

Combined All-Inside Anterior Cruciate Ligament Reconstruction and Minimally Invasive Posterolateral Corner Reconstruction Using Ipsilateral Semitendinosus and Gracilis Autograft

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Abstract: The anterior cruciate ligament (ACL) is the most commonly injured knee ligament, particularly among adolescents and young adults. Unrecognized posterolateral laxity is understood as a major cause of ACL reconstruction failure, and concomitant injury to the posterolateral corner (PLC) is prevalent and underdetected. We advocate screening all ACL-deficient knees for PLC injury and present a technique combining minimally invasive PLC reconstruction with anatomic all-inside ACL reconstruction. The combined procedure uses only the ipsilateral hamstring tendons representing a major surgical advantage over traditional management approaches. The semitendinosus is quadrupled and attached to 2 adjustable suspensory cortical fixation devices to form the ACL graft. The gracilis tendon is looped through the fibula head and secured in a single femoral tunnel for the PLC reconstruction via 2 minimally invasive incisions. The use of a single femoral PLC tunnel combined with a single femoral ACL socket minimizes the risk of tunnel convergence.

The knee is a complex joint routinely exposed to significant multiaxial forces, particularly during athletic activity. As a result, knee ligament injuries are common. There is increased incidence among

adolescents and young adults, as well as the growing sporting population.¹ The ACL is the most frequently injured structure.² This is often an isolated injury that can be reconstructed with high patient satisfaction and low failure rates.² The primary contributor to graft failure is unrecognized ligamentous laxity.^{3,4} Associated posterolateral corner (PLC) injury can be identified in 7.4% to 13.9% of cases.^{5,6}

The PLC is an anatomically complex region of the knee comprising capsular, ligamentous, and tendinous components. Injuries to these structures remain underreported.⁷ Biomechanical studies have shown that sectioning of PLC structures increases the tension across the ACL in varus stress and external tibial rotation.^{8,9} In addition, although not a significant biomechanical role in the ACL-intact knee, the PLC is a secondary restraint against anteroposterior translation of the tibia.⁶ This has implications on the forces experienced by an ACL graft in vivo if concomitant PLC injury is not addressed.⁸⁻¹⁰ It is therefore recommended that PLC damage should be addressed at the time of

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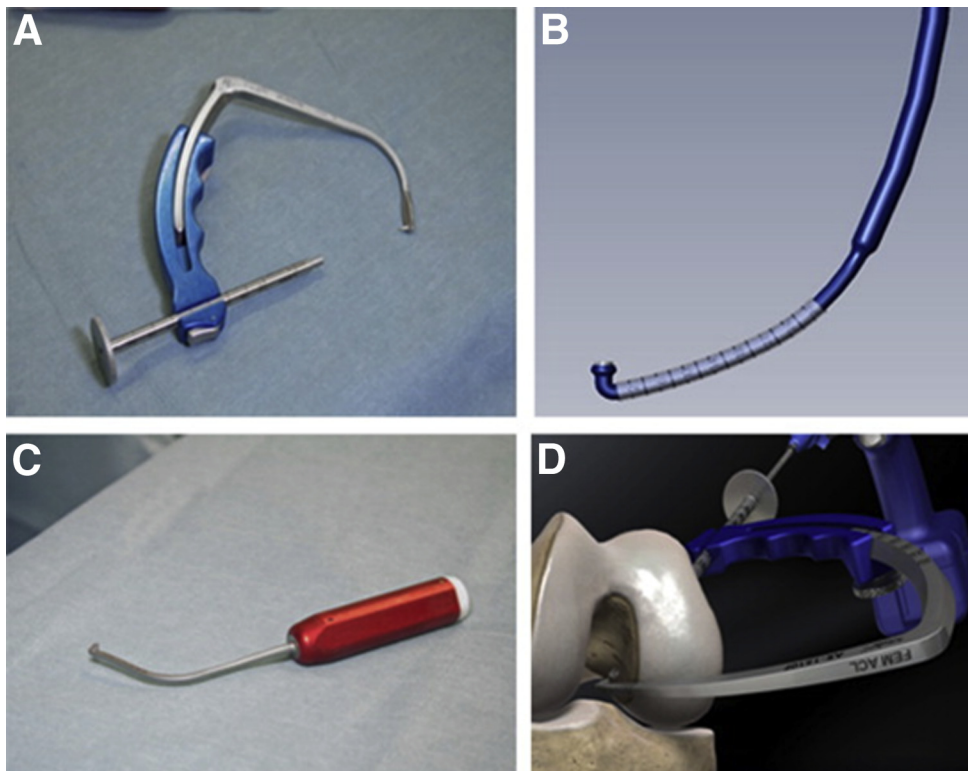


Fig 1. Instrumentation for use with the TransLateral all-inside technique. (A) FlipCutter aiming jig, used to deliver the Flip-Cutter into the knee at a point determined arthroscopically; (B) calibrated RF ablation probe, allowing simultaneous measurement and RF ablation of the soft tissues; (C) calibrated measuring/marketing tool offers an alternative to the calibrated RF device to measure the front-to-back distance and thus determine femoral socket positioning; and (D) schematic representation of femoral aiming jig and FlipCutter in situ in a left knee. (RF, radiofrequency.)

ACL reconstruction,¹⁰⁻¹² both for its direct effects on knee biomechanics and to ameliorate the risk of graft failure.

Diagnosis of PLC injury can be difficult. ACL-deficient knees should be carefully evaluated preoperatively by clinical and radiologic examination. Additional screening by examination under anesthesia before ACL reconstruction is also essential. This is performed at the beginning of the procedure as a tensioned ACL graft may partially obscure any pathologic laxity of the posterolateral structures.¹⁰ Clinical tests to aid the diagnosis include lateral laxity on varus stress, the dial test, and the external rotational recurvatum test as described by Hughston. Varus laxity is best appreciated at 30° of knee flexion and is compared to the contralateral knee. The dial test elicits increased external tibial rotation relative to the uninjured knee at 30° and 90° of flexion.³ Hughston's test shows recurvatum and external tibial rotation when the knee is passively extended.¹¹ We present a technique of an all-inside anatomic ACL reconstruction with minimally invasive PLC reconstruction (Video 1).

Surgical Technique

Specific instrumentation is required for this technique (Fig 1). A summary of required instruments is listed in Table 1. A thigh tourniquet is used throughout. The

patient is positioned supine with the knee flexed to 90° and supported with a side support and footrest. There is no need for knee hyperflexion throughout the technique. The technique begins with extra-articular dissection preparing for PLC reconstruction, as the soft tissues will become engorged following arthroscopic work. The key steps are summarized in Table 2.

Posterolateral Corner Preparation

A 20- to 30-mm longitudinal incision is made over the posterior aspect of the fibula head with the apex at its proximal tip. The common peroneal nerve (CPN) is identified and protected. Dissection is performed between the CPN and biceps femoris to access the posteromedial fibula head. The soft tissues can be manipulated to access either the anterior or posterior aspect of the fibula as required. The Arthrex PLC guide (Arthrex, Naples, FL) is inserted and a 2.4-mm guidewire passed through the fibula head from anterolateral (AL) to posteromedial parallel to the tibial slope. The tunnel is drilled to 4.5 mm, and subsequently enlarged if required. The CPN is protected throughout with a collateral ligament retractor. The mouth of the tunnel is debrided using an arthroscopic shaver, and a snaring suture is passed through the fibula head (Fig 2).

A 15-mm transverse incision is then made over the lateral femoral epicondyle. Dissection through both layers of the iliotibial band is performed to expose the origin of the lateral collateral ligament and the

Table 1. List of Requisite Instruments and Equipment

Instrument or Implant	Reason
Standard 30° arthroscope	
Thigh tourniquet	
Curved calibrated radiofrequency device (Coolcut CaliBlator; Arthrex)	Better preservation of bony landmarks compared to a shaver
ACL RetroConstruction Drill Guide Set (Arthrex)	Calibrated arm enabling direct measurement and marking of femoral tunnel placement
Tibial ACL aiming guide with marking hook	Specifically contoured instruments enabling accurate drilling without impingement on bony landmarks or patellar tendon
Femoral ACL aiming guide with marking hook	
Combined guide pin and retrograde drill (second-generation FlipCutter; Arthrex)	As popularized by “all-inside” ACL reconstruction
FiberTape (Arthrex)	Bone-preserving tibial and femoral sockets
ACL Fixation devices (Arthrex) Reverse tensioned ACL TightRopes	Used to reinforce the gracilis for use as PLC graft
PLC Fixation devices	Fixation and adjustable tensioning of ACL graft
5 × 20-mm PEEK screw for fibula head fixation	
5 × 25-mm PEEK screw for femoral fixation	
Shuttling sutures (Arthrex) FiberStick TigerStick	Fixation of PLC graft and maintenance of graft tension
	Stiffened plastic tube allows easy passage of the suture material through bone tunnels, allowing the suture to be retrieved from the opposite side

ACL, anterior cruciate ligament; PEEK, polyether ether ketone; PLC, posterolateral corner.

popliteus attachment. The femoral tunnel entry point is midway between these 2 points, equating to roughly 5 mm distal and 5 mm anterior to the lateral collateral ligament origin. A 2.4-mm guidewire is passed obliquely through the femur, and the tunnel drilled to a diameter appropriate for the gracilis graft. Again, the mouth is debrided with a shaver and a further shuttling suture is passed (Fig 3).

Graft Harvest and Preparation

The ipsilateral semitendinosus and gracilis are harvested in the standard way through an oblique incision over the pes anserinus. The gracilis is reinforced using a loop of high-strength composite polymer tape (FiberTape) and whip-stitched at both ends ready for PLC reconstruction.

The semitendinosus is loaded onto 2 adjustable suspensory devices and quadrupled. The free ends of the tendon are sutured together with a 2.0 FiberWire, and the construct is inverted such that the resulting knot is on the internal surface of the graft. The 4 strands are then whip-stitched at either end to secure the graft

shape. This forms the adjustable suspensory fixation construct for use as an ACL graft (Fig 4).¹² The graft diameter is measured to select an appropriately sized FlipCutter (Arthrex) with which to create femoral and tibial retrograde sockets.

ACL Reconstruction

A modified AL portal, slightly medial and distal to the traditional AL portal, is first created adjacent to the patellar tendon. An anteromedial portal is then established under direct vision. The procedure is performed

Table 2. Summary of Stages in Combined ACL and Posterolateral Corner Reconstruction

Operative Step	Summary
Patient setup	Supine with thigh tourniquet and knee flexed to 90° Side support and foot bolster
PLC dissection (fibula)	Posterior longitudinal incision over fibula head Tunnel drilled from anterolateral to posteromedial, parallel to tibial slope
PLC dissection (femur)	Transverse incision over lateral epicondyle and dissection through iliotibial band Femur drilled obliquely; entry point midway between lateral collateral ligament origin and popliteus attachment
Graft preparation	Ipsilateral semitendinosus and gracilis harvested Semitendinosus quadrupled and loaded onto 2 reverse tension TightRopes Gracilis reinforced with FiberTape and whip-stitched at both ends
Arthroscopic portals	Low anterolateral portal and anteromedial portal established Viewing through medial portal; working from lateral portal
Socket preparation	Radiofrequency ablation used to prepare femoral condyle Femoral ACL socket location identified and 20-mm retrograde socket created; 30-mm retrograde socket created within tibial footprint
Graft deployment (ACL)	Shuttling sutures extracted simultaneously and fixed to ACL TightRopes Femoral button deployed and graft “bottomed out” in femoral socket Graft docked into tibial socket Knee cycled and final tensioning with knee at 90°
Graft deployment (PLC)	Reinforced gracilis passed to its midpoint through the fibula tunnel and secured with PEEK screw Each limb passed deep into the iliotibial band and subsequently through the femoral tunnel Tension secured with PEEK screw with knee at 30° of flexion, valgus and neutral rotation

ACL, anterior cruciate ligament; PEEK, polyether ether ketone; PLC, posterolateral corner.

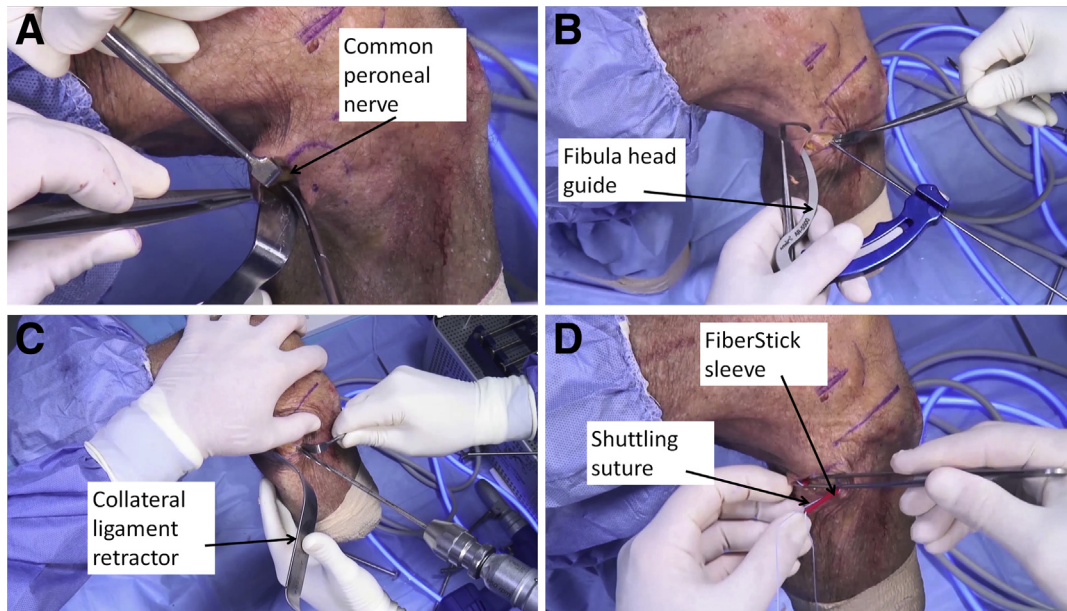


Fig 2. Dissection for posterolateral corner reconstruction—preparation of the fibula tunnel (demonstrated in a cadaveric right knee). (A) The incision is made along the posterior aspect of the fibula head and the common peroneal nerve identified. (B) The LaPrade fibula head guide is used to pass a guidewire. (C) Tunnel for graft drilled. (D) A shuttling suture is passed using a FiberStick.

with viewing through the medial portal and working from the lateral portal.

A curved radiofrequency probe is used to debride the medial wall of the lateral femoral condyle. Radiofrequency ablation allows clearance of the soft tissues while preserving the osseous anatomy, which is

essential to facilitate anatomic placement of the graft. The senior author's (A.J.W.) preference is to use the Calibrator (Arthrex), which allows simultaneous measurement and marking of the femoral position. The femoral FlipCutter aiming jig is introduced through the AL portal and centered over the chosen tunnel position.

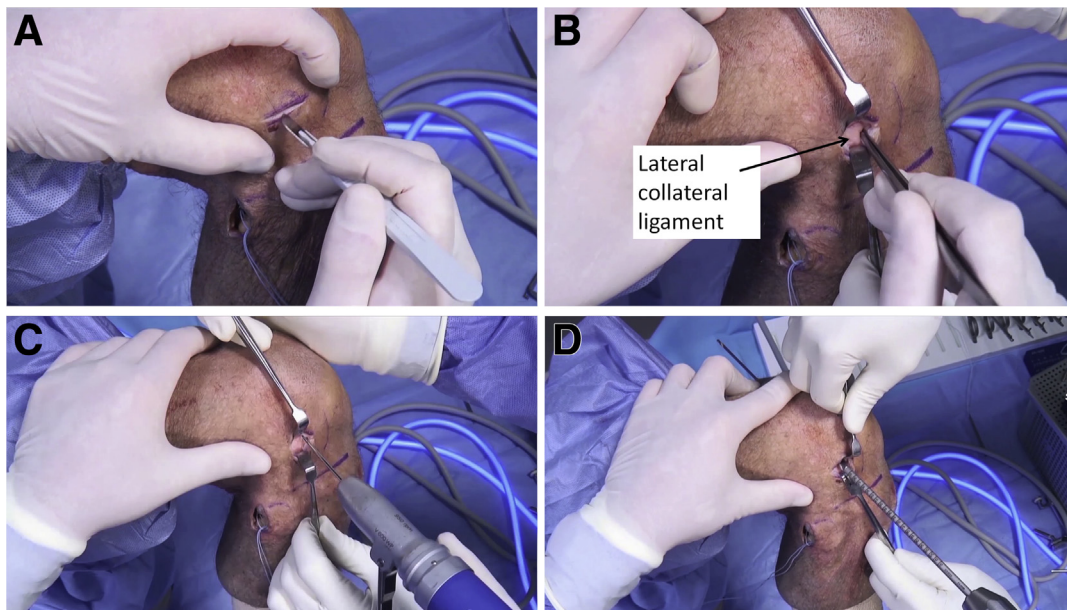


Fig 3. Dissection for posterolateral corner reconstruction—femoral socket preparation (demonstrated in a cadaveric right knee). (A) An incision is made over the lateral epicondyle and a dissection is made longitudinally through the iliotibial band. (B) The lateral collateral ligament and popliteus are identified. (C) Guidewire placed midway between these 2 structures, aiming proximally and anteriorly. (D) Appropriately sized drill for doubled gracilis graft passed.

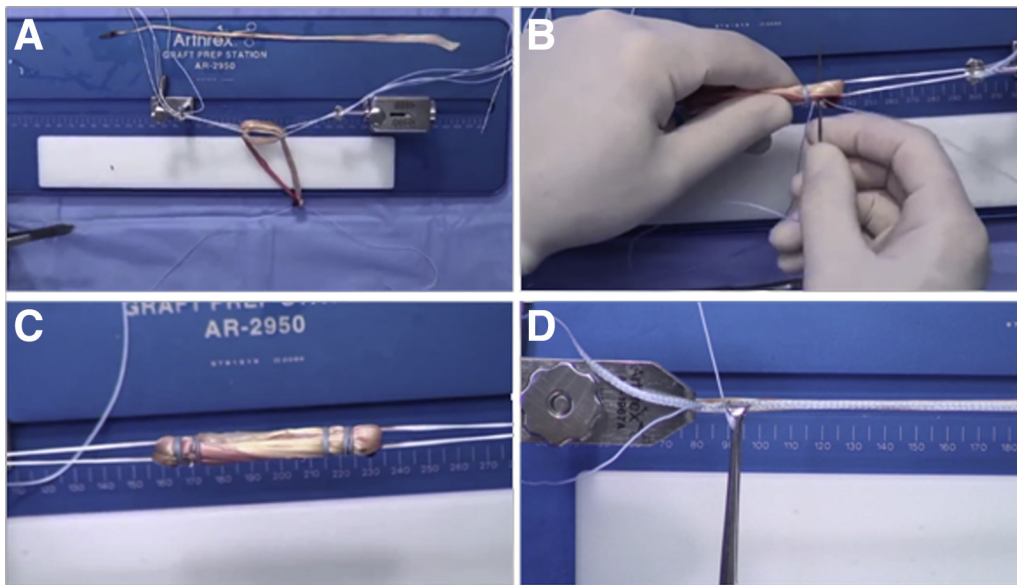


Fig 4. Graft preparation. Preparation of semitendinosus into a GraftLink construct for ACL reconstruction, and reinforcing the gracilis for PLC reconstruction. (A) The semitendinosus tendon is loaded onto 2 TightRopes, looped twice, and the ends are sutured together using FiberWire. (B) The loop of graft is then inverted, burying the knot and ensuring a streamlined profile to the graft which is whip-stitched. (C) Final appearance of quadrupled semitendinosus autograft construct with circumferential FiberWire sutures securing the shape. (D) The gracilis is reinforced with FiberTape for use as the PLC graft. (ACL, anterior cruciate ligament; PLC, posterolateral corner.)

An appropriately sized FlipCutter is drilled into the knee, the head deployed, and a 20-mm retrosocket created referencing off the laser-marked measurements on the drill sleeve. The tibial socket is similarly prepared. For this stage, viewing is through the AL portal, and the tibial aiming guide is delivered into the knee through the anteromedial portal. A retrosocket is created to a depth of 30 mm.

Passing sutures are passed through both sockets into the knee—a FiberStick on the femoral side and a TigerStick on the tibial side. A single strand of each is retrieved from the knee simultaneously to avoid any soft-tissue bridging. These passing sutures are attached to the TightRopes and allow the ACL graft to be drawn into the knee. Initially over-reducing the graft into the femoral socket facilitates docking of the tibial aspect of the graft. The femoral TightRope is deployed, and the arthroscope is passed into the lateral gutter to ensure that the button is opposed to bone without soft-tissue entrapment. The tibial TightRope is subsequently deployed and tensioned appropriately. The knee is cycled, and tensioning can be fine-tuned before cutting the TightRope cords (Fig 5).

PLC Graft Deployment

The reinforced gracilis graft is passed through the fibula tunnel. After ensuring the protruding ends are equal lengths, it is secured at its midpoint using a PEEK (polyether ether ketone) screw in the fibula. Using a curved clip, each limb is then passed deep into the

iliotibial band and out of the femoral incision, and subsequently passed through the femoral tunnel using the shuttling suture. The leg is placed at 30° of knee flexion, valgus, and neutral rotation, and the graft is tensioned and secured using a second PEEK screw at the aperture of the femoral tunnel (Fig 6).

Postoperative Rehabilitation

The patient is restricted to partial weight bearing for the initial 6 weeks. During this time, a brace is fitted for collateral support, but a free range of motion is permitted. Full weight bearing is encouraged thereafter with weaning out of the brace. Closed-chain activities may start from 2 weeks postoperatively and open-chain exercise no earlier than 3 months. Contact sports are delayed until 9 to 12 months postoperatively. Post-surgical appearance of the knee is shown in Figure 7.

Discussion

There is a paucity of literature regarding the management of combined ACL and PLC injuries.^{5,13} This is in the context of a recognition that PLC injuries occur concomitantly in a significant proportion of ACL ruptures,^{5,6} and that posterolateral laxity affects the outcomes of ACL reconstruction.^{8,9,13} Although there is an appreciation that PLC injury should be addressed at the time of ACL reconstruction,^{4,8,9,13} no consensus on surgical technique exists. A number of operative approaches have been described.^{2,14}

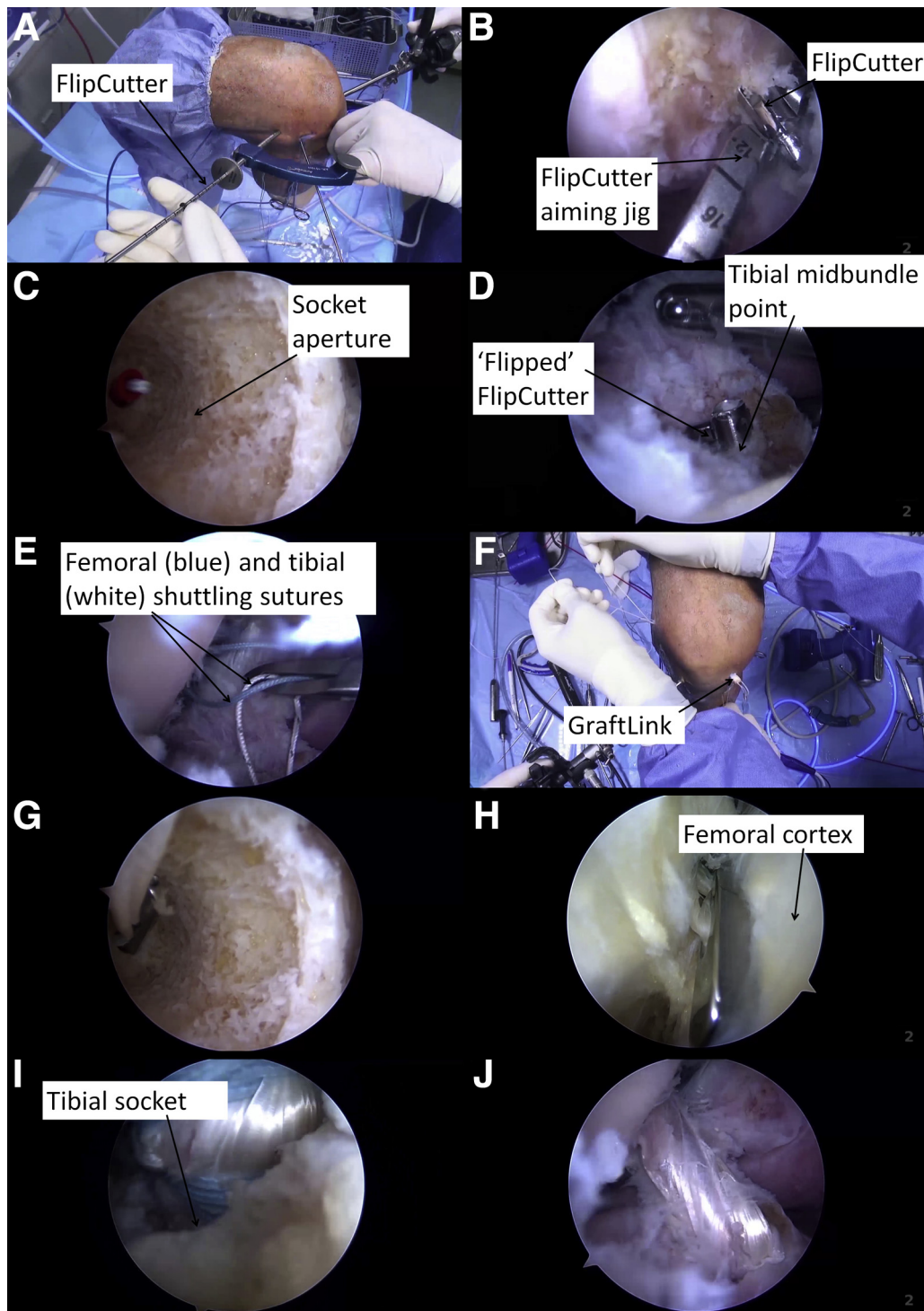


Fig 5. Translateral all-inside ACL reconstruction. Key steps in all-inside ACL reconstruction, including pictures from the medial portal of a right cadaveric knee, are shown. (A) The aiming jig is positioned at the surgeon's discretion. (B) A FlipCutter is delivered to the knee. (C) A 20-mm socket is created and a shuttling suture passed. (D) The FlipCutter is now delivered into the knee at the tibial footprint and flipped. A 30-mm socket is created and a suture passed. (E) Femoral and tibial sutures are retrieved simultaneously. (F) The graft is drawn into the knee on the passing sutures. (G) The femoral fixation device is taken through the femoral socket and out the femoral pilot hole. (H) It is flipped and seated down onto the lateral femoral cortex. (I) The graft is pulled into the tibial socket and the tibial TightRope similarly flipped. (J) Arthroscopic appearance after final tensioning is performed. (ACL, anterior cruciate ligament.)

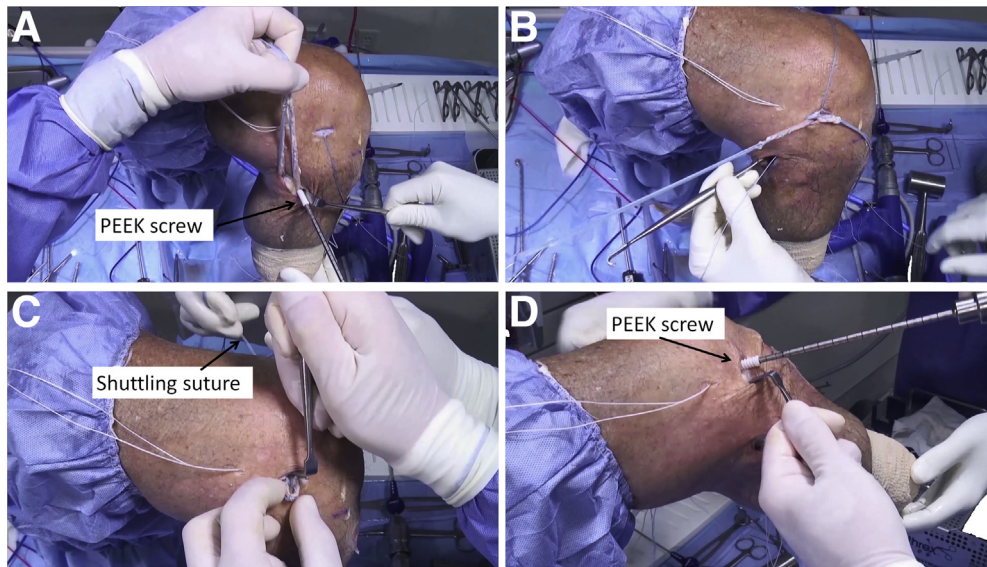


Fig 6. Securing the posterolateral corner graft—tensioning the PLC graft (demonstrated in a cadaveric right knee). (A) The reinforced gracilis is passed to its halfway point through the fibula and secured at this point with a PEEK screw. (B) Each limb is passed deep into the iliotibial band to exit by the femoral incision. (C) Both limbs are drawn through the femoral tunnel using a shuttling suture. (D) The tension is secured with a PEEK screw at the lateral aperture of this tunnel with the knee in 30° flexion, valgus and neutral rotation. (PEEK, polyether ether ketone; PLC, posterolateral corner.)

We present a technique for anatomic all-inside ACL reconstruction and PLC reconstruction using a single set of hamstrings. A summary of advantages and disadvantages of the technique is provided in [Tables 3 and 4](#). All-inside ACL reconstruction facilitates anatomic placement of the graft.^{15,16} This more accurately replicates the biomechanics of the native ACL and more accurately restores knee kinematics in comparison to nonanatomic reconstruction.^{15,17} Specifically, traditional transtibial graft placement tends to place the femoral tunnel high and deep within the intercondylar notch with respect to the ACL footprint, creating a vertically oriented graft that fails to restore rotational stability.^{18,19} The use of retrograde sockets in lieu of tunnels is bone-conserving and minimizes the risk of convergence with the femoral tunnel of the PLC reconstruction. In

addition, there is emerging evidence that use of sockets may result in less postoperative pain than the use of tunnels.^{20,21}

The use of adjustable-loop cortical suspensory fixation devices allows accurate in situ tensioning of the graft, with recent Level III evidence supporting no difference in failure rate or knee stability at 2 years' follow-up versus fixed-loop cortical suspension.²² The technique also obviates the need for hyperflexion of the knee, which carries the risk of iatrogenic cartilage injury during femoral drilling, among others.¹⁵ Furthermore, the technique allows simultaneous restoration of PLC stability, while still using only the ipsilateral hamstrings, thus avoiding donor site morbidity.

There are disadvantages to this technique. It requires specialist equipment, and the arthroscopic work is

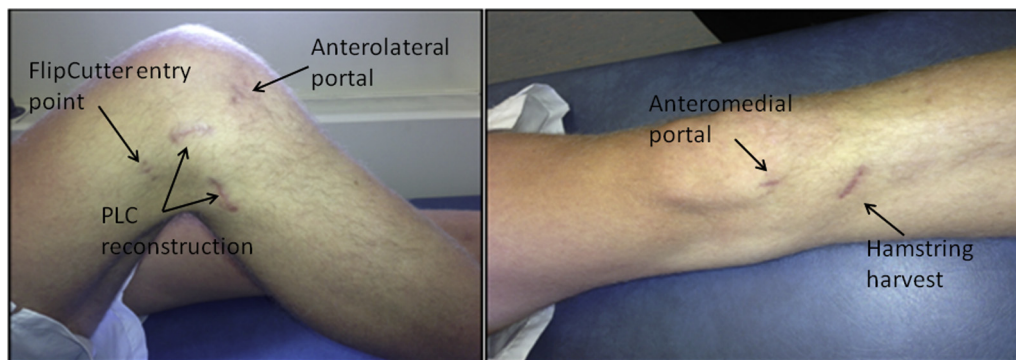


Fig 7. Postoperative appearance of the knee. Postsurgical appearance of a right knee that has undergone combined anterior cruciate ligament and minimally invasive posterolateral corner reconstruction. (PLC, posterolateral corner.)

Table 3. Advantages and Disadvantages of the Combined Reconstruction Technique

Advantages	Explanation
Cortical suspensory suspension	Allows in situ tensioning of the graft, and allows fine-tuning after the knee has been cycled
Sockets in lieu of bone tunnels	Both bone conserving and result in less postoperative pain
Single set of hamstrings used	Avoids contralateral donor site morbidity
Disadvantages	Explanation
Potential graft “bottoming out”	Insufficient socket depth with respect to the length of the graft can result in the grafts bottoming out in the sockets, resulting in a lax graft
Overconstrained knee	Overtensioning the graft can result in a reduced range of motion in the knee

Table 4. Pearls and Pitfalls of the Combined Reconstruction Technique

Pearls	
Retrieving passing sutures for the ACL reconstruction from the knee simultaneously reduces the chances of soft-tissue entrapment and suture entanglement.	
To further reduce the risk of suture entanglement, a passport cannula can be used.	
Aiming the femoral tunnel for PLC reconstruction anteriorly and proximally minimizes the risk of tunnel confluence.	
Pitfalls	
Combined socket depth plus the intra-articular length of the tensioned ACL graft must not exceed total graft length. This situation would not allow tensioning as a result of the graft “bottoming out.”	
Careful dissection around the common peroneal nerve is essential. Conversion to open procedure from minimally invasive approach is mandated if any concern regarding preparation of fibula tunnel for PLC reconstruction is encountered.	
ACL, anterior cruciate ligament; PLC, posterolateral corner.	

technically challenging. The use of sockets rather than tunnels for the ACL reconstruction creates the possibility of the graft “bottoming out” in both sockets, thus preventing adequate tensioning. Combined socket depth should therefore be considered in conjunction with graft length. Similarly, pulling too much graft into either socket can reduce the intra-articular graft length and consequently can overconstrain the knee.

There is biomechanical evidence that double-bundle ACL reconstruction—independently reconstructing the bundles of the ACL and differentially tensioning them to better replicate the isometry of the native ACL—is superior to single-bundle reconstructions.²³ However, these have not yet yielded improved clinical results.²⁴ In view of the lack of clinical benefit, the increased operative complexity and risk of tunnel convergence with the PLC reconstruction causes us to continue to recommend single-bundle reconstruction in this combined technique.

Injuries to the ACL and PLC often occur concomitantly and both should be reconstructed to ensure optimum patient outcome. The described technique represents a major potential surgical advantage by combining anatomic ACL reconstruction and PLC reconstruction using only the ipsilateral hamstrings.

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