Lateral Collateral Ligament Reconstruction With Tensionable Loops and Suture Tape Reinforcement

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Background: The posterolateral corner (PLC) is an important knee stabilizer that resists varus stress, external tibial rotation, and posterior tibial translation. Untreated PLC injuries have been shown to increase failure rates of anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) reconstructions and lead to degenerative changes. Our modified Arciero technique reconstructs the femoral insertion site and functionality of the lateral collateral ligament (LCL) and popliteal fibular ligament, components of the PLC, with an internal brace and tensionable loops.

Indications: The primary indication for PLC reconstruction is identified PLC injury. Patients often have a feeling of knee instability and a varus thrust gait. PLC injury should be confirmed with imaging.

Technique Description: We employed a modified Arciero technique via LCL reconstruction with tensionable loops and internal brace. We used a semitendinosus allograft truncated at 240-millimeters to avoid the graft bottoming out. A suture augment was incorporated into the graft to reinforce the LCL reconstruction construct during graft tensioning and early rehabilitation. The graft construct was then passed through the transfibular tunnel to femoral sockets at the LCL and popliteus insertions. The graft construct is then affixed to the opposite femoral cortex. The graft was then tensioned with the knee in approximately 30° of flexion, neutral to 10° of internal rotation, and a valgus force applied. This restored excellent valgus stability.

Results: Fibular and tibiofibular-based constructs are common procedures for PLC reconstruction. Our LCL reconstruction with tensionable loops technique and the Arciero technique are fibular-based constructs. The fibular-based construct and the tibiofibular-based construct have been found to be biomechanically equivalent at restoring knee stability. However, fibular-based constructs, such as our LCL reconstruction with tensionable loops, were found to be less technically demanding than tibiofibular-based constructs, used fewer grafts, and required a smaller surgical approach.

Conclusion: Given similar clinical outcomes, it was concluded that fibular-based constructs, such as our modified Arciero technique, may be more advantageous because of the ability to avoid some of the pitfalls of tibiofibular-based constructs.

Patient Consent Disclosure Statement: The author(s) attests that consent has been obtained from any patient(s) appearing in this publication. If the individual may be identifiable, the author(s) has included a statement of release or other written form of approval from the patient(s) with this submission for publication.

Keywords: posterolateral corner; posterolateral corner reconstruction; LCL reconstruction; Arciero technique; lateral collateral ligament reconstruction

VIDEO TRANSCRIPT

The following video covers our technique for an open anatomic reconstruction of the posterolateral corner (PLC) following a modified Arciero technique.

Our relevant disclosures are listed here.

The following is a brief overview of what will be discussed in this video.

The PLC is an important stabilizer that resists varus rotation, external tibial rotation, and posterior tibial translation about the knee.[7,10] The PLC consists of three main components: the lateral collateral ligament (LCL), the popliteus tendon, and the popliteofibular ligament.[5,9]

The most common cause of PLC injury is a posterolateral directed force that impacts the anteromedial knee.[5,10] However, hyperextension, external rotation twisting, high energy trauma, and noncontact varus stress can also induce PLC injury.[5,10]

PLC injuries are often associated with ACL (anterior cruciate ligament) and/or PCL (posterior cruciate ligament) tears.[10] Untreated PLC injuries have been shown to increase failure rates of ACL and PCL reconstructions

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and lead to degenerative changes of the medial knee compartment.[7]

The Arciero technique re-establishes the femoral insertion site and functionality of the LCL and popliteal fibular ligament by passing two graft limbs through dual femoral sockets at their native insertion sites.[2,7] In addition, the anterolateral to posteromedial direction of the transfibular tunnel closely reproduces the popliteofibular ligament while also maintaining the femoral insertion of the reconstructed LCL and popliteus.[2,7]

We performed a modified Arciero technique—a single-stage, multiligamentous reconstruction. We passed a semitendinosus allograft through a transfibular tunnel to the femoral sockets at the LCL insertion, which is slightly proximal and posterior to the lateral epicondyle, and the popliteus insertion, which is on the most anterior fifth and proximal half of the popliteal sulcus. The femoral attachment of the popliteus is always anterior to the LCL attachment, and the attachments are roughly 18.5-millimeters apart.[9] We then affix the graft to the opposite femoral cortex using a FiberTag button. There is no fixation placed in the fibula.

Another common procedure for PLC reconstruction is the LaPrade technique. The LaPrade technique uses two grafts to reconstruct the anatomical locations of the LCL, popliteus tendon, and popliteofibular ligament using attachments from the tibia to the femur and the fibula to the femur.[8,11]

The Arciero technique uses a single soft-tissue graft to reconstruct the anatomic locations of the LCL and popliteofibular ligament.[2] The Arciero technique employs a transfibular tunnel to connect the graft from the fibula to the femur.[7,11]

While the techniques differ, a biomechanical study found that the LaPrade and Arciero techniques are "equally effective at restoring stability to knees with PLC injuries."[11]

The primary indication for PLC reconstruction is identified PLC injury. Often patients present with a feeling of knee instability and have a distinctive varus thrust gait.[7] Suspicion of PLC injury should be confirmed with imaging of the knee.[7] In general, we delay surgery at least 10 to 14 days after injury to allow for decreased swelling, interval capsular healing, and knee range of motion to reach at least between 0° and 90°.[6]

Given that the Arciero and LaPrade techniques are equivalently effective at restoring knee stability, orthopedic surgeons should select a reconstruction technique based on their experience and operative judgment.[7,11]

Our patient is a healthy 27-year-old female who is an avid equestrian. She presents for evaluation of her right knee after blunt force trauma due to a kick by a horse. Patient reports persistent pain and swelling about the right knee.

Examination of the patient's right knee showed medial and lateral bruising of the knee with significant effusion, tenderness to palpation about the medial collateral ligament origin, medial femoral condyle, lateral joint line, and active range of motion from 0° to 110° of flexion. Compared to contralateral knee, there was a 10° increase in external rotation at 30° of flexion but not at 90° of flexion. Significant varus laxity at 0° and 30° of flexion can be observed. In addition, the patient exhibits Lachman 3B with no endpoint.

A 4-view radiograph series of the right knee was obtained. There were no acute fractures or osseous abnormalities detected. Right knee magnetic resonance imaging (MRI) without contrast was obtained. There was a complete rupture of the ACL. The PCL and medial and lateral menisci were intact. There was a complete tear of the LCL near the fibular attachment. In addition, there was a partial tear of the popliteus tendon at the femoral insertion. A mildly displaced fracture at the posterior lateral tibial plateau was also observed.

The patient was counseled on her treatment plan, and consent was given to proceed with an all-inside ACL reconstruction with quadriceps autograft procedure in a standard manner performed concurrently with the PLC reconstruction by modified Arciero technique. For our purposes, we will focus only on the LCL reconstruction.[1]

The patient was positioned on a flat table in the supine position. The operative right leg was positioned so that it could flex to 90°.

The semitendinosus graft is recommended to be truncated between 240 and 260 millimeters. In this case, the graft was truncated to 240 millimeters to prevent the graft from bottoming out. High-strength tape suture was also cut to 240 millimeters and was incorporated into the construct to act as an internal brace. Prior to the addition of suture tape augmentation, the graft was cycled and pretensioned. Incorporating the high-strength tape suture augmentation into the LCL reconstruction construct helps protect the graft during tensioning process. The augment also helps protect the graft during the early rehabilitation phase and minimize graft creep. The semitendinosus allograft was then whipstitched onto the high-strength tape suture. The graft was measured repeatedly and determined to be 6.5 millimeters in diameter.

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A curvilinear incision was then made from about 3 centimeters proximal to the lateral femoral condyle down distally to the anterior aspect of the fibular head and neck area.

The peroneal nerve was then identified just posterior to the biceps femoris. A neurolysis was performed from proximal, where the peroneal nerve was posterior to the biceps femoris, to distal, as it wrapped around the fibular neck. The nerve was confirmed to appear in continuity. Following completion of the neurolysis, the peroneal nerve was protected throughout the case.

A posterior retractor was placed to protect the peroneal nerve, and a guide pin was placed in the fibular head taking care to make sure that it was well-centered and directed in an anterolateral to posteromedial trajectory. The fascia was released distally to allow placement of the fibular guide anteriorly on the fibular head. The fibular head was then reamed with a 6.5-millimeter reamer. A looped shuttle suture was placed. A radiograph of the knee was then obtained allowing the identification of the LCL insertion just at the level of the lateral femoral condyle, as well as the popliteus insertion.[3]

A spade tip guidewire was placed at the level of the lateral femoral condyle at the popliteus insertion and was reamed from lateral to medial while angling slightly proximally and anteriorly to avoid the ACL femoral tunnel. This was done for both the popliteus guide pin and the lateral collateral guide pin. Their path was confirmed with fluoroscopy. A 6.5-millimeter reamer was then used to ream just short of the far cortex of the femur to prevent graft from bottoming out. Looped shuttle sutures were then passed into each of the femoral tunnels. The looped shuttle sutures were also passed underneath the iliotibial band (ITB) to shuttle the graft underneath the ITB from the transfibular tunnel. The looped shuttle sutures are passed underneath the ITB in advance of graft passage to make the graft passage more efficient.

One of the ends of the graft was initially docked into the popliteus insertion. The FiberTag button was then deployed with the aid of fluoroscopy on the anteromedial cortex of the femur and approximately 20 millimeters of graft was shuttled into the popliteus tunnel.

Using the previously placed shuttle sutures, the graft was then tunneled underneath the ITB and then from posterior to anterior through the tunnel in the fibular head. The graft was then shuttled back underneath the ITB and then into the LCL femoral insertion.

The graft was then tensioned from the femoral insertion with the knee in approximately 30° of flexion, neutral to 10° of internal rotation, and a valgus force applied. This restored excellent valgus stability, which was confirmed under fluoroscopic stress. The wounds were thoroughly irrigated and closed with 2-0 Vicryl and 3-0 nylon. A sterile dressing was applied. The patient had a hinged knee brace locked in extension applied and was brought to recovery room in stable condition.

Postoperatively, full weightbearing and early range of motion in a hinged knee brace is generally permitted.[6] However, associated PCL reconstruction or meniscal repair may necessitate some delay in the initiation of full weightbearing to allow additional time for healing.[6] Postoperative rehabilitation should be highly individualized based on the patient's specific goals, concomitant injuries, and protection needs to optimize the desired treatment outcome.

There is a risk of fibular head fracture during drilling of the transfibular tunnel. However, this complication can be avoided by ensuring that the tunnel is drilled in the center of the fibular head.[7]

It is important to protect the common peroneal nerve (CPN) throughout the procedure. Proper neurolysis and confirmation of the CPN's continuity should allow proper protection. In addition, the anterolateral to posteromedial trajectory of the transfibular tunnel mostly avoids the path of the CPN versus other PLC reconstruction techniques.

There is also a risk of over-tensioning the graft, which can be avoided with proper positioning of the knee as outlined earlier.

To prevent the graft from "bottoming out" select a graft length between 240 and 260 millimeters. The femoral tunnels were also drilled just short of the far cortex of the femur to further prevent "bottoming out" of the graft.

A 2023 meta-analysis compared the clinical outcomes of fibular-based constructs of the knee, like the Arciero technique, and tibiofibular-based constructs, like the LaPrade technique.

Both techniques resulted in similar postoperative subjective knee scores and equally restored varus and rotational stability.[4]

However, it also found that tibiofibular-based constructs were more technically demanding with a longer operative time and require more numerous grafts that were longer compared to the fibular-based constructs.[4] Moreover, the tibiofibular-based constructs required a larger surgical approach.[4]

Given similar clinical outcomes, it was concluded that fibular-based constructs may be more advantageous because of the ability to avoid some of the pitfalls of tibiofibular-based constructs.[4]

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