Anatomic Multiligament Knee Reconstruction With Biceps Femoris Tendon and Medial Meniscal Repair

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Background: Multiligament knee injuries are defined as tears of ≥2 of the following ligament structures: anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), posteromedial corner, or posterolateral corner (PLC). These injuries occur in various settings and may be associated with knee dislocations.

Indications: The literature has reported that anatomic technique and a single-stage approach for treating multiligament knee injuries are optimal because they may lead to improved outcomes. An anatomic double-bundle PCL reconstruction is suggested to improve knee kinematics compared with a single-bundle PCL reconstruction.

Technique Description: The technique described was used to surgically reconstruct the ACL, PCL, and PLC, and to repair the medial meniscus and biceps femoris tendon. Neurolysis of the common peroneal nerve and dissection of the biceps femoris tendon were performed through the release of scar tissue. Tunnel drilling for the anatomic reconstruction of the PLC, PCL, and ACL was completed. The double bundle PCL reconstruction was performed with Achilles and tibialis anterior tendon allografts, the ACL reconstruction utilized a bone-patellar tendon-bone autograft, and the PLC reconstruction was performed with a split Achilles tendon allograft. Final graft tensioning and fixation were performed in sequence as the PCL anterolateral bundle, the PCL posteromedial bundle, the ACL, the fibular collateral ligament (FCL), the popliteus tendon, and the popliteofibular ligament. A medial meniscal repair was performed with an all-inside suture device, and the biceps femoris tendon repair was performed with 2 suture anchors on the fibular head.

Results: Improved outcomes have been reported with single-stage anatomic reconstructions of multiligament knee injuries, with early initiation of rehabilitation. Acute (<6 weeks) versus late-stage surgical intervention has been discussed to have equivalent postoperative outcomes. A consensus statement described that the timing of surgery should be performed on a case-by-case basis, depending on patient factors.

Discussion/Conclusion: The literature on multiligament knee reconstruction performed in a single stage continues to demonstrate improved outcomes. The technique described restores native knee biomechanics through anatomic-based reconstructions of the ACL, PCL, FCL, popliteofibular ligament, and popliteus tendon.

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: anterior cruciate ligament reconstruction; biceps femoris repair; double bundle posterior ligament reconstruction; multiligament knee injuries; posterolateral corner reconstruction

VIDEO TRANSCRIPT

This is a video presentation depicting an anatomic multiligament knee reconstruction with concomitant repair of the medial meniscus and biceps femoris tendon.

BACKGROUND

Multiligament knee injuries are defined as tears of ≥2 of the 4 major knee ligament structures, the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), posteromedial corner, and posterolateral corner (PLC).[6,10] These traumatic injuries are sometimes associated with a knee dislocation, in addition to potential injury to the hamstrings, menisci, articular cartilage, or neurovascular structures.[3,7,8]

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INDICATIONS

The patient depicted here is a 46-year-old woman who presented to our clinic with right knee instability and pain. The injury occurred approximately 3 months before the initial visit when she stepped into a hole, resulting in a documented right knee dislocation.

Physical examination revealed 5 cm of heel height to 90º of flexion of the affected knee, whereas the contralateral knee demonstrated 3 cm of heel height to 140º of flexion. She had adequate quadriceps strength with mild atrophy when compared bilaterally. She had a grade 2+ Lachman, grade 3 posterior drawer, grade 3 varus stress at 0° and 30°, and a positive dial test. Her extensor hallucis longus had a slight strength deficit of 4+/5 and decreased subjective sensation over the dorsum of her foot.

Radiographs obtained at the time of the injury demonstrated evidence of a right knee dislocation. Stress PCL and varus radiographs obtained in the clinic 3 months after the injury were indeterminate due to muscle guarding. She had neutral long limb mechanical alignment with no evidence suggestive of an acute fracture, and preserved joint spaces. Magnetic resonance imaging revealed tears of the ACL, PCL, PLC, deep medial collateral ligament, posterior horn of the medial meniscus, and biceps femoris tendon.

The patient elected to undergo an anatomic right knee arthroscopic ACL reconstruction, double-bundle PCL reconstruction, complete PLC reconstruction, medial meniscal, and biceps femoris repair, and peroneal nerve neurolysis.

Approximately 5 months after injury, the examination under anesthesia confirmed the clinical findings of a multiligament injury with a high-grade Lachman, pivot shift, posterior drawer, dial test, and varus stress testing at 0° and 30°.

TECHNIQUE DESCRIPTION

The posterolateral corner was approached first with a standard lateral hockey-stick incision, and dissection was carried down to the superficial layer of the iliotibial band (ITB). Dissection continued to the biceps femoris tendon, which was retracted 6 cm with significant scar tissue.

After a prolonged, meticulous dissection, the common peroneal nerve (CPN) was visualized and released, as it was scarred to the biceps femoris, and it appeared very irritable.

Next, the anatomic attachment of the fibular collateral ligament (FCL) was identified about 8 mm posterior to the anterior margin of the fibular head. Using a fibular head guide (Smith & Nephew), a guide pin was drilled at a slight proximal and posterior angle and exited posteromedially on the fibular head. It was then overreamed with a 7-mm reamer with placement of a passing stitch.

Next, the dissection of the tibial flat spot distal and medial to the Gerdy tubercle identified the anterior location for the PLC tibial tunnel. A guide pin was then drilled at the flat spot anterior to posterior while evaluating the exit at the popliteus musculotendinous junction. The exit site was 1 cm medial and proximal to the fibular head tunnel. The guide pin was then overreamed with a 9-mm reamer with a large retractor protecting the posterior neurovascular structures, followed by placement of a passing stitch.

The PLC attachments on the femur were then approached with splitting of the ITB, and a small lateral arthrotomy incision was made just anterior to the popliteal sulcus. The popliteus tendon femoral attachment was identified at the anterior fifth of the popliteal sulcus. An eyelet pin was drilled at this location anteromedially across the femur at a 40° angle anterior and slightly proximal to prevent convergence with the ACL tunnel. Next, the FCL attachment site was located 18 mm posterior and proximal to the popliteus tendon femoral attachment. The remnant of the FCL femoral attachment was identified, and a guide pin parallel to the popliteus tendon guide pin was drilled. After confirming there was no convergence of the tunnels, the FCL and popliteus pins were overreamed with a 9-mm reamer to a depth of 25 mm, and the passing sutures were placed.

An anteromedial incision was created medial to the patellar tendon, providing access for the future ACL and PCL tibial tunnels, along with exposure for the bone-patellar tendon-bone (BTB) autograft harvest. The BTB autograft was harvested from the central third of the patellar tendon with a 10 × 20 mm bone block from the patella and a 10 × 25 mm bone block from the tibial tubercle.

The PCL anterolateral bundle (ALB) was prepared from an Achilles tendon allograft, while the PCL posteromedial bundle (PMB) was prepared from a tibialis anterior allograft. The graft for the PLC was a split Achilles tendon allograft for the FCL and popliteus tendon.

Arthroscopy was then initiated with medial and lateral parapatellar portals. Grade 2 chondromalacia was visualized at the patella and medial tibial plateau, and a gentle chondroplasty was performed. An undersurface posterior

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horn medial meniscal tear was visualized, which confirmed the previous magnetic resonance imaging findings.

Complete chronic ACL and PCL tears were visualized. The lateral compartment presented with a wide-open drive-through sign, consistent with a complete PLC tear.

Next, the PCL ALB femoral anatomic attachment was located 7.4 mm from the trochlear point and 11 mm from the medial arch point. An 11-mm acorn reamer was positioned at the ALB attachment, and an eyelet pin was drilled through the reamer anteromedially, with the knee at 90° of flexion. A closed socket tunnel was reamed 25 mm over the eyelet pin, followed by placement of the passing suture. The PCL PMB anatomic attachment was located 12 mm from the ALB center and 5 to 6 mm posterior to the notch cartilage margin. A 7-mm acorn reamer was placed at the PMB center, and another eyelet pin was drilled through the reamer with a divergent trajectory from the ALB tunnel. Then, a 7-mm closed socket tunnel was reamed 25 mm over the eyelet pin, ensuring that a 2-mm bone bridge was maintained between tunnels, followed by placement of another passing suture.

The ACL femoral attachment was then visualized, an accessory medial portal was created, and a bur hole was used to mark the ACL femoral footprint. With maximal flexion of the knee, an over-the-top guide pin was drilled anterolaterally out of the thigh. This was then overreamed with a 10-mm acorn reamer, leaving a 1.5-mm posterior cortex, followed by placement of a passing stitch.

A posteromedial portal was created to evaluate and prepare the desired location of the PCL tibial tunnel at the bundle ridge. Care was taken to ensure that the shaver and coagulator were facing anteriorly to avoid the posterior neurovascular bundle. The shiny white fibers of the medial meniscus were identified, and cleaning continued until the desired location, just superior to the champagne glass drop-off, was visualized.[4] The choice of guide pin drill location on the anteromedial tibia was 6 cm distal to the joint line, located between the anterior tibial crest and medial tibial border, exiting posteriorly at the bundle ridge (tibial PCL facet).[1]

Next, rasping was performed to stimulate vascularity near the posterior horn medial meniscal tear. An all-inside meniscal repair was then performed using a Fast-Fix Flex suture (Smith & Nephew).

For the ACL tibial tunnel, an ACL guide (Arthrex) was used to drill a guide pin adjacent to and medial to the anterior root of the lateral meniscus. An optimizer was used, as the guide pin was not initially in the optimal location.

The PCL tibial tunnel was then reamed with a 12-mm reamer, using power for 60% of the way, and finished by hand to prevent overpenetration posteriorly, while a large curette was placed over the guide pin to protect the neurovascular bundle. A Gore Smoother (Smith & Nephew) was placed in the tibial PCL tunnel to remove any bony spicules and passed out the anterolateral arthroscopic portal. The ACL tibial guide pin was then overreamed with a 10-mm reamer.

Graft passing then began. The PCL PMB allograft was passed first and fixed in its femoral tunnel with a 7 × 20 mm bioabsorbable screw. Then, the PCL ALB allograft bone plug, cortical side up, was fixed in the femoral tunnel with a 7 × 20 mm titanium screw. Both grafts were then passed down the tibia using the Gore smoother.

The ACL autograft was then passed up the tibial tunnel and into the femoral tunnel, where the bone block was fixed with a 7 × 20 mm titanium screw. Cycling of the knee was performed with no evidence of graft impingement.

Attention was turned to passing the PLC split Achilles tendon allograft. The bone blocks of the popliteus tendon and FCL grafts were pulled into their femoral tunnels and secured with 7 × 20 mm titanium screws. The popliteus tendon graft was passed down the popliteus hiatus, while the FCL graft was passed beneath the ITB and superficial to the popliteus tendon graft and then through the tunnel of the fibular head, anterolateral to posteromedial.

Moatshe et al,[9] described the graft fixation and tensioning sequence as PCL ALB, PCL PMB, ACL, FCL, and finally the popliteofibular ligament and the popliteus tendon. Both the ALB and PMB were fixed on the tibia with 6.5-mm titanium screws and 18-mm spiked washers. The ALB fixation on the tibia was approached first. The screw location was predrilled, measured, and tapped to determine the proper screw length for fixation. Fixation of the ALB occurred at 90° of knee flexion with an anterior reduction force. The PMB screw location was then predrilled, measured, tapped, and secured in full extension. After cycling the ACL autograft several times, it was then fixed in the tibial tunnel with a 9 × 20 mm titanium screw with the knee in full extension.

After removal of the tourniquet and hemostasis, the FCL graft was fixed with traction into the fibular head with a 7 × 20 mm bioabsorbable screw with 20° of knee flexion.

The remaining portion of the FCL graft, which becomes the popliteofibular ligament, and the popliteus tendon were then passed posterior to anterior through the tibia and fixed in the tibial tunnel with a 9 × 20 mm bioabsorbable screw with the knee in 60° of flexion and foot in neutral rotation.

Lastly, to fix the biceps femoris tendon, 2 double-loaded Q-fix anchors were anchored into the posterior aspect of the fibular head. One limb of each suture anchor was whipstitched into the biceps tendon, while the other limb served as the post. The limbs were then secured with the knee in full extension while ensuring the CPN was not in the surgical field.

Deep and superficial closure was followed by application of a sterile dressing and a knee immobilizer in full extension.

Although multiligament knee injuries are relatively uncommon, they present a unique set of challenges due to the critical nature of the injury. In chronic cases, especially with injury to the biceps femoris tendon, the CPN may be scarred in unusual positions. A slow and meticulous CPN neurolysis should be performed to minimize the risk of further postoperative sensory and motor deficits. While drilling the FCL and popliteus tendon femoral tunnels, collision with the ACL femoral tunnel or damage to the trochlea is a possible complication. These risks can be significantly decreased if the FCL and popliteus tendon femoral tunnels are drilled at an angle of 35° to 40° anteriorly and slightly proximally. When reaming the tibial tunnel for the PCL, it is important to place a curette on top of the pin and finish reaming by hand to help prevent posterior neurovascular complications.

RESULTS

Day 1 postoperative physical therapy begins with quadriceps activation, edema control, and prone knee flexion from 0° to 90° for 2 weeks, after which she can increase as tolerated. She will be nonweightbearing for 6 weeks and will transition to her dynamic PCL brace as soon as swelling allows, which will be worn at all times for the first 6 months postoperatively.

A case series performed by LaPrade et al,[5] reported the outcomes of 194 patients who received single-stage multiligament knee reconstructions. Among patients treated in the acute phase (<6 weeks) and the chronic phase, there was no significant difference in postoperative functional scores.

DISCUSSION/CONCLUSION

A systematic review by Everhart et al,[2] with 524 patients reviewed multiligament knee injuries and evaluated return to work or sport status. Surgical patients returned to work with little or no modifications 79.3% of the time, while return to any level of sport decreased slightly to 59.1% overall.

Plain films were ordered and received in the clinic on postoperative day 1. There was no evidence of acute fractures or soft tissue abnormalities. Hardware was intact and nondisplaced.

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