CURRENT CONCEPTS REVIEW

Posterior Cruciate Ligament: Current Concepts Review

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Abstract

The posterior cruciate ligament (PCL) is the largest and strongest ligament in the human knee, and the primary posterior stabilizer. Recent anatomy and biomechanical studies have provided an improved understanding of PCL function. PCL injuries are typically combined with other ligamentous, meniscal and chondral injuries. Stress radiography has become an important and validated objective measure in surgical decision making and post-operative assessment. Isolated grade I or II PCL injuries can usually be treated non-operatively. However, when acute grade III PCL ruptures occur together with other ligamentous injury and/or repairable meniscal body/root tears, surgery is indicated. Anatomic single-bundle PCL reconstruction (SB-PCLR) typically restores the larger anterolateral bundle (ALB) and represents the most commonly performed procedure. Unfortunately, residual posterior and rotational tibial instability after SB-PCLR has led to the development of an anatomic double-bundle (DB) PCLR to restore the native PCL footprint and co-dominant behavior of the anterolateral and posteromedial bundles and re-establish normal knee kinematics. The purpose of this article is to review the pertinent details regarding PCL anatomy, biomechanics, injury diagnosis and treatment options, with a focus on arthroscopically assisted DB-PCLR.

Level of evidence: IV

Keywords: Double bundle posterior cruciate ligament reconstruction, Posterior cruciate ligament, Posterior knee laxity, Stress radiographs

Introduction

Posterior cruciate ligament (PCL) tears comprise 3% of outpatient knee injuries and 38% of acute traumatic knee hemarthroses (1). These injuries rarely occur in isolation, and up to 95% of PCL tears occur in combination with other ligament tears. With more people participating in sporting activities, these injuries will potentially increase in the future. PCL tears are increasingly being recognized as source of morbidity and reduced function because of persistent instability, pain, impaired function and development of degenerative joint disease (2, 3).

In recent years, a better understanding of the anatomy and biomechanics of the PCL has emerged, leading to improved surgical techniques and rehabilitation protocols for the treatment of PCL tears. However, controversy still exists regarding the decisions for non-operative versus operative treatment, and the optimal surgical technique. The heterogeneity of these injuries can make it difficult to compare studies in the literature. Furthermore, studies with long-term follow-up are still lacking in the literature. The purpose of this review was to report on the current concepts of PCL tears including the anatomy, biomechanics, diagnosis, treatment options, rehabilitation, and outcomes reported in the literature.

Anatomy

The PCL is the largest and strongest intraarticular ligament of the knee joint, comprising of 2 functional bundles: the larger anterolateral bundle (ALB) and the smaller posteromedial bundle (PMB) (4). The size of the femoral attachment of the ALB is nearly twice the size

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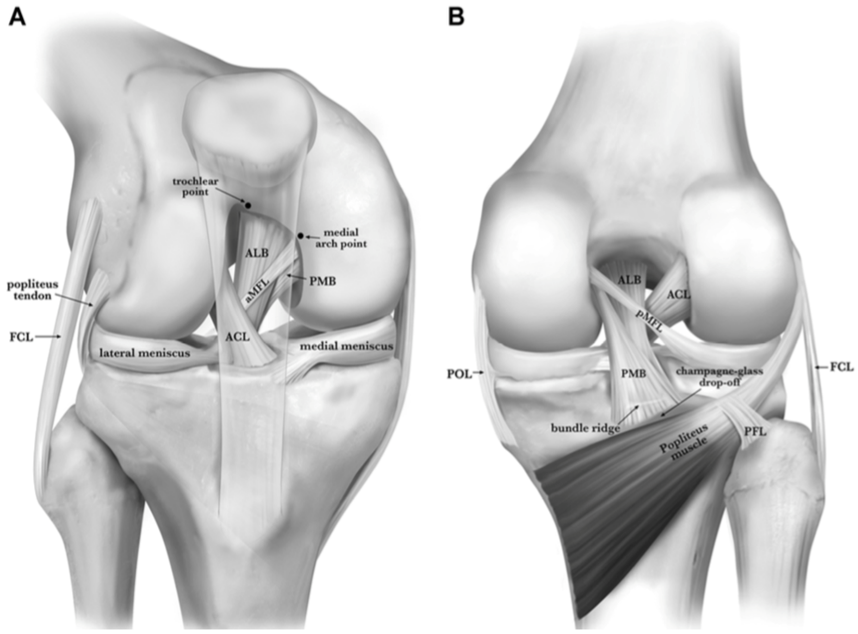

Figure 1. (A) Anterior and (B) posterior views of the native posterior cruciate ligament (PCL). Emphasized are the femoral and tibial attachments of the anterolateral bundle (ALB) and posteromedial bundle (PMB) of the PCL and the osseous landmarks: the trochlear point, the medial arch point, the bundle ridge, and the champagne-glass drop-off. ACL, anterior cruciate ligament; aMFL, anterior meniscofemoral ligament (ligament of Humphrey); FCL, fibular collateral ligament; PFL, popliteofibular ligament; pMFL, posterior meniscofemoral ligament (ligament of Wrisberg); POL, posterior oblique ligament ***(Reproduced with permission from Kennedy NI, Wijdicks CA, Goldsmith MT, et al. Kinematic analysis of the posterior cruciate ligament, part 1: the individual and collective function of the anterolateral and posteromedial bundles. Am J Sports Med. 2013;41(12):2828-2838.).***

of its tibial attachment and has been reported to range from 112 to 118 mm^2 (5–7). The center of the femoral ALB footprint is located 7.4 mm from the trochlear point, 11.0 mm from the medial arch point, and 7.9 mm from the distal articular cartilage. Furthermore, ALB tibial attachment center is located 6.1 mm posterior to the shiny white fibers of the posterior medial meniscus root, 4.9 mm from the bundle ridge (which separates both bundles), and 10.7 mm from the champagne glass drop-off of the posterior tibia (5).

The area of the PMB femoral attachment is between 60 mm^2 and 90 mm^2 in size and is located between the anterior and posterior meniscofemoral ligaments. The femoral PMB center is located 11.1 mm from the medial arch point and 10.8 mm from the posterior point of the articular cartilage margin. Meanwhile, the PMB tibial attachment center is located 4.4 mm anterior to the champagne glass drop-off of the posterior tibia and 3.1 mm lateral from the medial groove of the medial tibial plateau articular surface (5). These measures have biomechanical and surgical implications, because an anatomic reconstruction of the ALB and PMB better restores native knee kinematics and has been reported to improve clinical outcomes [Figure 1].

Biomechanics

Functionally, the PCL is a primary restraint to posterior tibial translation at all flexion angles. It also has a role in primary restraint for internal rotation beyond 90° and a supplemental restraint to external tibial rotation beyond 90° of flexion (7). Both bundles have a synergistic and codominant behavior during knee range of motion (ROM) (6, 7). Historically, the ALB and PMB were believed to function independently in a reciprocal nature, with the ALB primarily functioning in deep flexion and the PMB in extension (4, 8, 9). However, recent biomechanical studies have demonstrated that both the ALB and PMB assume a significant role in resisting posterior tibial translation at all flexion angles. This suggests a codominant relationship between both bundles and, therefore, both assume a significant role in knee stability in the absence of the other bundle (4, 6, 10).

The ALB is the main resistant to posterior tibial translation between 70° and 105°, while the PMB is the main resistant between 0° and 15°. This distribution of forces between the two bundles has surgical implications at the time of graft fixation during anatomic double-bundle (DB) PCL reconstructions (PCLR). Kennedy et al. reported in a biomechanical study that when both bundles were sectioned, 11.7 mm of posterior tibial translation at 90º was observed (7). This suggests that to have a grade III PCL injury, both bundles need to be torn. The PCL has recently been reported to have a more important role for rotational stability than previously thought. It restricts internal rotation at all flexion angles, and the PMB was reported to be the most important bundle for controlling rotation beyond 90º of flexion.

Evaluation

PCL tears are typically produced by external trauma such as the classic "dashboard injury" resulting from a posteriorly directed force on the anterior aspect of the proximal tibia with the knee flexed. In athletics, the typical mechanism of isolated PCL tears is a direct blow to the anterior tibia or a fall onto the knee with the foot in a plantar flexed position. Football, soccer, rugby and skiing are among the sports with highest incidence of PCL tears (1). Non-contact mechanisms, such as hyperflexion or hyperextension, are less common (11). Symptoms depend upon the injury mechanism (high vs low-energy) as well as chronicity. Stiffness, swelling and pain on the posterior aspect of the knee are typical symptoms, while anterior knee pain and instability when descending stairs are more often associated with chronic isolated tears (12).

Physical examination for acute conditions of the knee can be difficult due to pain and guarding. The combination of clinical examination tests, mechanism of injury, and symptoms is vital to make an accurate diagnosis of PCL deficiency. It is critical to examine the contralateral knee first and compare it to the injured knee. The posterior drawer test is performed at 90º of flexion, and has a sensitivity of 90% and a specificity of 99% (5, 13). A false-positive pseudo-Lachman test for the ACL is not uncommon. An important indication of PCL deficiency is a positive Clancy sign, which is a loss of the normal anteromedial and lateral prominences of the tibial plateau beneath the femoral condyles, as determined by palpation with the knee at 90º of flexion and neutral rotation. The posterior sag test (Godfrey test) is performed with the hip and knee flexed to 90º while the examiner supports the leg. If the PCL is torn, an abnormal contour or sag may be evident at the proximal anterior tibia viewed from a lateral position. The quadriceps active test is performed with the patient supine and the knee 90º flexed while the examiner stabilizes the foot. A positive test is observed when the patient performs an isometric quadriceps contraction and dynamically reduces the tibia. The dial test is used to assess combined lesions to the posterolateral corner (PLC) of the knee by assessing external rotation. If it is positive at both 30º and 90º of flexion, a PLC grade III tear combined with a PCL tear is present (14). In a recent study by Moulton et al, side-to-side differences in internal rotation were assessed under anesthesia by measuring anterior tibial tubercle excursion. The supine IR test performed between 60º and 120º resulted in 95.5% sensitive and 97.1% specific in diagnosing a grade III PCL tear (15).

Additional maneuvers must be utilized to evaluate for possible combined ligament and concomitant intraarticular injury. In a recent systematic review, Kopkow et al, reported that the quadriceps active test is the most specific test for detecting PCL deficiency, and the posterior sag sign is the most sensitive test, although there is a reported high risk of bias among studies reporting diagnosis (16).

Imaging Studies

Standard weightbearing radiographs are performed to detect the presence of fractures, bony avulsions, joint space assessment and tibiofemoral joint congruity. When posterior knee instability is discovered on physical exam, posterior stress radiographs should be performed to objectively quantify posterior knee laxity (17–21). Kneeling stress radiography allows for comparison of the magnitude of posterior tibial displacement on the femur between the injured and uninjured knees. A diagnostic algorithm has been validated where (1) 0–7 mm of side-to-side difference in posterior displacement constitutes a partial PCL tear, (2) 8–11 mm constitutes an isolated complete PCL tear and (3) ≥12 mm of posterior translation constitutes a combined PCL and posterolateral corner or posteromedial corner knee injury [Figure 2] (22).

Magnetic resonance imaging (MRI) is an important adjunct to the diagnosis of PCL tears because it has been found to have a sensitivity, specificity, and accuracy of nearly 100% for the diagnosis of acute PCL injuries (23–25). MRI has lower sensitivity in the evaluation of chronic PCL tears because the signal and shape of the PCL can be deceptively restored through the healing process in chronic cases despite residual laxity being present. However, a recent MRI study by Wilson et al quantified T2 and T2* PCL properties in asymptomatic population (26). They reported significant differences in T2 values in distal, middle and proximal regions of the PCL providing a feasible baseline to compare acute and chronic PCL tears in the future. Therefore, stress radiographs are strongly advocated to diagnose chronic PCL tears (27). MRI is also important to diagnose concurrent meniscal, cartilage, and ligamentous injuries.

In addition, it is important to evaluate alignment with weightbearing long limb radiographs, as well as sagittal plane tibial slope, especially in chronic or revision cases. Patients with isolated PCL tears and a decreased posterior tibial slope may be candidates for a high tibial osteotomy (HTO) to increase their slope and thereby decrease graft forces and reconstruction graft failure rate. Varus and valgus stress radiographs are also helpful in objectively diagnosing suspected concurrent medial and/or lateral sided injuries based on exam findings (28, 29).

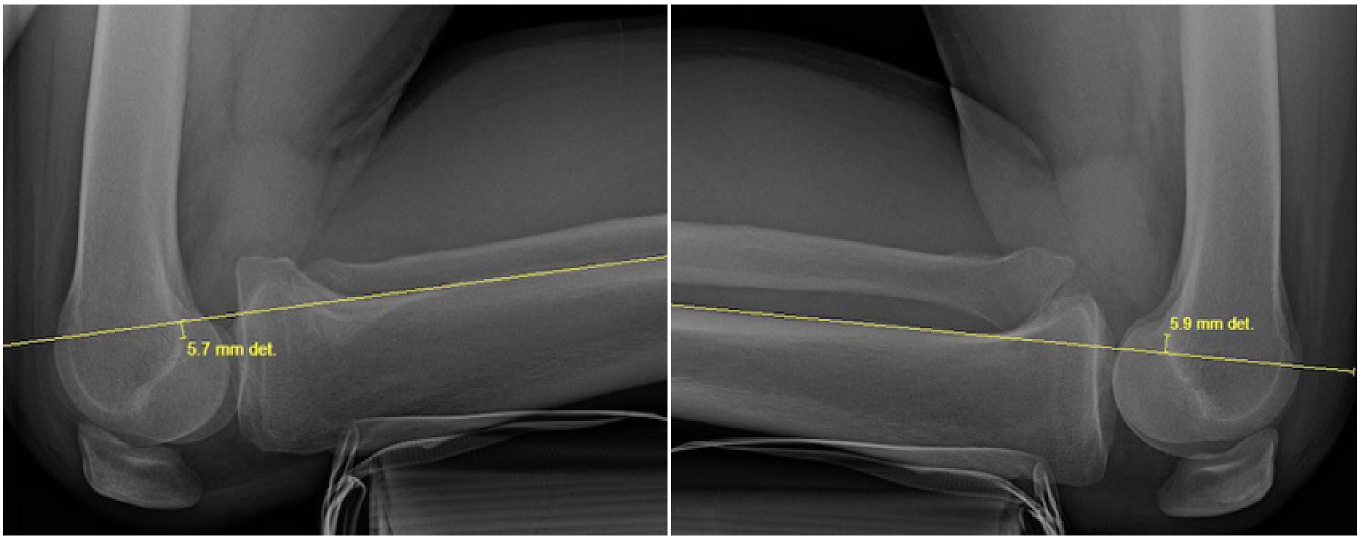

Figure 2. Lateral kneeling posterior stress radiographs that demonstrate an increase of 11.6 mm of posterior translation between the injured and uninjured knee. A line is extended parallel from the posterior cortex from at least 15 cm distal to the joint line. A perpendicular line is drawn from this line to the posterior point of the Blumensaat line and the distance is measured and recorded for each knee. The difference between these two points is the posterior tibial translation distance. ***("Jackman T, LaPrade RF, Pontinen T, Lender PA. Intraobserver and interobserver reliability of the kneeling technique of stress radiography for the evaluation of posterior knee laxity. Am J Sports Med. 2008;36:1571-1776."***

Treatment Rationale

The treatment of complete, isolated PCL tears remains controversial. Some studies have reported good outcomes after conservative treatment of partial PCL tears, while others have reported poor results at long-term follow-up with disabling symptoms and functional limitations (28-35, 30–41). Most authors agree that partial isolated PCL tears should be treated nonoperatively. Complete PCL tears treated non-operatively have been reported to increase the risk of degenerative changes of the medial and patellofemoral compartments at long term, and were associated with poor function (42–45). Surgical treatment is therefore recommended for symptomatic complete and combined PCL injuries to restore joint stability and improve function. Surgical treatment of PCL tears has also been reported to improve patient outcomes. Several surgical techniques are described in the literature; however, controversy exists on which is superior. Furthermore, no long-term study has been able to demonstrate that PCLR prevents the development of knee OA (46).

Nonoperative treatment

Nonoperative treatment is an option for isolated acute PCL tears because of the inherent healing capacity of the PCL; however, there is a risk that it can heal in a lax position (47–50). Dynamic PCL braces can help keep the tibia reduced during healing by avoiding posterior tibial sag (47, 51, 52). It has been reported that because the PCL has a variable tension throughout knee ROM, a properly designed PCL brace should apply a force that varies with knee flexion angle and replicate anatomic forces applied to the native PCL. This led to the design of functional dynamic force braces, which provide significantly greater applied force at 45º of flexion that increases with knee flexion angle (51, 52). However, further clinical studies are necessary to determine whether posterior knee laxity is improved long-term following treatment of PCL tears with a dynamic brace. Dynamic bracing is indicated both for nonoperative treatment and postoperative rehabilitation of PCL tears. If nonoperative treatment fails, operative treatment is indicated.

Operative Treatment

Several techniques for PCLR have been described in the literature, depending on tibial graft fixation (transtibial tunnel and tibial inlay techniques), the bundles addressed (single-bundle or double-bundle), and the type of graft used (53–57). The inlay techniques were developed to avoid the sharp angle at the proximal aperture of the tibial tunnel ("killer turn") when using a patellar tendon graft that can damage the PCLR graft, and increase the risk of failure (24, 53, 58). The inlay technique involves creating a trough at the tibial attachment of PCL to match with the graft bone plug fixed with a cannulated screw (with or without washers). Traditional inlay technique requires an open posteromedial approach between the semimembranosus tendon and the medial head of the gastrocnemius muscle, although arthroscopic tibial inlay techniques have been described (53, 58).

One of the biggest controversies concerning PCL

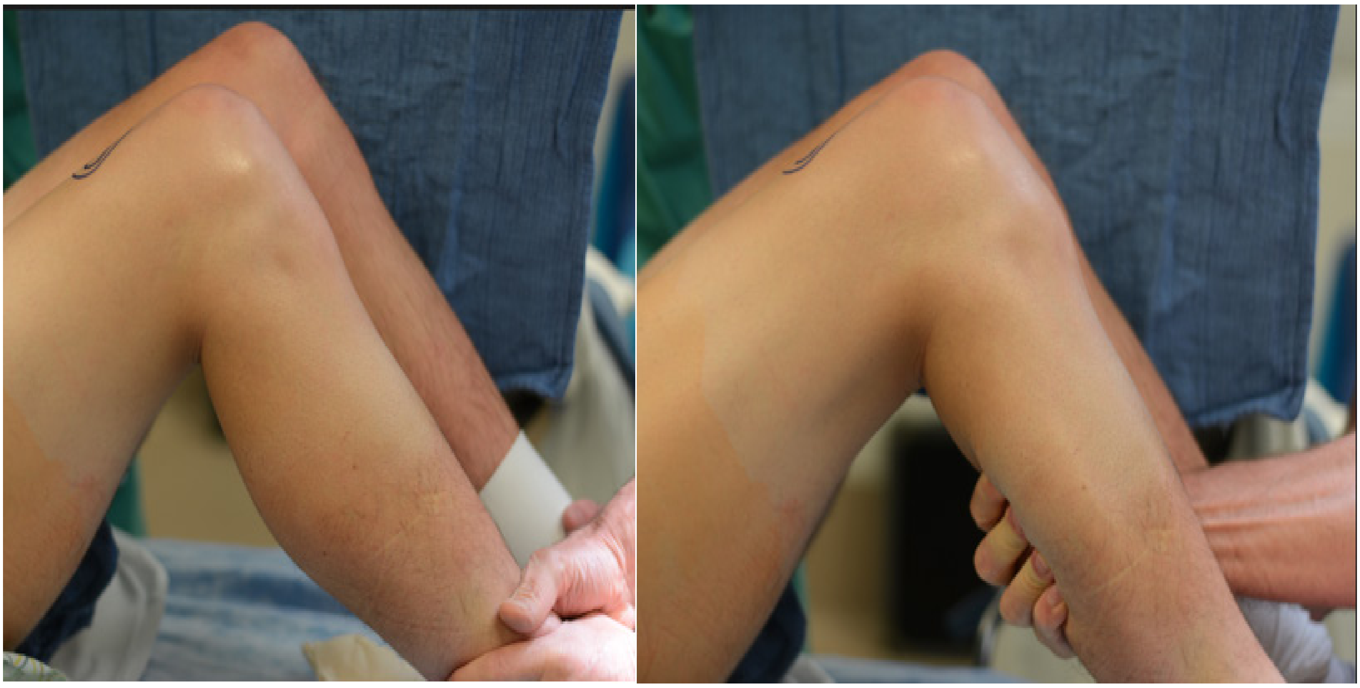

Figure 3. Examination under anesthesia. On the left, a posterior sag is observed. On the right, an anterior drawer is performed to reduce the posterior tibial subluxation.

reconstructions is regarding the outcomes of SB versus DB PCLR. While a SB PCL technique reconstructs only the ALB, a DB PCL technique reconstructs both ALB and PMB, thereby restoring normal anatomy and native knee kinematics (5–7, 27, 54, 57, 59–61). Recent biomechanical studies have demonstrated that a DB PCLR restores knee kinematics to near native better than a single bundle (SB) PCLR. Furthermore, DB PCLR restores rotational stability better than SB PCLR (57).

The authors preferred technique (after an examination under anesthesia), is a DB PCLR with an 11 mm Achilles tendon allograft for the ALB, and a 7 mm tibialis anterior allograft for the PMB [Figure 3]. For femoral tunnels, 11 mm and 7 mm diameter tunnels with a 2 mm bone bridge between the ALB and PMB reconstruction tunnels, respectively, are performed [Figure 4]. On the tibial side, a 12 mm tunnel is reamed under fluoroscopic guidance towards the center of the PCL tibial footprint. It has been demonstrated that aiming solely towards the ALB footprint, especially in SB reconstruction, might injure the medial meniscal root attachment and therefore lead to medial compartment cartilage overload with increased joint contact pressures comparable to a medial meniscectomy (62) [Figure 5]. The ALB is fixed at 90º with an anterior drawer to reduce the normal tibiofemoral step-off, and the PMB is fixed in full extension [Figure 6]. In the chronic setting, a limb alignment assessment is systematically performed to rule out a possible two-stage treatment with a first-stage corrective osteotomy and a second stage PCLR (63). In a multi-ligament reconstruction injury setting, in order to avoid PCL femoral tunnel convergence, the superficial medial collateral ligament (sMCL) tunnel should be oriented 40º proximally and anteriorly, while the posterior oblique ligament (POL) should be oriented 20º proximally and anteriorly (64). On the tibial side, the POL tunnel should be aimed 15 mm medial to Gerdy's tubercle, while the sMCL tunnel should be oriented transversely across the tibia (anterior to the fibula) and 30º distally in order to avoid tunnel convergence (65).

Post-Op Rehabilitation and Bracing

Following an algorithmic approach to the diagnosis and treatment of a PCL tear, rehabilitation plays a crucial next step in determining patient outcomes (27, 66, 67). Although different rehabilitation programs exist, there are key elements that should lay the foundation for any protocol. These elements include progressive weight-bearing, prevention of posterior tibial subluxation, and early quadriceps strengthening (66–68). We recommend that PCLR patients be kept non-weight bearing for 6 weeks given that PCL graft healing time has been reported to be almost double that following ACL reconstruction (66, 68, 69). Patients are initially placed into a knee immobilizer brace for 3 days prior to transitioning to a dynamic anterior drawer brace. It has been recommended that the PCL brace be worn around the clock for up to a minimum of 24 weeks postoperatively (67). A progressive, goal-oriented, 5-phase rehabilitation program following acute,

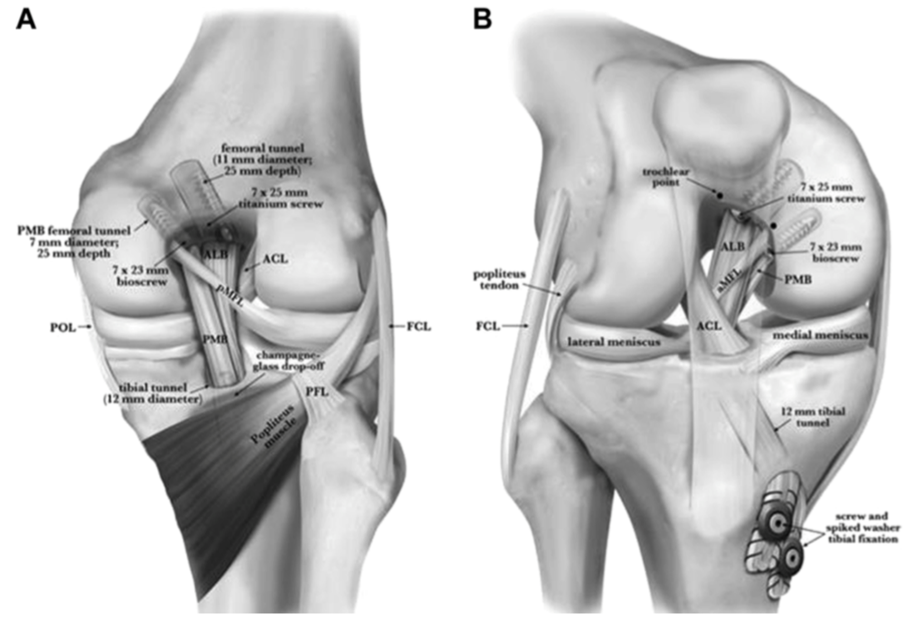

Figure 4. (A) Posterior and (B) anterior illustrations of the anatomic double-bundle, posterior cruciate ligament reconstruction. ACL, anterior cruciate ligament; aMFL, anterior meniscofemoral ligament (ligament of Humphrey); FCL, fibular collateral ligament; PFL, popliteofibular ligament; pMFL, posterior meniscofemoral ligament (ligament of Wrisberg); POL, posterior oblique ligament ***(Reproduced with permission from "Wijdicks CA, Kennedy NI, Goldsmith MT, et al. Kinematic analysis of the posterior cruciate ligament, part 2: a comparison of anatomic single- versus double-bundle reconstruction. Am J Sports Med. 2013;41(12):2839-2948".)***.

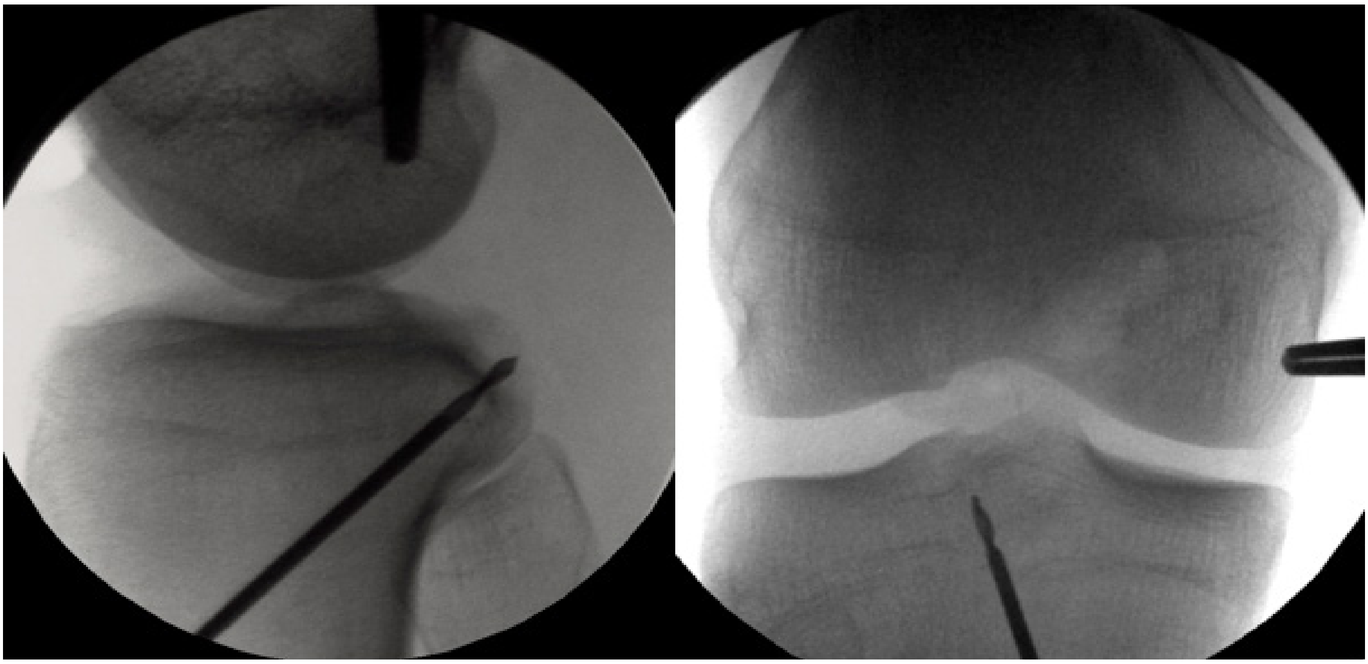

Figure 5. Fluoroscopic image of transtibial tunnel guide pin placement. On the left, the lateral view shows the guide pin successfully positioned approximately 6 to 7 mm proximal to the champagne-glass drop-off at the PCL facet. On the right, the AP view shows appropriate position of the guidewire at the medial aspect of the lateral tibial eminence and 1 to 2 mm distal to the joint line.

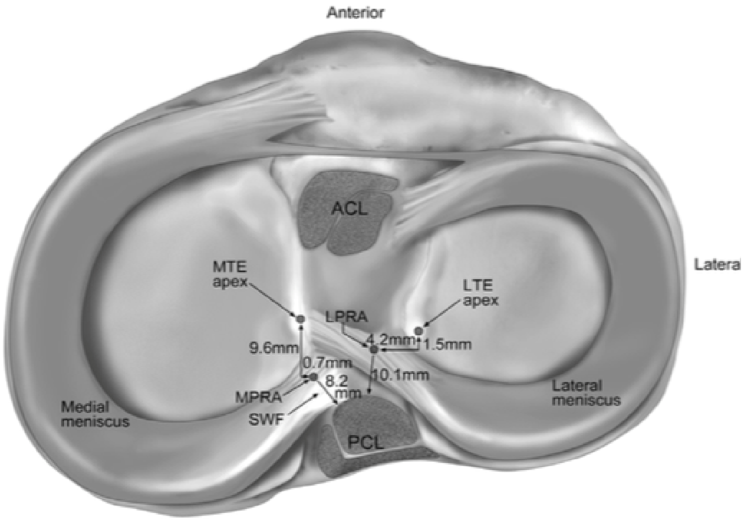

Figure 6. Illustration depicting the intimate relationship of the posterior meniscal roots with the posterior cruciate ligament (PCL) (right knee). LPRA, lateral meniscal posterior root attachment; MPRA, medial meniscal posterior root attachment; SWF, shiny white fibers. Reproduced with permission from *"Johannsen AM, Civitarese DM, Padalecki JR, Goldsmith MT, Wijdicks CA, LaPrade RF. Qualitative and quantitative anatomic analysis of the posterior root attachments of the medial and lateral menisci. Am J Sports Med. 2012;40(10):2342-2347".*

isolated PCLR has been reported to improve stabilization of posterior tibial translation, varus, and external rotation stresses (70). Pierce suggested such a protocol (67). Phase I, 0 to 6 weeks after surgery, is marked by progressive range of motion (ROM) exercises beginning with passive prone ROM from 0 to 90 degrees of knee flexion for the first 2 weeks after surgery advancing to full passive prone ROM as tolerated. During this phase, it is critical to prevent hyperextension and posterior tibial translation to protect the healing PCL graft from elongating. Phase II, from 7 to 12 weeks postoperatively, involves similar precautions with progression to crutch weaning and weightbearing activities as tolerated, while restricting the knee to less than 70º of flexion during weightbearing exercises. Brace use continues in phase III, from 13 to 18 weeks after surgery, with ROM weight-bearing exercise progressing past 70º of knee flexion after 16 weeks. Phase IV, 19 to 24 weeks postoperatively, is characterized by the gradual introduction of sport-specific drills. In phase V, 25 to 36 weeks after surgery, the patient may begin to wean from brace use if the 6 month postoperative PCL stress radiographs demonstrate sufficient healing and begin a straight-line jogging progression with the eventual goal of multiplanar agility exercises and, ultimately, return to preoperative activities (67). Although the above protocol reflects rehab guidelines following an acute isolated PCLR and chronic isolated or combined ligament PCLR may be rehabilitated in a similar fashion, PCL stress radiographs may be required to objectively gauge postoperative progression and to determine any modifications for a patient with concomitant MCL, PLC, or meniscal injury (22, 27).

Outcomes

Tibial Inlay and Transtibial SB Techniques

A recent systematic review analyzed seven studies between 2006 and 2014 that evaluated the outcome scores for SB tibial inlay and transtibial SB techniques. The authors reported that there were no clinically significant differences in outcomes between both treatments (71). However, 26% of knees in the transtibial group and 27% of knees in the tibial inlay group had Grade II or greater posterior laxity postoperatively. Small discrepancies were found between Lysholm and Tegner scores, but were determined to not be statistically significant in a clinical setting (71). Of the four studies reporting Tegner scores, only one suggested slight superiority for the tibial inlay technique, with the margin being only 0.5 points higher than the transtibial technique (72). For all studies reviewed, Tegner scores ranged from 5.6 to 6 for the transtibial technique and 5.84 to 6.1 for the tibial inlay technique (71). For Lysholm scores, only one of five studies favored the transtibial approach, although this differential was less than 7 points in scale out of 100 (71, 73). Lysholm scores in this systematic review ranged from 81 to 91.3 for the transtibial technique and 76 to 92.8 for the tibial inlay technique (71).

In an earlier systematic review by Kim et al, it was reported that 75% of patients analyzed over 10 studies had normal or nearly normal subjective IKDC scores for those who underwent transtibial PCLR (74). Objectively, posterior knee laxity ranged between 2.0 to 5.9 mm postoperatively among the studies reviewed, which was substantial improvement from preoperative scores ranging between 8.4 mm to 12.3 mm (significance was not reported) (74). Although a large decrease in laxity was seen, it was concluded that normal knee function and posterior stability was not restored in patients analyzed in any of the reviewed studies. Hermans et al. reported that 60% of patients had evidence of osteoarthritis (OA) after SB PCLR at 9.1 years follow up – a possible concomitant occurrence due to the inability to fully restore knee kinematics (54). Therefore, despite improved outcomes after SB procedures, persistent posterior laxity remains a problem, and it has been theorized that this instability can lead to the development of OA.

Clinical Outcomes Comparison between SB and DB PCLR

Recently, Chahla et al performed a systematic review and meta-analysis comparing the SB versus DB PCLR technique. Significantly improved objective posterior tibial stability and objective IKDC scores were obtained within the DB PCLR cohort in comparison to SB group. However, no significant differences were reported in postoperative Lysholm or Tegner scores (75). Another recent systematic review comparing the two techniques challenged the idea that DB techniques were superior to a SB PCLR (76). In their evaluation of eight studies, with levels of evidence (LOE) ranging between II to V, seven studies reported no statistical differences in functional and objective assessments when comparing both techniques (76). Li et al (LOE=2) was the only study suggesting that DB PCLR was superior at a minimum 2-years follow-up. Using a KT-1000 arthrometer, a significant difference was reported in posterior translation of 4.1 and 2.2 mm for SB and DB PCLR, respectively ($P<.05$) (77).

It is worth mentioning that a limitation when comparing these studies falls on the varied utilization of tibial inlay and transtibial surgical procedures. However, recent literature has suggested that the difference between the two techniques is small in the context of a DB PCLR. Four studies utilizing the transtibial technique reported that postoperative subjective outcome substantially improved (19, 65, 69, 70). Additionally, these studies ranged between 0.9 mm to 3.9 mm in posterior translation postoperatively, with the highest values of this range being involved with combined ligamentous injury of the posterolateral corner (74).

Similar to the transtibial technique, studies utilizing the tibial inlay technique reported significant improvement in subjective and functional outcome scores. In addition, at a minimum follow-up of 2 years, Telos stress radiography showed that posterior translation for isolated PCL injury had a significant improvement of 2.6 to 5.1 mm postoperatively based on two reports (58, 78). In addition, Lee et al recommended that a tibial inlay DB procedure might be the best option for revision PCLR, as it was reported to have the lowest posterior translation of 2.4 mm postoperatively (79). When comparing posterior translation between the two techniques, objective posterior translation measurements via Telos radiograph suggest a slight advantage to the transtibial technique. Therefore, LaPrade et al recommended that the transtibial DB PCLR procedure should be selected given the ability to most closely restore native knee kinematics (27).

Limitations exist when comparing all studies described, as they vary with their assessments of posterior tibial translation by utilizing either a KT-1000 arthrometer, kneeling, or Telos stress radiograph technique. Currently, literature lacks studies with level I of evidence of PCLR. Furthermore, there is a relative paucity between the long-term outcomes of patients who underwent a DB PCLR procedure since this treatment option is still emerging. Future long-term studies should be performed to ultimately distinguish any significant differences between SB and DB surgical treatments and their outcomes.

An improved understanding of PCL tear diagnosis, anatomy, biomechanics, and surgical technique has recently been demonstrated. Stress radiography has become an integral and objective component within the PCL treatment algorithm. Anatomy and biomechanics studies have highlighted the codominant behavior of the ALB and PMB. When restoring both these bundles on the femur with DB PCLR, knee kinematics are also restored. Variability of outcomes measurements between studies have made it difficult to determine clinical differences between SB and DB PCLR; however, recent literature has more strongly substantiated the clinical benefit of DB PCLR over SB technique. Future prospective, long-term outcomes studies are needed as the treatment of PCL tears advances.

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