Double-Bundle Posterior Cruciate Ligament and Concomitant Medial Collateral Ligament and Posterior Oblique Ligament Reconstruction After a Motor Vehicle Accident

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Background: Motor vehicle accidents constitute the most prevalent high-energy mechanisms for knee dislocation, resulting in multiligament knee injuries (MLKIs). When concomitant posterior cruciate ligament (PCL) and posteromedial corner injury becomes chronic after failed conservative treatment, surgical intervention is indicated to restore the native knee biomechanics.

Indications: Double-bundle PCL reconstruction is indicated for chronic instability, increased posterior tibial translation, decreased tibial slope, and failure of conservative treatment measures. posteromedial corner reconstruction is indicated for increased valgus laxity, anteromedial rotary instability, and in the setting of a chronic MLKI.

Technique Description: The gracilis and semitendinosus autografts are identified, harvested, and fixated to suture anchors that are placed at the anatomic distal medial collateral ligament (MCL) attachment. At the femur, the adductor tubercle is identified to localize the anatomic femoral attachments of the MCL and the posterior oblique ligament (POL). Guide pins are placed in the anatomic attachment sites, and 7-mm tunnels are reamed. The tibial POL attachment is identified just distal to the anterior arm of the semimembranosus tendon and then overreamed with a 7-mm reamer. The hamstring grafts are passed under the sartorius fascia, with the excess used for the POL autograft. For the PCL, the anterolateral (ALB) and posteromedial (PMB) femoral tunnels are reamed to 11 mm and 7 mm, respectively. The tibial PCL tunnel guide pin location is confirmed with fluoroscopy and reamed with a 12-mm reamer using a protective curette. A tibialis anterior allograft is passed and fixed in the femoral PMB, and an Achilles allograft is passed and fixated in the femoral ALB PCL tunnels. The PCL ALB graft is fixed to the tibia at 90° and neutral rotation and the PMB at 0°. The MCL and POL grafts are pulled into their tunnels and fixated at 30° and 0°, respectively.

Results: Concomitant PCL, MCL, and POL reconstruction with concurrent medial meniscus repair restores knee biomechanics, decreases pain and instability, and reduces the risk of progression of osteoarthritis.

Discussion/Conclusion: Clinical and biomechanical studies report comparative outcomes for acute reconstructions of ACL- and PCL-based MLKIs in the short- and long-term follow-up.

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: posterior cruciate ligament reconstruction; medial collateral ligament; posterior oblique ligament; multiligament injury; posteromedial corner reconstruction

VIDEO TRANSCRIPT

This is a video presentation depicting a left knee double-bundle posterior cruciate ligament (PCL) and concomitant medial collateral ligament (MCL) and posterior oblique ligament (POL) reconstruction after a motor vehicle accident.

Shown here are the senior author's disclosures.

BACKGROUND

Multiligament knee injuries (MLKIs) are commonly classified as tears of at least 2 or more of the major ligament

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complexes: anterior cruciate ligament (ACL), PCL, posteromedial corner, and/or posterolateral corner (PLC).[1] Injury mechanisms vary from ultra-low-velocity trauma with obese patients, to sports-related low-energy trauma, to high-energy trauma resulting from high falls or motor vehicle accidents.[3,7] Motor vehicle accidents are one of the most common high-velocity mechanisms and require heightened attention with acute management of concomitant meniscal, chondral, and neurovascular injury alongside ligament damage.[4-6] When conservative treatment fails and patients have chronic pathology, gross instability, and functional limitation, surgical reconstruction becomes necessary to restore the native biomechanics of the knee.

INDICATIONS

A 44-year-old otherwise healthy man presented to the clinic 2.5 months after a motor vehicle accident, where he was thrown from the vehicle and sustained multiple injuries to his upper and lower extremities. He reported ongoing medial-sided left knee pain and instability since the accident. He denied limitation in range of motion, radiating pain, weakness, numbness, or tingling of the lower extremities. Conservative treatments, including physical therapy and bracing, had failed. He reported a history of a left partial medial meniscectomy 3 years prior.

Examination of the patient's left knee revealed well-healed arthroscopic portal incisions and trace effusion. He was tender to palpation at the medial joint line, and knee motion was from 4 cm of heel height to 130° of flexion. The knee was stable to Lachman's. He had a posterior tibial sag sign and 3+ anteromedial and posterior drawer tests. There was also increased medial joint line gapping on valgus stress testing at both 0° and 20° of knee flexion. The knee was stable to varus stress. Sensory-motor function was intact with no neurovascular deficits.

Radiographs (including full limb length views) revealed the patient was in neutral alignment bilaterally. His anteroposterior and lateral radiographs showed no evidence of acute fracture, soft tissue abnormalities, or joint line narrowing. Valgus stress radiographs demonstrated a 3.2-mm increased side-to-side difference compared to the contralateral side. PCL stress radiographs revealed an 8-mm increased posterior tibial translation on the left compared to the right.

Magnetic resonance imaging demonstrated a grade 3 MCL tear with concomitant tearing of the deep MCL and POL at the meniscocapsular junction and associated bone marrow edema along the anterior aspect of the lateral femoral condyle and posterior lateral tibial plateau. A moderate-grade PCL tear was present. Additionally, there was a horizontal cleavage tear of the posterior horn of the medial meniscus and the sequelae of the previous small partial medial meniscectomy.

We determined the patient's diagnosis of grade 3 PCL, MCL, and POL tears, as well as a posterior horn medial meniscus tear. The patient's conditions were discussed, and the risks and benefits of the surgery were provided. The patient elected to undergo a double-bundle PCL reconstruction, MCL and POL reconstructions, and an all-inside medial meniscus repair to resolve medial knee pain, instability, and mechanical dysfunction.

TECHNIQUE DESCRIPTION

The patient was induced under general anesthesia. The examination under anesthesia confirmed complete tears of his PCL, MCL, and POL and was consistent with our previous clinical examination.

An anteromedial incision was made extending from the vastus medialis oblique to 8 cm distal to the joint line, splitting the distance between the anterior tibial crest and the posteromedial aspect of the tibia. Significant scarring was encountered due to the chronic nature of the injury.

A split was made in the sartorial fascia to visualize the gracilis and semitendinosus tendons.

After careful attention was taken to remove all adhesions and scar tissue to prevent graft amputation, the tendons were meticulously harvested with open hamstring harvesters to ensure adequate graft length was preserved for concomitant POL reconstruction. We measured 6 cm distal to the joint line at the distal MCL tibial attachment and placed 2 Q-Fix anchors (Smith & Nephew) at this location. The grafts were fixed at this location, which reconstituted the distal tibial attachment of the MCL.

We then dissected proximally and identified the adductor magnus tendon. This allowed us to locate the adductor tubercle at the tendon's femoral insertion. The medial epicondyle was measured 12 mm distal and 8 mm anterior to the adductor tubercle, and the remnant of the MCL was found, identifying the anatomic femoral attachment. The POL femoral attachment was identified 7.7 mm distal and 6.4 mm posterior to the adductor tubercle. Beath pins were drilled through the center of these attachment

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sites and overreamed with a 7-mm diameter acorn reamer, and passing sutures were placed. The MCL pin was aimed 40° proximal and 20° to 40° anterior, while the POL pin was aimed 20° proximal and 20° anterior to prevent tunnel convergence. We then brought the grafts under the remaining sartorius fascia and proceeded to whipstitch the end of it such that 3 cm would sit in the femoral tunnel. The excess portion was used for the 12-cm-long POL graft.

We then dissected posteromedially and identified the semimembranosus tendon and identified where the POL tibial tunnel would go and then proceeded to use the tibial collateral ligament system guide (Smith & Nephew) to drill a Beath pin, which emerged near Gerdy's tubercle. We then overreamed this with a 7-mm diameter reamer and placed a passing stitch for the POL graft.

The physician assistant prepped the PCL and POL grafts on the back table. The anterolateral bundle (ALB) of the PCL was prepared from an Achilles tendon allograft with an 11 × 20-mm bone plug and tubularized distally. The posteromedial bundle (PMB) of the PCL was prepared from a tibialis anterior allograft. The excess portion of the MCL reconstruction graft, used to prepare the POL autograft, was 12 cm long and whipstitched on each end with No. 2 nonabsorbable suture (Ethicon).

Anteromedial and anterolateral parapatellar portals were then made, the camera was inserted, and the joint was insufflated with normal saline. Assessment of the intra-articular compartments identified the medial meniscus tear, which was repaired using an all-inside haybale technique.

His ACL had a slack sign, which was reduced when we pulled the tibia forward, reducing the PCL tear.

Viewing from the anterolateral portal, we then outlined on the medial notch where the PCL attaches. The ALB and the PMB were identified using anatomic landmarks. The ALB was located midway between the trochlear point and the medial arch point, touching the edge of the cartilage. The PMB was midway between the medial arch point and the posterior point, at a distance of 8.6 mm posterior to the articular cartilage, leaving a 2-mm bone bridge for the PMB. Guide pins were then placed using each reamer to localize the position and exited at the anteromedial aspect of the femur, and then 11-mm and 7-mm diameter tunnels were reamed, respectively.

A posteromedial arthroscopic portal was made under direct vision, dissection was carried down to the tibia, and the PCL bundle ridge was identified. We then proceeded to drill a guide pin, which came out in the center of the bundle ridge, and we confirmed fluoroscopically that it was in the proper anatomic location, 7 mm proximal to the champagne glass drop-off of the tibia.

We then proceeded to ream the PCL reconstruction tibial tunnel. We reamed to about 70% of the depth by power and completed the rest by hand with a large curette to protect from overpenetration. A large Gore Smoother (Smith & Nephew) was then passed up the tibial tunnel and used to smooth off the posterior aperture. The end of the Gore Smoother was then pulled out of the lateral portal.

The PMB graft was passed into its femoral tunnel and fixed with a 7 × 20-mm bioabsorbable screw (Smith & Nephew). The bone plug for the ALB was passed into its femoral tunnel and fixed with a 7 × 20-mm titanium interference screw (Smith & Nephew). The Gore Smoother was then used to pull the PCL grafts down the tibial tunnel. The arthroscope was used to confirm that there was no bunching of the grafts.

We then proceeded with a 6.5-mm screw and washer (Arthrex) to fix the ALB first at 90° of knee flexion with an anterior tibial force to reduce the posterior tibial translation, followed by the PMB in full extension. The posterior drawer was eliminated following the fixation of both bundles.

We then fixed the MCL graft into the femoral tunnel with a 7 × 20-mm bioabsorbable screw in 20° of knee flexion and traction on the graft.

The POL graft was then passed into the femur and tibia, respectively, and fixed in full extension. An additional Q-Fix anchor (Smith & Nephew) was placed approximately 12.2 mm distal to the medial joint line, restoring the native proximal tibial attachment site of the superficial MCL. We noted that his valgus stress test was completely eliminated. We visualized the intra-articular compartment a final time to confirm repairs and that his PCL grafts were taut.

The tourniquet was let down, and hemostasis was obtained. The deep tissues were closed with 0 and 2-0 Vicryl (Ethicon), followed by a Monocryl (Ethicon) stitch for the skin.

On postoperative day 1, the patient should start physical therapy to work on quadriceps activation, edema control, and knee motion. The patient should work on prone knee flexion from 0° to 90° for the first 2 weeks and then increase the prone range of motion as tolerated. The patient should transition to their PCL Rebound (Ossur) brace when the incision allows, between 5 and 14 days. The patient should then plan to wear the PCL Rebound (Ossur) at all times, except to change clothes and shower for the first 6 months postoperatively. Stress radiographs will be obtained at 6 months postoperatively to determine when to start weaning out of the PCL brace.

DISCUSSION

With the complex nature of MLKIs, potential complications should be considered to avoid surgical pitfalls. One such complication is nonanatomic tunnel placement, resulting in tunnel malposition. The MCL femoral attachment is 4.8 mm posterior and 3.2 mm proximal to the medial epicondyle, and the POL femoral attachment is located 6 mm posterior and 7 mm distal to the adductor tubercle. When placing guide pins at these locations, use caution to avoid convergence with the PCL tunnels. The MCL pin should be aimed 20° to 40° anterior and 40° proximal, and the POL guide pin should be aimed 20° anterior and 20° proximal. The POL tibial tunnel is located just distal to the anterior arm of the semimembranosus tendon and should be aimed 15 mm anterior to Gerdy's tubercle to avoid convergence with the tibial PCL tunnel.

Second, failure to treat complete injury pathology can lead to graft failure. Untreated unstable meniscus tears in the short term alter proper knee biomechanics and

stability, elevating the chances of uneven graft loading and risk of reconstruction graft failure. From a long-term perspective, unattended damage promotes increased compartment loading and accelerates degeneration with the progression of osteoarthritis.

Finally, iatrogenic neurovascular injury and/or failure to recognize existing neurovascular deficiency are known risks of a PCL reconstruction. Risks of neurovascular injury to the common peroneal nerve and popliteal artery are well established, specifically with traumatic knee dislocations or revision surgical procedures. Failure to treat these issues acutely can delay the overall recovery time, limit long-term function, and elevate the risk of life-threatening conditions. Utilize curettes, spoon retractors, and hand reaming to prevent posterior puncture with guide pins, shavers, and reamers.

RESULTS

A study by LaPrade et al[2] evaluated the clinical and radiographic outcomes of single-stage MLKIs and compared ACL-based versus PCL-based reconstructions with immediate postoperative rehabilitation. The study identified 276 patients with MLKIs and obtained complete follow-up from 194. At follow-up (mean, 3.5 years; range, 2-8 years), significant improvement ($P < .001$) was observed in all postoperative patient-reported outcome measures (Tegner, Lysholm, and Western Ontario and McMaster Universities Osteoarthritis Index scores). No significant differences were observed in patient-reported outcome measures between patients in the acute or chronic treatment settings. ACL- and PCL-based reconstructions observed no significant difference in outcome scores. There were significant improvements in valgus, posterior kneeling, and varus stress radiographs from pre- and postoperative states for patients with MCL ($3.4 \pm 0.9 \longrightarrow 0.2 \pm 0.9$, $P = .002$), PCL ($12.5 \pm 2.9 \longrightarrow 1.2 \pm 1.3$, $P < .0001$), and fibular collateral ligament/PLC-based ($2.9 \pm 0.9 \longrightarrow -0.1 \pm 0.8$, $P < .0001$) injuries. Further surgical intervention was required in 9.3% (18) of knees postoperatively.

CONCLUSION

Left knee anteroposterior and lateral radiographs were obtained and revealed no evidence of acute fractures, soft tissue abnormalities, or displaced hardware. All joint spaces appeared preserved compared to prior imaging.

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