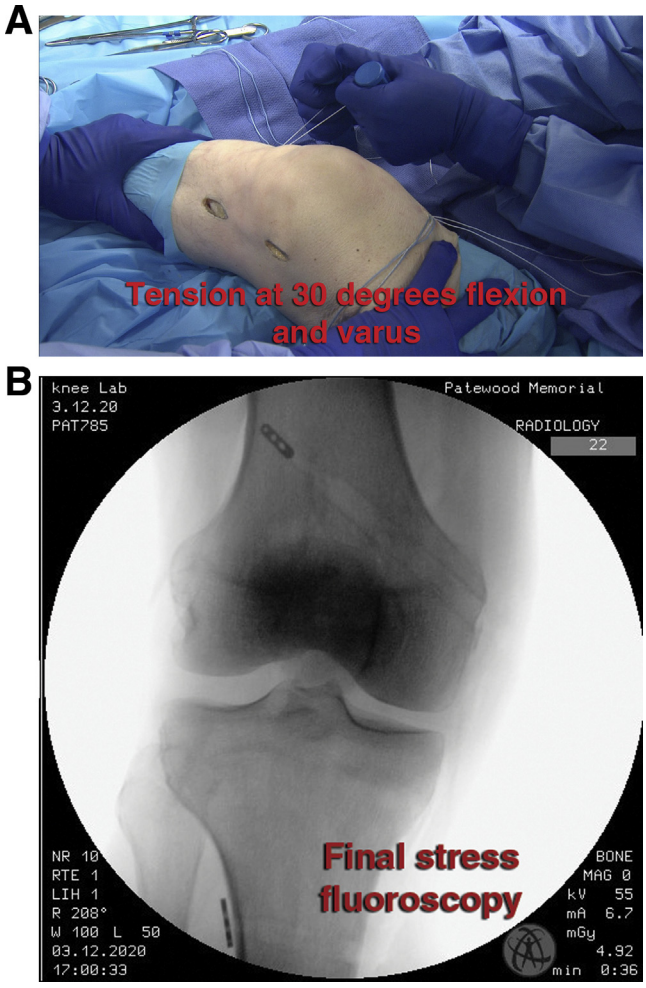

Fig 8. (A) Intraoperative photograph shows tensioning of the graft in 30° of flexion and slight varus force on the tibial side, with a goal of at least 20 mm of graft in both sockets. This process will be completed on the femoral side as well. (B) Final anteroposterior stressed fluoroscopic view of the right knee after completion of the minimally invasive, dual-suspensory fixation medial collateral ligament reconstruction showing no medial joint space widening, indicating successful tension of the graft.

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