All-Inside Bicruciate Ligament and Open Posterolateral Corner Reconstruction With Suture Augmentation

Matthew S. Gwilt,*† MS, Jonathan D. Groothoff,† MA, Caleb D. Puckett,† BS, Jelle P. van der List,‡ MD, PhD, Anthony P. Fiegen,‡ MD, and Brian R. Waterman,†‡ MD
Investigation performed at Department of Orthopaedic Surgery, Atrium Health Wake Forest Baptist, Winston-Salem, North Carolina, USA

Background: Multiligamentous knee injuries (MLKIs) are complex, often highly traumatic injuries that require broad surgical techniques to restore joint stability. This study outlines novel surgical techniques for posterolateral corner (PLC) reconstruction with suture augmentation in the context of bicruciate reconstruction.

Indications: Reconstruction is indicated in complete tears of the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), and PLC due to joint instability. Allografts augmented with suture augmentation may be implemented at surgeon and patient discretion for enhanced long-term graft viability and have the benefits of lower donor morbidity with allografts along with suture augmentation to prevent stretching of allografts.

Technique Description: The ACL was reconstructed with all-inside tunnels and allograft usage, and the same was performed for single-bundle allograft PCL reconstruction. The PLC reconstruction consisted of a modified open Arciero technique in which the lateral collateral ligament (LCL) and popliteus were reconstructed using 1 continuous allograft, and additional suture augmentation was performed for the LCL to prevent stretching. The PCL was fixed first, after which the ACL and the PLC were fixed.

Results: At 6 weeks postoperatively, the patient continues to progress in restoring passive range of motion and tolerance of partial weightbearing. Barring any potential complications, a full recovery is expected in approximately 9 to 12 months, as is consistent with the MLKI recovery protocol.

Discussion/Conclusion: This study describes the surgical management of a Schenck knee dislocation class III-L injury with concomitant Arciero open PLC reconstruction in a 65-year-old man. The ideal strategy for reconstruction of MLKIs is unclear and warrants further evidence to help guide treatment in the context of concomitant injuries.

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: reconstruction; cruciate; augmentation; knee; MLKI

VIDEO TRANSCRIPT

This video demonstrates our technique for an all-inside bicruciate ligament and open posterolateral corner reconstruction with suture augmentation. Here are our disclosures. This is an overview of our presentation.

BACKGROUND

Multiligamentous knee injuries (MLKIs) are defined as a disruption of 2 or more of the major ligaments of the knee.[17] These types of injuries are relatively rare, but among them, the specific combination of anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), and a posterolateral corner (PLC) injury has been documented to comprise up to 43% of all MLKIs.[2] The mechanism is often related to high-impact trauma and in such cases is often associated with additional injuries such as avulsion fractures or nerve or vascular compromise.[9,17,19] Due to the complexity of these surgeries, some surgeons may elect for 2-staged interventions to address underlying knee instability. Prior literature has favored PLC reconstruction over repair in lieu of lower failure rates. However, recent studies have shown repair to be a viable option in specific settings, such as distal avulsion fractures of the PLC, demonstrating markedly improved failures rates of 10% that warrant its consideration.[11,14,16,19]

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CASE

Here is our case presentation. In this case, all-inside arthroscopic reconstruction of the ACL and PCL was performed with allografts, and the lateral root was repaired. The PLC was reconstructed using a modified Arciero technique with suture anchor fixation for the popliteus and button fixation for the lateral collateral ligament (LCL) with suture augmentation.

The patient is a 65-year-old man who presented from an outside hospital following an accident where his lawnmower fell on his left leg while loading it onto a trailer. The patient had outside magnetic resonance imaging (MRI) performed that characterized complete tears of the ACL and PCL, as well as an extensive PLC injury with disruption of all lateral structures. Last, MRI showed a tear of the medial meniscus and a lateral meniscal root tear. The medial collateral ligament remained intact. On physical examination of the patient's left knee, a moderate effusion was noted. Gross sagittal instability was noted with positive Lachman, anterior drawer, and posterior drawer tests. Tenderness to palpation was appreciated at the fibular head and medial and lateral joint lines. The patient remained neurovascularly intact with no discernable peroneal nerve deficits.

PREOPERATIVE PLANNING AND EXAMINATION

To prepare for this surgery, the patient was placed in a supine position.

An examination under anesthesia confirmed instability and rotational laxity in the left knee, with a grade 2 Lachman, grade 2B pivot shift, grade 2 posterior drawer, 3 + laxity in the LCL, and a positive dial test at both 30° and 90° of flexion. In this case, the authors selected a modified Arciero technique as the preferred treatment strategy as there was an absence of tibiofibular instability on examination.

SURGICAL TECHNIQUE

Diagnostic arthroscopy

Confirmation of complete tears of the ACL and PCL was found on diagnostic arthroscopy, along with the lateral meniscus root tear, as can be seen here. A routine shaver was used to debride the soft tissue remnants of the ACL, PCL, and septum posteriorly in preparing the notch for allograft reconstruction. Radiofrequency ablation was used to further prepare the femoral notch and identify the anatomic footprints for the ACL and PCL on the femoral condyles.

Bicruciate ligament tunnel preparation

A guide pin was threaded through a 10.5-mm low-profile cannulated reamer and drilled through the femoral condyle. Positioned in the high anterolateral (AL) bundle footprint above the medial arch point, the 10.5-mm low-profile cannulated reamer was then drilled in an inside-out fashion to create a closed-socket tunnel with a depth of 20 mm. Loose debris was evacuated with a shaver.

A transtibial femoral ACL drill guide was introduced through the anteromedial portal, and a guide pin was placed using a 6-mm over-the-top guide. This was then followed by a 9.5-mm cannulated reamer using an inside-out technique for creation of the closed-socket femoral ACL tunnel. The tunnel was drilled to a depth of 30 mm. It is not shown, but both tibial tunnels were drilled using FlipCutter (Arthrex) in retrograde fashion.

Lateral root repair

With all tunnels prepared, we turned our attention to dealing with the lateral root repair. A 2.4-mm cannulated drill pin was directed through the tibial plateau using a guide. The SutureLoc (Arthrex) system was shuttled in a retrograde fashion, then seated and tensioned just below the tibial plateau. Both suture limbs were passed through the meniscus in a simple suture configuration using a Scorpion (Arthrex) suture passer. Sequential tensioning of the lateral root was performed. The medial meniscus was amenable to stable debridement without need for repair.

PCL reconstruction

Here, we began the graft passage of the PCL using a quadriceps Graftlink (Arthrex) allograft. The FiberWire (Arthrex) traction suture was retrieved from the femoral tunnel. The PCL Graftlink was shuttled posteriorly into the 10.5-mm tibial tunnel. A dilator was used to facilitate graft passage into the tibial tunnel. Now that the tibial portion of the graft had been anchored using a concave button, the femoral end of graft was shuttled through the closed-socket tunnel. An alligator grasper was used to facilitate passage of the button through the tunnel. The

*Address correspondence to Matthew S. Gwilt, MS, Wake Forest University School of Medicine, 1 Medical Center Blvd, Winston-Salem, NC 27157, USA (email: mgwilt@wakehealth.edu).

†Wake Forest University School of Medicine, Winston-Salem, North Carolina, USA.

‡Department of Orthopaedic Surgery and Rehabilitation, Atrium Health Wake Forest Baptist, Winston-Salem, North Carolina, USA.

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femoral portion of the PCL graft was now seated into the high AL tunnel and appropriately tensioned.

ACL reconstruction

We turn our attention to the all-inside ACL reconstruction. Passing sutures were collected from the medial femoral condyle tunnel for graft passage. The ACL Flexigraft (Arthrex) was pulled into position and seated in the femoral tunnel. The tibial portion of the ACL graft was tensioned into position and secured with a concave button.

PLC reconstruction

We now transition to the open PLC reconstruction using a modified Arciero technique with suture augmentation. This external portion of the case was demonstrated on a cadaver. A lateral approach with a hockey stick–shaped incision was made from the fibular head to the lateral femoral condyle. This was followed by blunt dissection to identify and isolate the peroneal nerve. If the peroneal nerve is difficult to dissect in case of scar tissue, it may be beneficial to start the dissection more proximal before working distally to isolate the nerve. The iliotibial band was then split longitudinally. Here, the popliteus insertion on the lateral femoral condyle was identified for drill pin placement. A pin was passed in both a 35° anterior and proximal fashion through the near and far cortices of the femur, as described in LaPrade's guidelines for avoiding tunnel convergence.[13] A second pin was drilled at the native insertion of the LCL while ensuring no convergence was seen. Between pins, 18 mm was confirmed, as reported in the literature.

A 5-mm cannulated reamer was placed over the guide pin to first drill the popliteal tunnel to a depth of 25 mm. Next, the femoral tunnel at the insertion of the LCL was drilled to the far cortex. In this case, the distance was recorded at 65 mm. Passing sutures were then threaded through the open end of the guide pin and passed through the tunnels. The fibular head was drilled in an AL to posteromedial fashion using a 7-mm cannulated reamer. A Fiberstick (Arthrex) as utilized to assist the passing suture through the tunnel. Care was taken to avoid the neurovascular bundle located deep to this.

The tibialis posterior allograft was first passed through the popliteal tunnel in a retrograde fashion and anchored using a 4.5-mm biocomposite locking screw. Here, a helpful maneuver using 2 clamps (that we call the 2-clamp lay-off) is demonstrated to transfer the allograft deep to the biceps femoris along the path of the native popliteus. The graft was then guided through the fibular head in a posteromedial to AL fashion. The tibialis posterior graft was then brought back up to the lateral femoral condyle tunnel, again passing deep to the overlying biceps femoris muscle.

The starting graft in this case well exceeded the 240-mm minimum length recommendation. As such, it required trimming to appropriately fit inside the 65-mm femoral tunnel. In this case, it was measured and shortened to 40 mm and affixed to the FiberTag TightRope (Arthrex) selected for suture augmentation. The tensioning sutures were lassoed and shuttled retrograde through the femoral tunnel for button fixation. The FiberTag TightRope augment was transferred deep to the biceps femoris along the path of the native fibular collateral ligament. Last, the LCL allograft was available for retensioning before the suture augmentation was fixed from the native origin on the lateral femoral condyle to the AL aspect of the fibular head with a 4.5-mm biocomposite screw.

Final inspection

Nerve integrity was confirmed at the conclusion, and Lachman and varus stress testing confirmed appropriate graft tension. The iliotibial band was reapproximated and the capsule imbricated for a water-tight closure. Portal sites were closed, and the knee was placed in an immobilizer.

REHABILITATION AND FOLLOW-UP

A standard postoperative rehabilitation protocol was utilized, emphasizing the importance of early protected range of motion during the first weeks to allow time for graft taking. It is critical to avoid hyperextension of the knee in patients in whom the native structures that resist this motion are injured, including the PCL and PLC.[15] Several studies have indicated positive return-to-sport rates upward of 80%, with no appreciable difference in ability to do so based on the initial number of ligaments involved in the injury.[4,7]

DISCUSSION

Complication rates following multiligamentous knee reconstruction are variable.[4] Axibal et al[1] showed a 30% postoperative complication rate at 90 days in their study of 296 patients, with similar rates found in the study of 133 knees by Cook et al.[5] It has also been shown that rates are directly linked to the number of ligaments involved, with a positive trend as you increase the number of ligaments.[5,6] Kahan et al[9] showed that patients with concomitant PLC injuries had significantly higher rates of peroneal nerve deficits compared to MLKIs without. Further, it has been shown that 90% of those with peroneal nerve deficits at the time of initial injury have associated ACL and/or PLC injury.[12] Arthrofibrosis may perhaps be the most experienced postoperative complication, with reported ranges up to 57%, many of which required manipulation under anesthesia or a secondary surgery to correct.[6] Due to more restrictive early rehabilitation protocols with the knee brace locked in full extension, consistent and timely progression toward increasing range of motion and physical therapy in the postoperative period may be beneficial in reducing the risk of arthrofibrosis.[10]

Good functional outcome scores are achievable for patients undergoing multiligamentous knee reconstruction.[14] However, rates of both future revision surgery and radiographic evidence of osteoarthritis are high in these

patients.[14] The literature with regard to how timing and staging of procedures influence outcomes is conflicting and unclear.[8,11,19] Ultimately, with insufficient evidence to guide a decision, management of these injuries should be made on an individualized basis. Finally, a growing body of literature supports that long-term outcomes are more favorable for reconstruction over repair for cruciate ligaments in the younger population.[11,19] The superior strategy for stabilizing the PLC is less evident. Some authors prefer a tibia-based reconstruction over fibular-based reconstruction in the setting of chronic injuries or tibiofibular instability. No appreciable differences in outcomes comparing the 2 approaches have been reported in biomechanical or clinical studies.[3,18] Therefore, surgical repair, especially in the setting of distal avulsion-type injuries, and reconstruction with augmentation should be considered when discussing surgical management for patients with these injuries.[16,18] Here are our references. Thank you for your attention.

ORCID iDs

Matthew S. Gwilt https://orcid.org/0009-0000-4685-486X
Jonathan D. Groothoff https://orcid.org/0009-0006-7419-6781

REFERENCES

1. Axibal DP, Yeatts NC, Hysong AA, et al. Intraoperative and early (90-day) postoperative complications and associated variables with multiligamentous knee reconstruction: 15-year experience from a single academic institution. *Arthroscopy*. 2022;38(2):427-438.
2. Becker EH, Watson JD, Dreese JC. Investigation of multiligamentous knee injury patterns with associated injuries presenting at a level I trauma center. *J Orthop Trauma*. 2013;27(4):226-231.
3. Boksh K, Ghosh A, Aujla R, et al. Fibular- versus tibiofibular-based reconstruction of the posterolateral corner of the knee: a systematic review and meta-analysis. *Am J Sports Med*. 2013;51(14):3880-3892.
4. Cain EL Jr, Mussell EA, Crawford AE, et al. Long-term outcomes of multiligament knee injuries in American football players. *Am J Sports Med*. 2024;52(8):1918-1926.
5. Cook S, Ridley TJ, McCarthy MA, et al. Surgical treatment of multiligament knee injuries. *Knee Surg Sports Traumatol Arthrosc*. 2015;23:2983-2991.
6. Fahlbusch H, Krivec L, Muller S, Reiter A, Frosch KH, Krause M. Arthrofibrosis is a common but poorly defined complication in multiligament knee injuries: a systematic review. *Arch Orthop Trauma Surg*. 2023;143(8):5117-5132.
7. Fien R, Curtis W, Stevens K, et al. Return to sport after multiligament knee injury in young athletes. *Orthop J Sports Med*. 2023;11(6):23259671231179109.
8. Hohmann E, Glatt V, Tetsworth K. Early or delayed reconstruction in multi-ligament knee injuries: a systematic review and meta analysis. *Knee*. 2017;24(5):909-916.
9. Kahan JB, Li D, Medvecky MJ. The pathoanatomy of posterolateral corner ligamentous disruption in mulitligament knee injuries is predictive of peroneal nerve injury. *Am J Sports Med*. 2020;48(14):3541-3548.
10. Lee DR, Therrien E, Song BM, et al. Arthrofibrosis nightmares—prevention & management strategies. *Sports Med Arthrosc Rev*. 2022;30(1):29-41.
11. Levy BA, Dajani KA, Whelan DB, et al. Decision making in the multiligament-injured knee: an evidence-based systematic review. *Arthroscopy*. 2009;25(4):430-438.
12. Markus DH, Mojica ES, Bi A, et al. Relationship between peroneal nerve and anterior cruciate ligament involvement in multiligamentous knee injury: a multicenter study. *J Am Acad Orthop Surg*. 2022;30(22):e1461-e1466.
13. Moatshe G, Brady AW, Slette EL, et al. Multiple ligament reconstruction femoral tunnels: intertunnel relationships and guidelines to avoid convergence. *Am J Sports Med*. 2017;45(3):563-569.
14. Moatshe G, Chala J, LaPrade RF, Engebretsen L. Diagnosis and treatment of multiligament knee injury: state of the art. *J ISAKOS*. 2017;2(3):152-161.
15. Monson J, Schoenecker J, Schwery N, Palmer J, Rodriguez A, LaPrade RF. Postoperative rehabilitation and return to sport following multiligament knee reconstruction. *Arthrosc Sports Med Rehabil*. 2022;4(1):e29-e40.
16. Moran J, Kahan JB, Schneble CA, et al. Repair of acute grade 3 combined posterolateral corner avulsion injuries using an enhanced fixation technique. *Orthop J Sports Med*. 2022;10(11):23259671221131817.
17. Poploski KM, Lynch AD, Burns TC, et al; STaR Trial for Multiple Ligament Knee Injuries Network. Presentation and surgical management of multiple ligament knee injuries: a multicenter study from the Surgical Timing and Rehabilitation (STaR) trial for MLKIs network. *J Bone Joint Surg Am*. 2023;105(8):607-613.
18. Treme GP, Salas CS, Ortiz G, et al. A biomechanical comparison of the Arciero and LaPrade reconstruction for posterolateral corner knee injuries. *Orthop J Sports Med*. 2019;7(4):2325967121994203.
19. Vincenti G, Solarino G, Carrozzo M, et al. Major concern in the multiligament-injured knee treatment: a systematic review. *Injury*. 2019;50(2):S89-S94.