PCL

Anatomy

The PCL originates from a semi-circular area on the lateral border of the medial femoral condyle. The diameter of the semicircle is superior. It inserts on the posterior aspect of the tibia in a depression between the medial and lateral tibial plateaus called the PCL facet or fovea. The ligament is oriented vertically in the frontal plane and angles forwards 30 to 45 degrees in the sagittal plane.

The PCL is 38mm long and 13mm wide on average.

It has two main bundles; anterolateral and posteromedial. The anterolateral bundle is the stronger and more important of the two and is tightened by flexion; the posteromedial bundle is tightened by extension. The anterolateral bundle is more anterior at its origin and more lateral at its insertion. The anterolateral bundle is significantly stronger than the posteromedial bundle (1600 vs. 450N). It is also stiffer.

The variable meniscofemoral ligaments of Humphrey and Wrisberg are around 20% of the size of the PCL. They are not constant; most knees will have one or the other but not both. They have a failure strength of around 300N.

Biomechanics

The PCL has two main functions:

1. Primary restraint against posterior tibial displacement
    a. Secondary restraints are the LCL, MCL, meniscofemoral ligaments and PLC. These have little role to play when the PCL is intact but are vital when the PCL is damaged.
    b. Note that some feel that the PCL is most important with the knee flexed; with the knee in 30 degrees of flexion the PLC is the main restraint to posterior translation.
2. Works in conjunction with ACL to regulate the screw home mechanism of the knee

The PCL is a secondary restraint to external rotation of the tibia.

The anterolateral bundle is significantly stronger than the posteromedial bundle (1600 vs. 450N). It is also stiffer.

Very little of the PCL is truly isometric during knee ROM. Alteration of the femoral site of insertion leads to greater changes in the graft tension during knee flexion than does alteration of the tibial insertion site, implying that getting the femoral site of insertion right is most important.

Epidemiology

PCL injuries are probably under diagnosed, and may occur in around 1/5th of all acute knee injuries. Torg, and Dandy, feel that many patients with PCL injuries don't ever see an orthopod.

Mechanism of injury

Most common mechanism is a posteriorly directed force to the proximal tibia when the knee is flexed. This often occurs in a MVA when the knee strikes the dash-board.

A similar mechanism can occur during a football tackle.

If the force is combined with a varus or rotatory force a concomitant lateral or posterolateral corner injury may occur.

Another mechanism is a fall onto a flexed knee, particularly with the foot plantarflexed. This is a common cause of isolated PCL injury in sports.

Clinical findings

History

A history of hearing a "pop" is uncommon.
Mechanism of injury
Time interval from injury

Physical examination

Palpate to establish the normal femoral-tibial step off (10mm).

The *posterior drawer test* is the most accurate test for PCL injury. If there is more than 9.4mm of posterior translation there is a 95% probability of PCL injury.

EUA findings on the posterior drawer test may include:
When the tibial plateau remains anterior to the medial femoral condyle there is a grade 1 tear.
No anteromedial tibial plateau step off means that there is at least a 2+ posterior drawer present.

If the tibia is subluxed posterior to the medial femoral condyle this is a 3+ drawer.

The *posterior sag test* is performed with the knee flexed 90 degrees and the foot resting on the bed. A piece of paper along the anterior aspect of the knee may reveal a hollow indicating posterior translation of the PCL.

With the *quadriceps active test* the examiner stabilizes the foot and asks the patient to slide the foot down the bed. The contracting quadriceps will cause reduction of the posteriorly subluxated tibia.

Other tests in the JAAOS article:

1. *Dynamic posterior shift test*: the patient's hip is flexed 90 degrees. Starting with the knee flexed, the examiner slowly extends the patients knee until the posteriorly subluxated tibia reduces with a clunk as the knee nears full extension

2. The *reverse pivot shift test*: used to evaluate posterolateral stability. The examiner externally rotates the foot and brings the knee into extension as a valgus stress is applied to the knee. Palpable reduction of the displaced tibia is considered a positive test, but is present bilaterally in one third of normal subjects

3. The *posterolateral drawer test* is performed with the knee flexed 90 degrees and externally rotated 15 degrees. With a positive test the tibia rotates posteriorly and laterally off the lateral femoral condyle

4. The *tibial external rotation test* (also called the *dial test*) is performed with the knee in both 30 and 90 degrees of flexion. It is positive when the medial border of the foot or the tibial tubercle externally rotates 10 to 15 degrees more than the contralateral side Rotation at 30 degrees only is found with a PLC injury. Rotation at both 30 and 90 degrees is found with a combined PLC and PCL injury

Most sensitive

Basics of PCL vs. PLC injury

PCL causes increased posterior laxity in flexion.

PLC causes increased posterior laxity in near extension and increased external rotation at 30 degrees.

Radiology

The standard XR views required are AP, lateral, skyline and notch views.
Avulsion fractures of the PCL insertion will sometimes be seen.

Chronic PCL injury will lead to degenerative change in the medial and patellofemoral compartments. Patients with isolated PCL injury will have less degenerative changes than those with multidirectional instability.

Can perform stress XR: these can be done while kneeling or with a manual posterior drawer test

MRI: can look relatively normal when a chronic PCL tear has healed in an elongated position. Meniscal tears and bone bruises are seen less frequently than in ACL tears.

Natural history

Isolated PCL injuries are relatively benign and do not preclude high level sporting activity (e.g. 2% of NFL draft players had evidence of chronic PCL deficiency). Parolie and Berfeld looked at 25 athletes with isolated PCL tears at an average of 6 years and found that 80% returned to their previous level of activity, and all of these had normal or increased quadriceps strength.

Cross and Powell found that patients with isolated PCL injuries and good quadriceps power did well with conservative management.

Partial injuries of the PCL are more likely to heal than partial ACL injuries because the PCL is larger and has a better blood supply.

Patients with combined PCL and PLC injuries do not do well and should be treated surgically. The results of acute PLC repair are better than those of reconstruction, and scar tissue quickly obscures the anatomy.

A combined ACL and PCL tear may represent an occult knee dislocation, with a high rate of neurovascular damage.

Nonoperative treatment

Isolated Grade 1 and 2 injuries: treat with a brief period of splinting and protected weightbearing followed by early ROM and quads strengthening activities. Many patients are able to get back to sport within 4 weeks.

Grade 3 injuries: the potential concern is that there may be coexisting PLC damage. The knee should be splinted in full extension for 2-4 weeks (this will decrease tension on the more important anterolateral bundle). Quads strengthening and ROM exercises are then started (JAAOS Sept 2001).

Operative Treatment

The first treatment was by Hey Groves (1917) who used the semitendinosis tendon; this was detached distally, rerouted through femoral and tibial tunnels and then attached to the anterior tibial periosteum. The results were disappointing

Primary suture repair is not effective.

Displaced PCL bone avulsion fragments should be directly repaired surgically. Mid substance repairs fail.

Arthroscopy and PCL deficiency

The PCL often looks intact, but the ACL becomes floppy.

PCL reconstruction techniques

The two main techniques of placement of the PCL graft involve a transtibial tunnel drilled arthroscopically, and a tibial onlay technique using a posterior arthrotomy.

A potential risk with the transtibial tunnel technique is that the graft makes an acute (killer) turn around the posterior part of the tibia which can subject it to high strains. It an also be difficult to accurately site the tunnel.

The tibial onlay technique has the theoretical advantages that the graft can be placed in the correct position under direct vision and is not required to make an acute turn around the proximal tibia.

Miller states (ICL 1995) that current techniques can only reproduce one of the two bundles, and because the anterolateral bundle is more important biomechanically this is the one that should be reconstructed.

Single bundle technique with tibial tunnel (Miller)

He uses Achilles tendon allograft because of lack of donor site morbidity, high tensile strength and easy passage.

He uses the transtibial tunnel technique. He uses a 70 degree arthroscope to adequately visualize the back of the knee. He passes the guide wire from the anterior aspect of the tibia to the tibial footprint of the PCL, taking care to exit in the lateral half of the footprint (to recreate the anterolateral bundle). The starting point on the anterior aspect of the tibia is usually 1-2cm below and 2-3 cm medial to the tibial tubercle. The line of

passage of the K wire is said to be parallel to the proximal tibio-fibular joint. After passing the transtibial guide wire he gets a lateral XR.

The femoral tunnel originates on the medial condyle, 1.5cm from the articular cartilage and exits in the notch 10mm from the articular cartilage.

A wire loop is passed through the femoral tunnel and then through the tibial tunnel to pull the graft through. The graft is fixed in the tibia with an interference screw, and to the femur using whatever technique the surgeon prefers.

The graft is tensioned prior to the femoral fixation by flexing the knee to 80 degrees and applying an anteriorly directed force.

Postoperatively the knee is braced in extension. ROM exercises are started in the first week. Closed chain quads strengthening exercises are started early. Crutches and partial weight bearing are used for 8 weeks. Full knee motion may take up to 6 months to regain and patients are able to get back to sports by 9 months.

Double bundle technique

Technique is similar, but two femoral tunnels are used. Both bundles pass through a single tibial tunnel. The anterolateral graft is tensioned and fixed at 80 degrees and the posteromedial bundle at 30 degrees. Harner (Current Orthopaedics 2000) states that the double bundle technique better recreates normal knee mechanics. When performing this technique, Harner uses an Achilles tendon allograft for the anterolateral bundle and a semitendinosis autograft for the posteromedial bundle. The anterolateral bundle is tensioned at 80 degrees and the posteromedial bundle tensioned at 30 degrees. The knee is then locked in extension.

Tibial inlay technique

The patient is positioned on their side. The joint is prepared and the femoral tunnels drilled arthroscopically. The joint is exposed via an oblique incision over the medial head of gastrocnemius and the interval between the medial head of gastrocnemius and semimembranosis is developed.

HTO

A valgus HTO may be the most reliable method of correcting abnormal varus alignment with soft tissue laxity. Harner recommends performing an HTO prior to a PCL reconstruction as it may be enough to alleviate the patient's symptoms.

Results

The results of PCL repair have not been as predictable as those of ACL repair.

Patients with single bundle reconstruction generally have some improvement but many continue to have some posterior laxity.

Use of double bundle techniques may decrease posterior translation (e.g. in a cadaveric model using an additional posteromedial bundle decreased posterior laxity by 3.5mm).