



QUESTION | MY PATIENT HAS A PCL INJURY BUT HAS BEEN TOLD HE DOES NOT NEED AN OPERATION. WHAT MAKES THE PCL SO DIFFERENT FROM THE ACL?

In this month's Question for Physiotherapists, Dr Doron Sher discusses PCL injury. Part one of a two part series - this article will focus on the anatomy, biomechanics and function of the PCL and an injury classification system. Next month will look at examination, investigations and treatment.

ANSWER |

PCL injuries can be very roughly divided into low energy and high energy injuries. This makes it very difficult to generalize when it comes to treatment since the two groups are so different. Low energy sporting injuries to the PCL account for about 3% of all knee injuries and this article will focus on these patients (Up to 1/3 of multi-trauma patients with injuries to their knees also injure their PCL and other structures). There have been major advances recently with regards to the anatomy and biomechanics of the PCL but the improvements in clinical outcomes have not been as impressive. Many studies have looked at inlay fixation rather than tunnel fixation, single and double bundles, the femoral tunnel locations and graft tensioning. No single reconstructive technique has yet been shown to be superior to the others but we do know that addressing the PCL without fixing a posterolateral corner injury (if there is one present) will lead to inferior results.

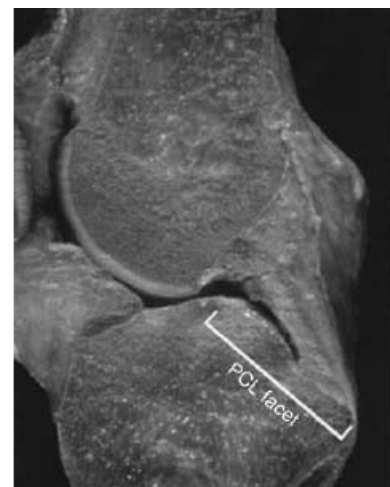
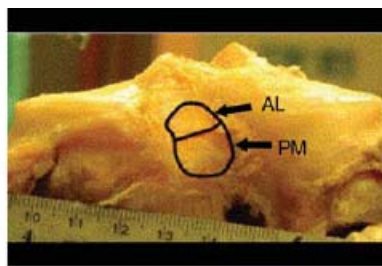
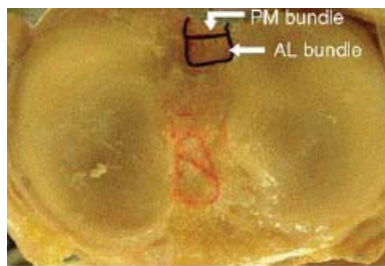
Anatomy

The PCL is the primary restraint to posterior translocation of the proximal tibia and is a secondary restraint to varus, valgus, and external rotation forces. It originates from a broad, crescent-shaped area on the anterolateral aspect of the medial femoral condyle in the intercondylar notch and inserts into a depression between the two tibial plateaus named the PCL fossa. The PCL has a wide variation in shape and size of its femoral attachments, whereas the tibial attachment patterns are fairly constant. It is extra-articular and lies within its own synovial sheath.

The PCL is 32 to 38 mm long, with a cross-sectional area of 11 mm² at its midpoint. The midsubstance of the ligament is approximately one third the diameter of both the femoral and tibial insertion sites. The PCL complex includes the anterior (ligament of Humphrey), and posterior (ligament of Wrisberg) menisiofemoral ligaments. It is known that the menisiofemoral ligaments contribute to posterior drawer stability. There are no attachments between the PCL and the medial meniscus.

The PCL can be functionally divided into two components: a larger anterolateral (AL) bundle and a smaller posteromedial (PM) bundle. This terminology is derived from the relationship of the anatomic location of the femoral insertion (anterior or posterior) to the tibial insertion (lateral or medial). These bundles have different functions that allow the PCL to resist posterior translation in both extension and flexion. The AnteroLateral Bundle makes up the bulk of the ligament and is taut at 90 degrees of flexion and loose in extension, whereas the PosteroMedial Bundle is taut at 30 degrees of flexion and loose at 90 degrees of flexion. This makes the PCL a complex, anisometric continuum of fibers whose patterns of orientation and tension differ with differing knee flexion angles.

The PCL is the primary restraint to posterior tibial translation at all flexion angles greater than 30 degrees and is a secondary restraint to external rotation of the tibia. Posterior knee structures provide the primary restraint from 0 to 30 degrees. These are the: posteromedial and posterolateral capsule, medial collateral ligament (MCL), lateral collateral ligament (LCL), arcuate, menisiofemoral; and fabellofibular ligaments. The PCL provides increasing resistance to posterior translation from 30 to 90 degrees of knee flexion. At 90 degrees it provides 95% of the total restraining force for the straight posterior drawer. Both bundles of the PCL play an important role during posterior tibial loading. As the knee progresses from flexion to extension, the tibia externally rotates relative to the femur (Traditionally called the "screw-home" mechanism of the knee). This mechanism is related to a combination of factors including the bony anatomy of the knee and the relative lengths of the cruciates.



Axial (A) and posterior (B) views of the tibial insertions of the anterolateral (AL) and posteromedial (PM) bundles (outlined) of the posterior cruciate ligament onto the tibial plateau in a left knee. (Reproduced with permission from Edwards A, Bull AM, Amis AA: The attachments of the fiber bundles of the posterior cruciate ligament: An anatomic study. *Arthroscopy* 2007;23:284-290.)

Blood Supply

The majority of the blood supply to the PCL stems from the middle genicular artery, a branch of the popliteal artery. The middle genicular artery also supplies the synovial sheath, which itself is a major contributor to the blood supply of the PCL.

Nerve Supply

The PCL and its synovial sleeve are supplied by nerve fibers from the popliteal plexus. The popliteal plexus is derived from the posterior articular nerve and the terminal branches of the obturator nerve. *Injury to the PCL not only creates a mechanical disturbance but also a neurologic one by disrupting the afferent signals to the central nervous system.*

Biomechanics

It was initially thought that conservative treatment of isolated PCL injuries had good results. Newer studies are questioning this because they have shown higher rates of arthrosis developing many years later. This has led to an increased interest in the surgical reconstruction of PCL injuries. Research done on the biomechanics of the PCL has allowed an evolution in surgical techniques for PCL reconstruction. These biomechanical studies have shown that the joint contact force in the medial femoral condyle increases by up to 34% under combined posterior tibial and axial loads when the PCL is torn. There is no increase in the forces experienced in the menisci or lateral articular compartment. This supports the role of the PCL as a secondary stabilizer to external rotation and varus stress. Cutting the posterolateral corner (PLC) increases in situ forces in the PCL by 2 to 6 times compared with that of an intact knee. This is significant because PLC injuries occur in many PCL injuries, and unrecognized injuries to the PLC make a PCL reconstruction more likely to fail.

Mechanism of PCL Injury

PCL tears may result from a variety of injuries. Isolated injuries are usually from hyperflexion but overall the majority of these injuries are caused by a posteriorly directed force on the proximal tibia (Like a "dashboard" injury with the knee flexed or a fall onto a flexed knee with the foot in a plantar-flexed position). These injuries commonly result in partial tears of the PCL with the PMB remaining intact.

Injury patterns involving hyperextension, forced varus or valgus, and knee dislocations are associated with PCL tears plus other ligament and vascular or nerve injuries.

Classification of PCL Injuries

PCL injuries are graded based on (1) Severity, (2) Time since injury, and (3) Presence of associated injuries.

- 1) **SEVERITY:** Tears are graded I to III based on the degree of posterior tibial translation compared with that of the contralateral leg. The medial tibial plateau usually sits 1 mm anterior to the medial femoral condyle with the knee flexed to 90 degrees. Grade I tears have 1 to 5 mm of excess posterior translation, but the anterior step-off is maintained. Grade II tears have 5 to 10 mm of excess translation, which allows the medial tibial plateau to become flush with the medial femoral condyle. Grade III injuries have greater than 10 mm of excess posterior tibial translation. This is best felt with the thumb moving up and down over the medial joint margin.

Grade I and II injuries represent partial tears of the PCL, whereas grade III tears represent complete tears and suspicion of associated injuries should be increased.

- 2) **TIMING:** Acute vs chronic. Acute injury is defined as within 3 weeks of injury. Chronic PCL injuries have a higher incidence of pericapsular stretching which might affect the choice of graft material.
- 3) **ASSOCIATED INJURIES:** Isolated vs multi-ligament injured knees is important for treatment decisions. Isolated injuries to the PCL may have good results with nonoperative treatment, whereas multi-ligament injured knees have better outcomes with surgical intervention. Patients with multi-ligament injured knees must be closely evaluated for injuries to vessels, nerves, and other structures because they are more likely to have dislocated their knee.

Surgical intervention is recommended for the PCL/ PLC-deficient knee with >10 mm increased posterior translation and about 15° of increased external rotation.

Diagnosis

PCL disruptions can be interstitial disruptions (midsubstance tears), bony avulsions from the tibia or femur, or insertional disruptions. PCL injuries range from isolated partial tears to PCL injuries associated with multi-ligament injured knees. As injury severity varies, so does the patient's presenting complaint

Stay tuned next month for the continuation of this article

Dr Doron Sher

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