Operative Techniques in
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High Tibial Osteotomy in Posterior Cruciate Ligament Posterolateral Instability: Decision Making and Surgical Technique

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Osteotomies for the posterior cruciate ligament and the posterolateral corner injuries are a powerful tool in the treatment of patients with malalignment. An osteotomy may obviate the need for soft tissue reconstruction when performed in a staged fashion and can off-load injured or degenerative cartilage. The evidence base for osteotomy in the setting of the posterior cruciate ligament or the posterolateral corner injuries is limited to biomechanical studies and case series. Careful patient selection is required with thorough history, examination, and radiographic investigation and is based on an understanding of the knee anatomy and kinematics. The surgical approach commences with a systematic examination under anesthesia and arthroscopic joint examination with treatment of intra-articular lesions. Longitudinal skin incision is centered over the site of the osteotomy and is made middle line if tibial tubercle osteotomy is planned. Guide wires, fluoroscopy, and the combined use of oscillating saw and ostetomes are used to precisely guide the osteotomy and reduce the risk of intra-articular fracture. Mechanical axis correction to neutral alignment is desired in the setting of instability and is checked intraoperatively with a drop rod or long guide wire. The knee is examined for stability. The femoral head allograft is used to fill bone voids and the osteotomy site is secured with puddu plate or periarticular plate. Early range of motion is commenced and weight bearing is restricted until bone healing has occurred.
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Injuries to the posterior cruciate ligament (PCL) and the posterolateral corner (PLC) often occur in combination and can be associated with progressive malalignment of the knee. Osteotomy of the proximal tibia for PCL, PLC injuries, or combined injuries is a powerful tool to change coronal and sagittal alignment to affect the weight-bearing axis of the lower extremity and may obviate the need for soft tissue reconstruction or protect reconstructed ligaments. Additionally, osteotomy may off-load chondral injuries and meniscal damage or deficiencies. Indications for osteotomy in the setting of PLC-PLC injuries are based on an understanding of the anatomy of the knee and its kinematics. The evidence base for these procedures primarily consists of biomechanical studies on cadavers or computer modeling with some limited prospective clinical evidence in the setting of high grade PLC injuries and combined PLC-PCL injuries.

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Osteotomy for Isolated PCL Injuries

The treatment of chronic isolated PCL injuries is controversial owing to the absence of long-term, high-level evidence on clinical results to guide indications for nonoperative and operative treatment. Additionally, despite the large variety of soft tissue reconstruction techniques, significant residual laxity is a common feature. The effect of chronic high-grade PCL deficiency is asymmetric loading and accelerated degeneration of the anterior tibial plateau and the patellofemoral joint. Eventual fixed posterior subluxation of the tibia may occur.[1] Posterior tibial slope is recognized to play a crucial role in the

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sagittal stability of the cruciate-deficient knee. Osteotomies to change sagittal alignment by altering tibial slope may result in significant clinical improvement in the PCL-deficient knee by reducing posterior sag and posterior tibial translation.

Shelburne et al[2] used a validated computer model to examine the effect of increasing posterior tibial slope on the knee joint loading and cruciate ligament forces during daily activities. Increases in the posterior tibial slope of upto 10° were modeled during activities of standing, squatting, and walking. They determined that during each task, tibial shear forces, anterior tibial translation, and cruciate forces increased linearly with increases in posterior tibial slope. When posterior tibial slope was increased by 10°, the anterior tibial translation increased 5 mm for walking and 4 and 3 mm for standing and squatting, respectively. This is in agreement with other studies examining tibial translation in certain pathologic or anatomical scenarios.[2-6]

Giffin et al[6] examined the effects of increasing the tibial slope on knee kinematics in the PCL-deficient knee. Using a force-moment sensor, the multiple degree of freedom knee kinematics were determined under anterior-posterior (AP) and axial compressive loads. A total of 10 cadaveric knees were tested in 3 states: intact PCL, PCL deficient, and PCL deficient with increased tibial slope (via 5 mm anterior opening wedge osteotomy). At various degrees of flexion, 3 external loading conditions (134 N AP tibial load, 200 N axial compressive load, and combined 134 N AP and 200 N axial loads) were applied to each knee. Kinematics of the knee were measured, specifically AP translations, medial-lateral translations, proximal-distal translations, internal external rotations, and varus-valgus rotations. The investigators found an increased slope reduced posterior sag of the PCL-deficient knee by significantly increasing the anterior shift of the tibial resting position. Additionally, they found a further deduction of posterior sag when the specimens were subjected to axial compressive loads. The authors suggest that a slope-increasing osteotomy may improve sagittal stability and resting position of the tibial, especially under axial load. They suggest that an osteotomy in a PCL-deficient knee may improve joint congruity and help restore the posterior horn of the medial meniscus to its functional weight-bearing position.

Osteotomy for Isolated PLC and Combined PCL-PLC Injuries

Treatment decisions for PLC injuries depend on the timing of diagnosis, the severity of injury, and associated injuries. PLC injuries are frequently treated on a delayed basis with reconstruction owing to delayed diagnosis of the injury or surgeon and patient preference. It is important to recognize that PLC injuries rarely occur in isolation. Concomitant injury to the PLC occurs in 60% of knees with PCL deficiency and is the most commonly associated injury.[7] Knees with chronic PLC injuries are at risk of triple varus deformity, occurring due to the following 3 factors: tibiofemoral osseous varus alignment, separation of the lateral tibiofemoral compartment, and increased tibial external rotation and hyperextention. Combined ligament injuries may accelerate or increase the risk of developing deformity. It is critical to assess for malalignment when treating chronic PLC injuries, as reconstructions in the setting of varus alignment are at risk of stretching or failing over time.[8,9]

Petrigliano et al[10] examined the effect of high tibial osteotomy on dynamic knee stability using computer-assisted navigation. Posterior drawer, dial, and reverse pivot-shift test were performed on 10 cadaveric specimens with PCL and PLC structures sectioned. Medial and lateral compartment translation was measured before and after proximal tibial osteotomy in the sagittal plane in either +5 or −5 slope variations. Sectioning of the PCL and PLC structures produced significant increases in the posterior drawer test, dial test, and reverse pivot-shift test. Increasing the posterior tibial slope by 5° significantly reduced medial compartment translation during the drawer test but had no significant effect on the dial test or reverse pivot-shift test. Conversely, reducing the posterior slope by 5° dramatically increased the translation in both the medial and lateral compartments and increased translation during the reverse pivot-shift test. The investigators concluded that increasing posterior tibial slope should be considered in the PLC-PCL–deficient knee to improve sagittal stability. They also concluded that mulitplanar instability may be worsened in the setting of decreased posterior tibial slope and a PLC-PCL–deficient knee.

Prospective clinical evidence exists to support the correction of coronal alignment before or in addition to reconstruction of the chronically injured posterolateral structures. There are 2 studies with heterogeneous patient populations that have reported good outcomes with proximal tibial osteotomy in the patients with isolated PLC and combined PLC-PCL injuries.[11,12] Arthur et al[9] reported on the outcomes of patients with combined genu varus alignment and grade 3 PLC injuries treated initially with proximal tibial opening wedge osteotomy, followed by second stage soft tissue reconstruction if necessary. Patients who continued to have functional deficits and instability for a minimum of 6 months after osteotomy were offered a soft tissue reconstruction. A total of 21 patients were enrolled: 6 patients had an isolated PLC injury; 6 patients had an anterior cruciate ligament (ACL) and PCL deficiency; 6 patients had PCL and PLC deficiency; 2 patients had ACL, PCL, and PLC deficiency; and 1 patient had a PLC ligament injury with medial tibial plateau fracture (treated and healed elsewhere). There was a significant change in coronal alignment preoperatively and postoperatively with no significant change in tibial slope. At an average of 37 months, a total of 8 patients (38%) felt they did not require further surgery and did not require a brace for their activities. The most predictive factor for patients requiring a second stage soft tissue procedure was a high severity of the initial knee injury and multiple ligament injuries. Of the isolated PLC injuries, 4 of 6 patients did not require the second stage procedure. In the treatment of PLC-deficient knees, the authors concluded an initial proximal tibial opening wedge osteotomy followed by a period of convalescence to determine subsequent clinical and functional instability is a reasonable approach.