

Technical Note

Anatomic Anterior Cruciate Ligament and Full Posterolateral Corner Reconstruction With Lateral Capsule, Biceps Tendon, and Iliotibial Band Repairs Attributable to Hyperextension Injury

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Abstract: Injuries to the posterolateral corner (PLC) have been reported to occur in 13.3% to 19.7% of patients with anterior cruciate ligament tears. Severe cases can also lead to injury of the biceps femoris tendon, the iliotibial band, the lateral capsule, and the peroneal nerve. In cases in which a high-grade PLC injury with additional pathology is suspected, early surgical intervention is critical. This Technical Note describes a combined anterior cruciate ligament and PLC reconstruction with repairs to the lateral capsule, biceps femoris tendon, and iliotibial band attributable to a hyperextension injury.

Isolated injuries to the posterolateral corner (PLC) of the knee are rare and often a part of a multiligament knee injury involving the anterior cruciate ligament (ACL) and/or the posterior cruciate ligament.^{1,2} The main stabilizers of the PLC consist of the fibular collateral ligament (FCL), the popliteus tendon, and the popliteofibular ligament.³ Other structures related to the PLC include the lateral capsule, bicep femoris tendon, iliotibial band (ITB), and the common peroneal nerve.³ Severe high-grade injuries to the PLC can include additional damage to any of these structures.⁴

The main function of the PLC is to stabilize varus gapping and external rotation, and the main function of the ACL is to prevent anterior tibial translation. Although the ACL and PLC have different functions, both are associated with hyperextension-type injuries.⁴⁻⁶ In this Technical Note, we describe the surgical

reconstruction of the ACL and PLC with repair of the ITB, lateral capsule, and bicep femoris tendon due to a hyperextension injury.

Surgical Technique

A detailed video of the anatomic ACL and PLC reconstruction with lateral capsule, biceps tendon, and ITB repair is shown in [Video 1](#). The step-by-step guide and surgical pearls are in [Table 1](#).

Anesthesia and Positioning

The patient is positioned in the supine position and induced under general anesthesia. An examination is performed to validate the clinical examination findings, including the Lachman examination, varus stress, and dial test. A high thigh tourniquet is placed on the surgical leg. The surgical leg is placed in a leg holder (Mizho OSI, Union City, CA) and the nonsurgical leg into a well-padded abduction stirrup (Birkova Product LLC, Gothenburg, NE). For infection prophylaxis, appropriate dosing of cefazolin is administered.

Approach

The bone–patellar tendon–bone autograft harvest for ACL reconstruction is approached first with an anterior incision from the midpatella to the medial aspect of the tibial tubercle ([Fig 1](#)). The paratenon is exposed, and the central 10 mm of the patellar tendon is harvested with a 10 × 20-mm patellar bone plug and a 10 × 25-mm tibial bone plug.

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Table 1. Step-by-Step Guide and Surgical Pearls for an Anatomic ACL and PLC Reconstruction With Lateral Capsule, Biceps Tendon, and ITB Repair

Steps	Pearls
Anteromedial incision for bone–patellar tendon–bone autograft harvest to be used for the ACL reconstruction.	Middle third of the patellar tendon should be harvested with 10 × 20-mm bone plug off the patella and a 10 × 25-mm bone plug from the tibial tubercle.
Lateral hockey stick incision for the PLC reconstruction.	Proper dissection through tissue planes is critical with severe injuries to the PLC.
A peroneal nerve neurolysis should be performed.	When the bicep femoris is torn, the peroneal nerve may be located more anterior than normal.
A fibular head guide is used to drill a guide pin through the FCL fibular head attachment. This is over reamed with a 7-mm reamer. A passing stitch is placed.	The anatomic attachment is located 8 mm posterior to the anterior margin of the fibular head. The guide pin should aim for the posteromedial downslope of the fibular styloid.
The tibial tunnel originated on the flat spot just distal and medial to the Gerdy tubercle and should exit at the musculotendinous junction of the popliteus muscle. A tibial guide is used to drill the guide pin and is over reamed with a 9-mm reamer. A passing stitch is placed.	The tunnel should aim 1 cm proximal and 1 cm medial to the exit of the fibular head tunnel.
Next, the ITB is split above the FCL and popliteus attachment sites.	A Z retractor is placed anteriorly in the lateral capsule to help identify the popliteus tendon attachment site.
Using a femoral guide, the guide pin for the popliteus tendon is drilled first, followed by the FCL, which is usually approximately 18.5 mm posterior and proximal. Both guide pins are overreamed with a 9-mm reamer to a depth of 20 mm and passing stitch are placed.	Both guide pins for the popliteus and FCL should be parallel and aimed 30 to 40° anterior to avoid convergence with the ACL femoral tunnel later in the case.
Medial and lateral parapatellar portals are made.	An accessory medial portal will also be made for the ACL femoral tunnel.
The torn ACL is debrided, and a guide pin is drilled using an over-the-top guide and is overreamed with a 10-mm acorn reamer to the depth of the patellar bone plug. A passing stitch is placed.	ACL femoral attachment, midway between the anteromedial and posterolateral bundles of the ACL, is identified.
The ACL tibial attachment is now identified, and a guide pin is drilled using a tibial guide and is overreamed with a 10-mm acorn reamer. The passing stitch through the ACL femoral tunnel is pulled down the ACL tibial tunnel.	The ACL tibial attachment is in line with the lateral meniscus anterior root and they both overlap by 40%.
The ACL graft is pulled into place and fixated with a 7 × 20-mm titanium screw in the femur.	The interference screw should be located at the anterior aspect of the tunnel to avoid blowing out the posterior wall.
The popliteus tendon graft and the FCL graft are then fixated in the femur. Both grafts are secured with 7 × 20-mm titanium screws.	The screws should be located on the anterior aspects of the tunnels.
The popliteus tendon graft is passed down the popliteal hiatus, deep to the ITB. The FCL graft is then passed distally under the lateral capsule and ITB but superficial to the popliteus tendon.	Care should be taken with the tissue planes, especially when multiple other structures are injured.
The lateral capsule is repaired with 2 Q-FIX anchors and 1-2 Q-FIX anchors are placed at the Gerdy tubercle to repair the ITB.	The knee should be in 20° of flexion for the lateral capsule and extension for the ITB.
The FCL graft is then fixed in the fibular head with a 7 × 20-mm bioabsorbable screw.	The knee should be in 20° of flexion with a slight valgus force.
The popliteus tendon graft and the remnant of the FCL graft, which becomes the PFL, are passed from posterior to anterior through the tibial tunnel and are fixated with a 9 × 20-mm bioabsorbable screw.	The knee should be in 60° of flexion.
Two Q-FIX anchor are then placed at the attachment site of the biceps femoris tendon on the fibular head to repair the biceps tendon.	These anchors should be located on the posterior aspect of the fibular head with the knee in full extension and should be placed after the FCL graft is passed and fixed in the fibular tunnel or the anchors could interfere with graft passage.
Then the knee is cycled while tensioning the ACL graft and final fixation occurs with a 9 × 20-mm titanium screw in the tibia.	The knee should be in full extension.
The ACL graft is checked arthroscopically, and the deep and superficial tissues are closed with sutures.	

ACL, anterior cruciate ligament; FCL, fibular collateral ligament; ITB, iliotibial band; PLC, posterolateral corner; PFL, popliteofibular ligament.

The PLC is then approached with a lateral hockey stick incision based along the ITB and extended distally to the Gerdy tubercle (Fig 2). Sharp dissection down to the ITB and biceps femoris tendon is performed. The common peroneal nerve is located posteromedial to the biceps femoris; however, careful dissection is vital because anatomic landmarks can be disrupted in

high-grade injuries. A neurolysis is then performed proximally and distally, incising 5 to 7 mm of peroneus longus fascia.

Graft Preparation

The grafts are prepped on the back table with the ACL graft shaped to fit smoothly through a 10-mm tunnel



Fig 1. Anterior incision for a bone–patellar tendon–bone (BPTB) graft harvest for use during an anterior cruciate ligament (ACL) reconstruction in a left knee with the patient in the supine position. The paratenon (purple arrows) is exposed and the BPTB graft is harvested from the central third of the patellar tendon with a 10×20 mm patellar bone plug and a 10×25 -mm tibial bone plug.

with 2 passing sutures in each bone plug. Two 9×20 -mm split Achilles allografts are prepared, and the distal aspect of the graft is whipstitched.

PLC Tunnels

The FCL attachment on the fibular head is approached next through the biceps femoris bursa via subperiosteal dissection of the fibular head. A small elevator is used to elevate the soleus muscle from the posteromedial aspect of the fibular head and a guide pin is drilled through the anatomic attachment using a

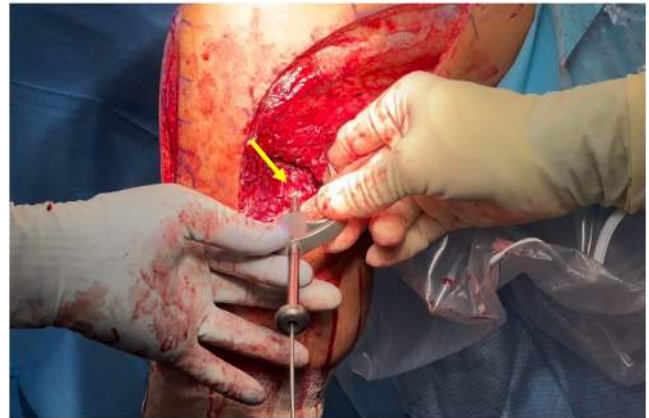


Fig 3. Fibular head tunnel for a fibular collateral ligament (FCL) reconstruction during a full posterolateral corner reconstruction in a left knee with the patient in the supine position. This tunnel should be located at the anatomic attachment of the FCL (yellow arrow), located 8 mm posterior to the anterior margin of the fibular head and 27 mm from the fibular styloid. The FCL attachment should be dissected, and the tunnel should enter at this site. The exit point should be the posteromedial downslope of the fibular styloid. This guide pin will be overreamed with a 7-mm reamer.

fibular head guide (Arthrex, Naples, FL), about 8 mm posterior from the anterior margin of the fibular head (Fig 3). The guide pin is overreamed with a 7-mm reamer, a retractor is used to protect the deep tissues, and a passing stitch is placed.

The flat spot on the anterolateral tibia distal and medial to the Gerdy tubercle is identified, and another guide pin is drilled from anterior to posterior through



Fig 2. Posterolateral corner hockey stick incision for a posterolateral corner (PLC) reconstruction, peroneal nerve neurolysis, and repair of the lateral capsule, bicep femoris tendon, and iliotibial band (ITB) in a left knee with the patient in the supine position. With severe injuries the PLC, especially when the bicep femoris tendon is torn of the fibular head, care should be taken to identify the peroneal nerve as it could be displaced. Sharp dissection is carried down to the ITB (black arrow) and biceps femoris tendon.

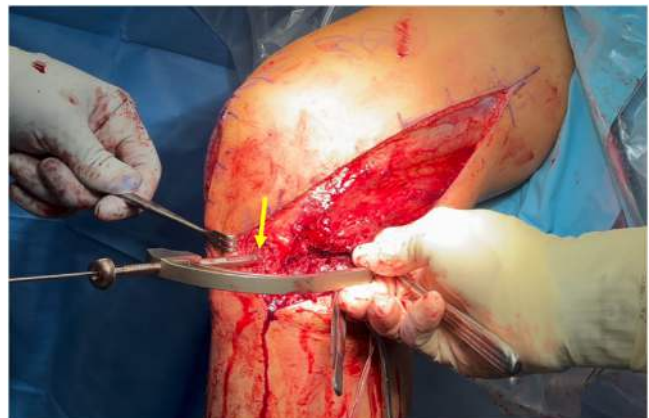


Fig 4. Tibial tunnel for the posterolateral corner (PLC) reconstruction to reconstruct the popliteus tendon and the popliteofibular ligament (PFL) in a left knee with the patient in the supine position. This tunnel is drilled from anterior to posterior and should originate at the flat spot just distal and medial to the Gerdy tubercle (yellow arrow) and converge with the musculotendinous junction of the popliteus muscle posteriorly. The exit point should be 1 cm proximal and 1 cm medial to the exit site of the fibular head tunnel. This will be overreamed with a 9-mm reamer.

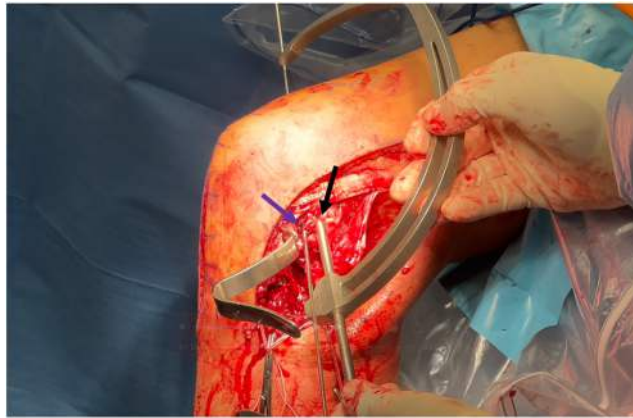


Fig 5. Fibular collateral ligament (FCL) and popliteus tendon femoral tunnels to be used during a full posterolateral corner (PLC) reconstruction in a left knee with the patient in the supine position. These guide pins should be aimed parallel to each other and aimed about 30-40° anterior to avoid convergence with the ACL femoral tunnel. The anatomic attachment of the FCL (black arrow) is located just posterior and proximal to the lateral epicondyle and the popliteus (purple arrow) is located about 18.5 mm anterior and distal in the anterior fifth of the popliteal sulcus. These guide pins will be over reamed with a 9-mm reamer to a depth of 20 mm.

the tibia and aiming at the musculotendinous junction of the popliteus tendon using a tibial guide (Smith & Nephew, London, England) (Fig 4). This is overreamed with a 9-mm reamer with a retractor protecting the posterior structures. A passing stitch is placed.

Next, the ITB is split above the FCL and popliteus attachment sites. A Z retractor is placed anteriorly in the lateral capsule and the popliteus tendon attachment site

is identified. Both guide pins for the popliteus and FCL tunnels should enter parallel to one another at their femoral anatomic attachment sites and aimed 30 to 40° anterior to avoid convergence with the ACL femoral tunnel. Using a femoral guide (Arthrex), the guide pin for the popliteus tendon is drilled first, followed by the FCL, which is 18.5 mm posterior and proximal (Fig 5). Both guide pins are overreamed with a 9-mm reamer to a depth of 20 mm and passing stitch are placed.

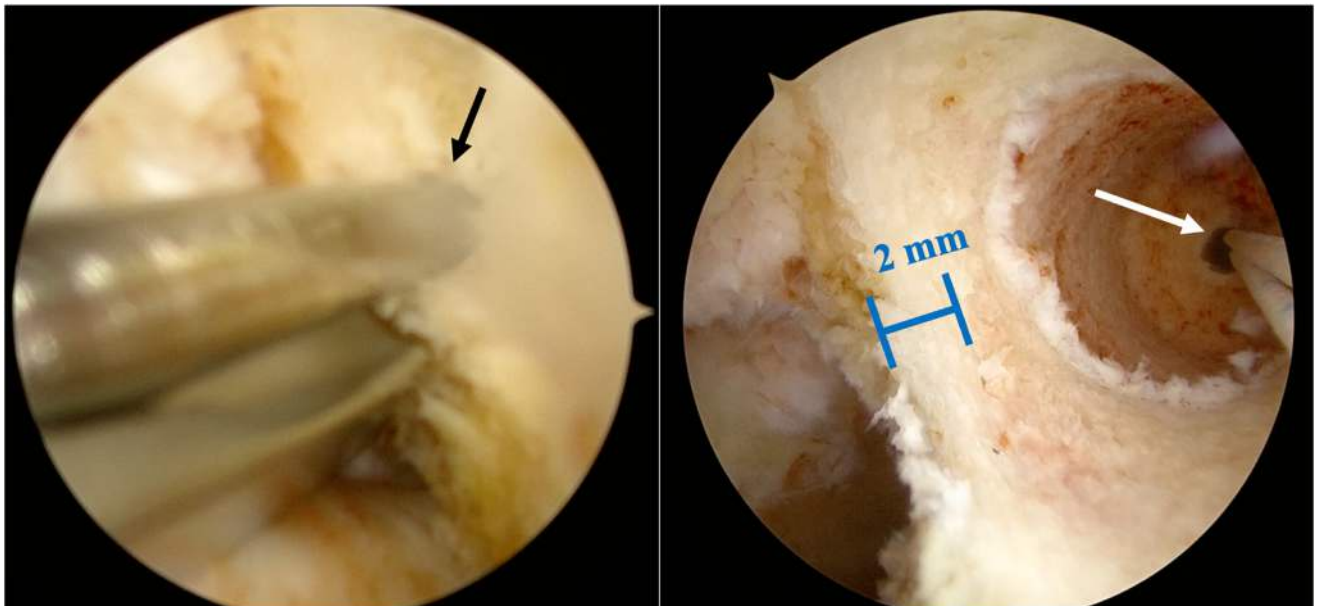


Fig 6. Femoral tunnel for an anterior cruciate ligament (ACL) reconstruction in a left knee with the patient in the supine position. An over-the-top guide is used to drill a guide pin (black arrow) through the ACL femoral attachment midway between the anteromedial and posterolateral bundles of the ACL. This is overreamed with a 10-mm low profile reamer while a 2-mm back wall should be maintained. The depth of the tunnel should match the length of the patellar bone plug. A passing stitch (white arrow) is placed to pass the graft later in the case.

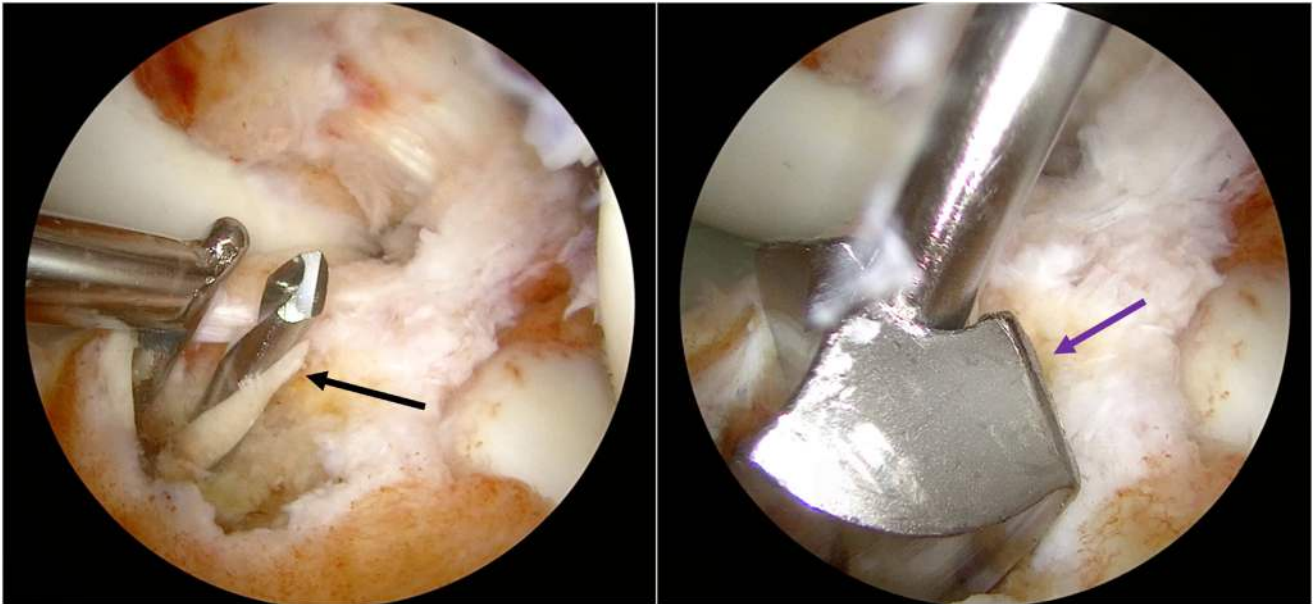


Fig 7. Tibial tunnel for an anterior cruciate ligament (ACL) reconstruction in a left knee with the patient in the supine position. A guide pin (black arrow) is drilled through the anatomic tibial attachment of the ACL. The stump of the ACL can help identify this location, which is just medial to the anterior root of the lateral meniscus. The guide pin should be held with a small Kocher and should be over reamed with a 10-mm reamer (purple arrow).

ACL Reconstruction

Anteromedial and anterolateral parapatellar arthroscopic portals are created. The torn ACL remnant is debrided, and the ACL femoral attachment, midway between the anteromedial and posterolateral bundles of the ACL, is identified. A guide pin is drilled using a 7-mm offset over-the-top guide (Arthrex) and is

overreamed with a 10-mm acorn reamer to the depth of the patellar bone plug (Fig 6). A passing stitch is placed.

The ACL tibial attachment is now identified, adjacent to the lateral meniscus anterior root. A guide pin is drilled using a tibial guide (Arthrex) and overreamed with a 10 mm acorn reamer (Fig 7). The ACL graft is pulled into place and fixated with a 7 × 20-mm titanium screw (Smith & Nephew) in the femur.

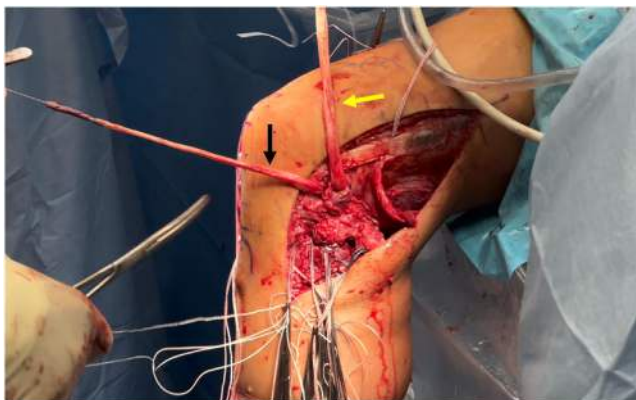


Fig 8. Femoral tunnels for the fibular collateral ligament (FCL) and popliteus tendon for a full posterolateral corner (PLC) reconstruction in a left knee with the patient in the supine position. The grafts utilized in this case were split Achilles allografts with two 9 × 20-mm calcaneal bone plugs. The popliteus tendon graft (black arrow) and then the FCL graft (yellow arrow) are passed into their tunnels using the previously placed passing sutures. Both graft bone plugs are fixated in the femoral tunnels with a 7 × 20 mm titanium screw.

PLC Fixation

The fixation for the PLC is performed next starting with the popliteus tendon and FCL grafts in the femur. Both grafts are secured with 7 × 20 mm titanium screws (Smith & Nephew) (Fig 8). Next, the popliteus tendon graft is passed down the popliteal hiatus, deep to the ITB. The FCL graft is then passed distally under the ITB and superficial to the lateral capsule and popliteus tendon.

Before FCL fixation, the lateral capsule is repaired with 2 Q-FIX anchors (Smith & Nephew) placed one cm distal to the lateral joint line with the knee at 20° of flexion. Another 2 Q-FIX anchors are placed at the inferior aspect of the Gerdy tubercle to repair the ITB with the knee in extension (Fig 9). The FCL graft is then fixed in the fibular head with a 7 × 20-mm bioabsorbable screw with the knee in 20° of flexion (Fig 10).

The popliteus tendon graft and the remaining portion of the FCL graft, which becomes the popliteofibular ligament graft, are passed from posterior to anterior through the tibial tunnel and are fixed at 60° of flexion

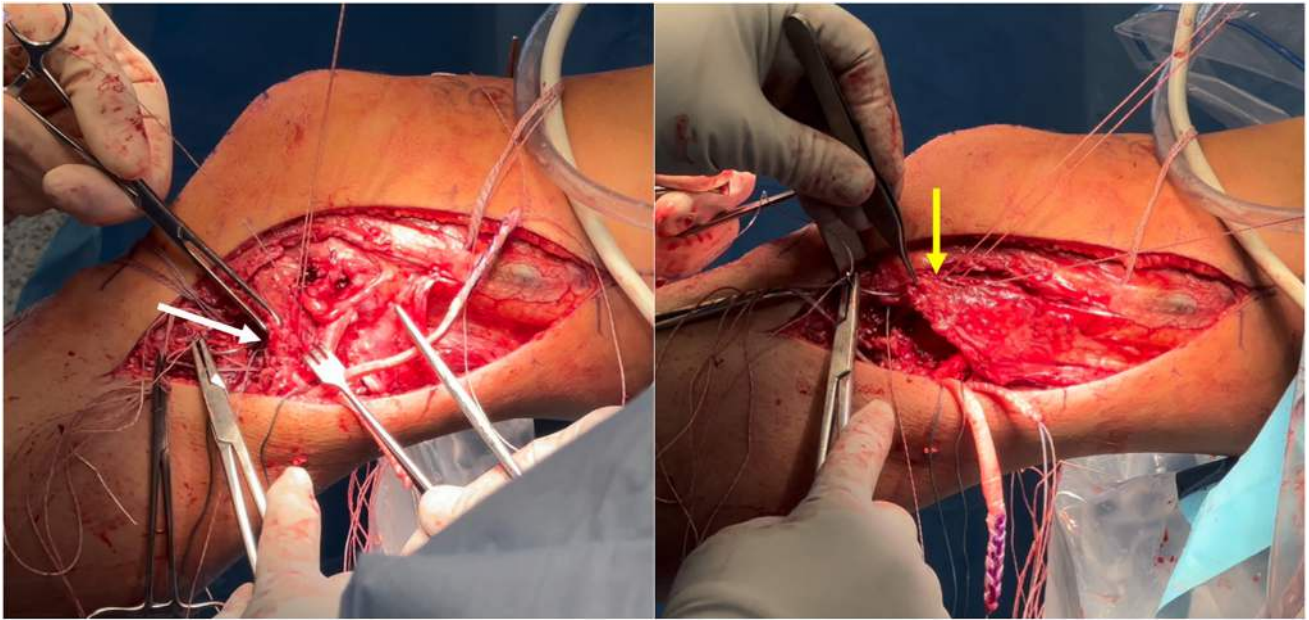


Fig 9. Lateral capsule repair and posterior iliotibial band repair (ITB) repair during a posterolateral corner (PLC) reconstruction in a left knee with the patient in the supine position. In severe cases of PLC injuries, additional structures like the lateral capsule (white arrow) and ITB (yellow arrow) can also be torn. In this case, the lateral capsule had torn off the tibia and the distal portion of the ITB had torn off the Gerdy tubercle. Both were repaired with 2 Q-FIX anchors. Care should be taken to ensure the grafts for the fibular collateral ligament (FCL) and popliteus tendon are in the proper tissue planes.

with a 9×20 mm bioabsorbable screw (Smith & Nephew) in the tibial tunnel (**Fig 11**). Two Q-FIX anchors are then placed at the attachment site of the

biceps femoris tendon on the fibular head and the biceps tendon is repaired with the knee in extension (**Fig 12**). It is important to place these suture anchors

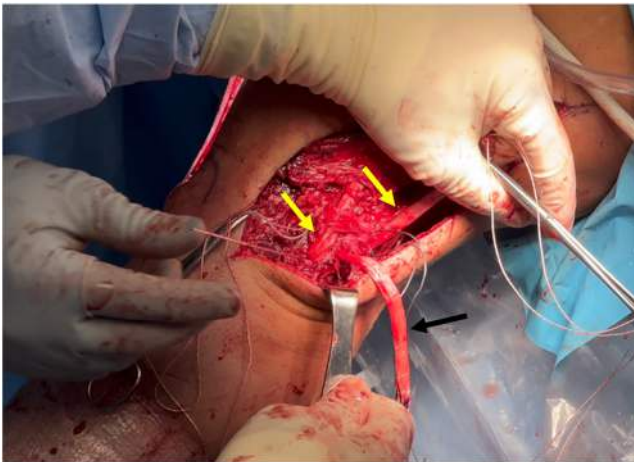


Fig 10. Fixation of the fibular collateral ligament (FCL) graft in the fibular head during a full posterolateral corner (PLC) reconstruction in a left knee with the patient in the supine position. The patient is in the supine position on the operating table. The FCL graft should be passed under the superficial tissues but is superficial to the popliteus tendon graft (black arrow). The FCL graft (yellow arrows) is passed the from lateral to medial through the fibular head and fixated with a 7×20 mm bioabsorbable screw with the knee placed in 20° of flexion with a slight valgus reduction force.

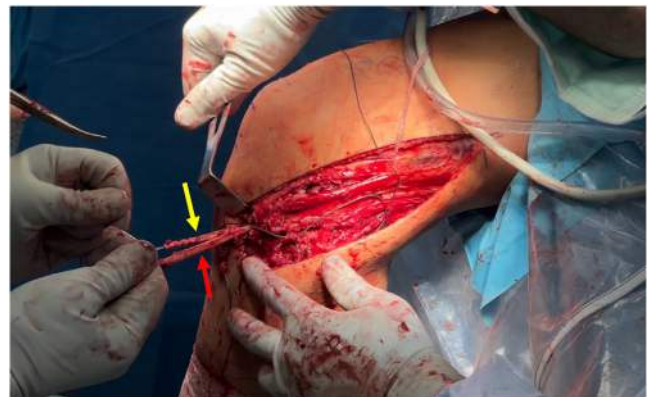


Fig 11. Fixation of the popliteus tendon and popliteofibular ligament (PFL) grafts in the tibial tunnel during a full posterolateral corner (PLC) reconstruction in a left knee with the patient in the supine position. Both grafts are passed from posterior to anterior through the tibial tunnel. The previously fixed fibular collateral ligament (FCL) graft becomes the PFL graft (yellow arrow) after being passed through the fibular head. The popliteus tendon graft (red arrow) originates at its anatomic attachment on the femur. These grafts are fixed in the tibial tunnel with the knee in 60° of flexion with a 9×20 -mm bioabsorbable screw.

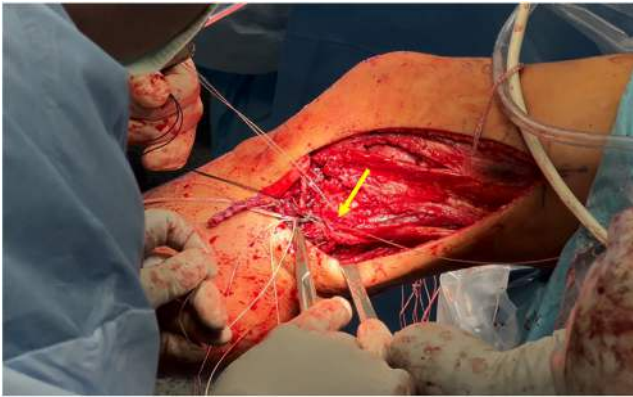


Fig 12. Biceps femoris tendon repair during a posterolateral corner (PLC) reconstruction in a left knee with the patient in the supine position. In severe cases of PLC injuries, additional structures like the bicep femoris tendon can tear from the fibular head. In this case, 2 Q-FIX anchors are placed at the anatomic attachment of the biceps femoris tendon on the posterior aspect of the fibular head. These anchors should be tensioned to repair the biceps tendon (yellow arrow) with the knee in full extension.

after the FCL graft has been placed or the suture anchors could prevent graft passage through the tunnel. The knee is cycled while tensioning the ACL graft and final fixation occurs with a 9×20 -mm titanium screw (Smith & Nephew) in the tibial with the knee in extension. The ACL graft is checked arthroscopically to ensure it is taut with no graft impingement on the roof or the edge of the intercondylar notch, and the deep and superficial tissues are closed with suture.

Rehabilitation

The patient will be non-weight-bearing on their surgical limb for 6 weeks. Flexion will be limited to 90° for the first 2 weeks postoperatively. Hamstring exercises should be avoided for the first 4 months.

Discussion

Injuries to the ACL and PLC are one of the more common injury patterns for multiligament knee

injuries with incidence around 13.3% to 19.7% of patients with ACL tears.⁷⁻⁹ Further injuries to the biceps femoris, ITB, lateral capsule, and common peroneal nerve are rare, but can occur in severe cases of PLC injuries.⁴ In cases in which there is extensive injury to the PLC, acute reconstruction should be performed with repair of any additional damaged structures.¹⁰ Furthermore, a common peroneal nerve neurolysis should be performed in all cases to assess the nerve and prevent iatrogenic damage.

Outcomes for combined PLC and ACL reconstruction have improved outcomes.^{1,9,11} A study by Geeslin and LaPrade¹ reported on 30 knees with acute grade II posterolateral corner injuries (18 of these had ACL injuries). They reported that at ≥ 2 years follow-up, the International Knee Documentation Committee score increased by 52.4 points, the Cincinnati score increased by 59.5 points, and there was no significant difference in outcomes between those with isolated (just PLC) or combined (PLC + ACL/posterior cruciate ligament) injuries. The advantages and disadvantages of this surgical technique are listed in Table 2.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: R.F.L. reports consulting or advisory and funding grants with Ossur; consulting or advisory, funding grants, and travel reimbursement with Smith & Nephew; consulting or advisory with Responsive Arthroscopy; funding grants from the Arthroscopy Association of North America and the American Orthopaedic Society for Sports Medicine; speaking and lecture fees from Foundation Medical, LLC; and a patent with royalties paid to Ossur. All other authors (L.V.T., E.P.S., D.R.L., M.T.R.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Table 2. Advantages and Disadvantages for An Anatomic ACL and PLC Reconstruction With Lateral Capsule, Biceps Tendon, and ITB Repair

Advantages	Disadvantages
Bone plugs in both the femur and tibia for the ACL and the femur for the PLC grafts facilitate bone to bone healing.	High cost associated with split Achilles allograft.
Autograft for the ACL is less expensive.	Larger incisions.
Repair of all injured structures to restore function and stability.	Potential for fracture through the fibular head with FCL tunnel reaming.
Anatomic reconstruction of the torn major ligament and tendon structures allows for best restoration of knee stability.	Potential for iatrogenic neurovascular damage with FCL fibular head tunnel and PLC tibial tunnel.

ACL, anterior cruciate ligament; FCL, fibular collateral ligament; ITB, iliotibial band; PLC, posterolateral corner.

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