Posterior cruciate ligament injury: Diagnosis and management.

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Abstract

Introduction

Posterior cruciate ligament (PCL) injuries are less common than other knee injuries, but they account for considerable morbidity. PCL injuries have unique features that require specialized diagnostic skills and management. PCL injuries can result from high or low velocity trauma with the former being more common. Taking a careful history and performing a detailed physical examination are imperative when a PCL injury is suspected. While in grade I and grade II injuries can be managed conservatively, the best management for patients with grade III injuries remains a subject of discussion and debate.

Methods

This article describes the pathogenesis of PCL injuries and presents a review of the literature with an emphasis on assessment, management and rehabilitation.

Conclusion

PCL injuries are less common compared to the other ligamentous injuries of the knee. Nevertheless, they can result in significant morbidity and limitation for the injured patient. The physician should have a high index of suspicion for PCL injuries when examining patients presenting with knee injuries.

Introduction

Posterior cruciate ligament (PCL) injuries are less studied and understood than anterior cruciate ligament (ACL) injuries¹. Consequently, there has been substantially less research directed at the management of these injuries². PCL injuries make up 3% to 23% of knee injuries³. The true incidence of PCL injuries remains unknown, however, because many isolated PCL injuries are not detected⁴. This occurs because PCL injuries are often asymptomatic and not diagnosed⁵. There is a considerable controversy regarding the management of PCL injuries which is difficult to resolve because there are different grades of injuries and the understanding of the natural history of the injuries is poor⁶. Despite these facts, the management of PCL tears has advanced over the past few decades⁷. The purpose of this article is to provide background information on PCL injuries, including pathogenesis, diagnosis and management.

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Anatomy and Function

The PCL lies within the joint capsule of the knee, but it is considered an extra-articular ligament because it is enclosed within its own synovial sheath⁸. On average, the PCL is 32 to 38 mm long and has a cross-sectional area of 11 mm² at its midpoint⁹. The PCL originates from the lateral border of the medial femoral condyle and inserts, approximately 1 cm below the joint line in a depression between the posterior aspects of the medial and lateral tibial plateaus². The ligament itself is divided into two bundles: a large anterolateral bundle (AL) which tightens in flexion and is lax in extension and a smaller posteromedial bundle (PM) which is conversely tight in extension and lax in flexion¹⁰. The anterolateral bundle is also stiffer and has a higher ultimate load failure¹⁰. 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)⁷. The PCL is the primary restraint to tibial posterior translation, contributing approximately 90% of the resistance across most of the arc of knee flexion. Recently, however, there has been increasing awareness of the role of other structures in achieving this function as the knee reaches extension¹¹,¹². The collateral ligament and the posterolateral corner (PLC) act as secondary restraints to the posterior translation of the tibia². This helps to explain why an isolated PCL rupture often does not lead to disabling instability, despite the strength of the damaged structure¹³. Furthermore, the PCL acts a secondary restraint to varus and external rotation forces, which is primarily resisted by the lateral collateral ligament (LCL) and PLC².

Mechanism of Injury

Both high and low velocity mechanisms can result in PCL injuries². Classically, high velocity injuries are caused by motor vehicle collisions where a posteriorly directed force is applied to the proximal tibia while the knee is flexed, causing a ‘dashboard injury’. Another mechanism of injury is the application of a strong posterior force directed onto a hyperextended knee¹⁴. Low velocity injuries occur with the knee in hyperflexion in sports-related injuries that occur when the foot is in a plantar-flexed position¹⁵. In contrast to ACL injuries, high energy trauma accounts for the highest percentage of PCL injuries and is associated with other injuries such as ipsilateral fractures of the femur and tibia¹⁶.¹⁷. Recently, in a retrospective review, Schulz et al. studied the mechanism of injury in 587 patients with confirmed PCL insufficiency¹⁷. In this study, traffic accidents (45%) and athletic injuries (40%) were the most common causes of injury.
Clinical evaluation

A careful and detailed history is the foundation of evaluating a patient with a suspected PCL injury. Patients who have partial or even complete isolated PCL tears usually present with relatively minor symptoms. It is essential, therefore, that the clinician has a thorough understanding of the range of pathological changes that can occur in the knee6.

A thorough examination of the knee should include a comprehensive assessment of the lower extremity alignment, as well as the gait of the patient. Subtle varus malalignment, external rotation and varus thrust may be present in a chronic PCL-deficient knee5.

The following are several specific clinical tests that are valuable when assessing a suspected PCL injury. The posterior drawer test is the most sensitive clinical test for PCL injury. This test is performed with the patient in a supine position with both feet on the table and the knee flexed at 90 degrees. In this position, the medial tibial plateau is normally approximately 1 cm anterior to the medial femoral condyle18. The posterior drawer test can be graded according to this relationship. If the tibia can be displaced posteriorly by zero to 5 mm, it is considered a grade I posterior drawer sign, even though the tibia is still anterior to the medial femoral condyle. In a grade II injury, the tibia is displaced 5 to 10 mm posteriorly, which makes the tibial condyle flush with the femoral condyle. In a grade III injury, the tibia is displaced more than 10 mm posteriorly. This corresponds to a displacement of the tibial condyles posterior to the femoral condyles5,19.

The posterior sag test is performed with both the ipsilateral hip and knee flexed at 90 degrees. If the PCL is torn, there may be abnormal contour or sag evident at the anterior proximal tibia when viewed from a lateral position20.

The quadriceps active test is performed with the patient supine and the knee flexed at 90 degrees. The patient is asked to contract his quadriceps muscle or, alternatively, slide his foot down the table. The quadriceps contraction will then cause the tibia to translate anteriorly from a posteriorly subluxated position5,6.

The dynamic posterior shift test is performed while the patient’s hip is flexed at 90 degrees. The examiner then extends the patient’s knee until the posteriorly subluxated tibia reduces as the knee reaches full extension6.

Additionally, there are several tests that can be used to detect concurrent PLC injuries. The reverse pivot shift test is performed with the leg in a position of external rotation. A valgus force is then applied to the knee with it extended at approximately 70 to 80 degrees of flexion. The test is positive when there is a palpable reduction of the displaced tibia21.

The dial test is also useful for assessing PLC injuries22. The test measures external rotation of both legs with the knees flexed at 30 and 90 degrees. External rotation is measured using the medial border of the foot or the tibial tubercle as a reference point. The test is positive if the external rotation increases by at least 10 to 15 degrees compared to the contralateral, uninjured limb. Simultaneous PLC- PCL injuries can be observed when external rotation is increased in both 30 degrees and 90 degrees of knee flexion.

Radiologic Evaluation

Patients suspected of having a PCL injury should undergo a complete radiographic evaluation consisting of anteroposterior (AP), lateral, sunrise and tunnel views. The plain radiographs may reveal subtle changes, including posterior sag of the tibia or degenerative changes of the medial and patellofemoral compartments. Occasionally, avulsion fractures of the PCL tibial insertion are identified2,5.

Hewett et al.23 examined 21 patients with PCL tears. Ten patients had partial tears while 11 patients had complete tears. Stress radiography was performed on all patients. An 89-N posterior load was applied to the proximal tibia and a lateral radiograph was taken of each knee in 70 degrees of flexion. The relative amount of sagittal translation was determined at both the medial and lateral tibial plateaus from the radiographic films. Up to 8 mm or greater translation of the medial tibial plateau was evident in the presence of a complete tear compared to that seen with a partial tear. The authors concluded that stress radiography is superior to both the arthrometer and clinical posterior drawer test for evaluating the integrity of PCL.

Despite these findings, stress views have many disadvantages, including the possibility of guarding by the patient, which could activate the quadriceps muscle and reduce the degree of posterior displacement. Additionally, there is a learning curve for in taking and measuring stress radiographs5.

Magnetic resonance imaging (MRI) is highly accurate tool in detecting acute tears of the PCL. In a large, prospective, multicentre study, Gross et al.24 reported an accuracy of 99% in diagnosing acute PCL injuries with the use of MRI. These results were confirmed with the use of arthroscopy. On the contrary, MRI is less useful in detecting chronic PCL deficiency. As chronic tears may heal in an elongated position, they may look relatively normal on MRI25.

Unlike ACL injuries, corresponding meniscal tears are less common with PCL tears. This is attributed to the fact that pathological posterior tibial translation decreases the load on the posterior horns of the medial and lateral menisci26.

Management

Nonoperative Treatment

Patients with acute, isolated, grade I and grade II PCL injuries can be treated with splinting and protected weight-bearing followed by early range of motion and, most importantly, strengthening of the quadriceps muscle.

These patients are usually able to return to normal activities within four weeks18.

The most suitable management of acute, grade III injuries, however, is more controversial. The current recommendation is to splint the knee in full extension for
Operative Treatment

Avulsion Injuries
Operative management of PCL avulsion injuries usually results in favourable outcomes. Avulsion fractures usually involve the tibial insertion and can be seen on routine lateral radiographs. The avulsed fragment can be fixed with either a screw or suture, using either an open approach or arthroscopy. If the bone fragment is large, fixation can be achieved through a posterior approach using one or two screws, with or without a washer. In cases with smaller or comminuted bone fragments, suture fixation through small drill holes may be necessary. In these cases, the knee should be braced in extension following the operation and initial weight bearing should be minimized and protected.

PCL reconstruction
There are several methods for reconstructing the PCL. Considerable controversy exists regarding the optimal location of tibial fixation, the number of graft bundles, the ideal placement of a femoral tunnel or tunnels and the appropriate graft tension during reconstruction. The two accepted techniques are the single bundle transtibial tunnel technique and the single bundle tibial inlay technique. Double bundle grafts are another variation.

Transtibial Tunnel or Tibial Inlay Technique
In the single bundle transtibial tunnel technique, the graft is passed through a tibial tunnel that exists through the PCL foot print and enters a femoral tunnel placed in the position of the anterolateral bundle of the native PCL on the medial femoral condyle. The tibial inlay technique is an alternative to the transtibial tunnel procedure. It involves the arthroscopic placement of a femoral tunnel and the open creation of a trough at the native footprint of PCL. This technique allows the graft to be directly attached to the posterior tibia. The ‘killer turn’ associated with the transtibial tunnel technique? The ‘killer turn’ is defined as the sharp graft angulation that occurs when the graft winds around the proximal tibia as it heads towards the anteromedial margin of the femur. It has been hypothesized that the ‘killer turn’ could lead to increased graft tissue strain, graft elongation after fixation and graft fraying that could lead to persistent laxity of the posterior aspect of the knee. Bergfeld et al. compared both techniques in a cadaveric study. They concluded that the inlay technique resulted in less posterior translation with less graft degradation than did the tunnel technique for reconstruction of the PCL.

Graft Bundle Options
One of the controversial points in PCL reconstruction is whether to reconstruct using one or two bundle fibres. The rationale behind the double bundle technique is that it may provide a theoretical advantage as it attempts to reconstruct both bundles of the PCL, thereby restoring knee stability through a complete range of flexion. This technique has been described using both tibial inlay and transtibial techniques as well as a variety of grafts. Similarly, there is controversy regarding the ideal position for femoral tunnels. One method involves placing the anterolateral tunnel in the right knee at the 1 o’clock position, 6 mm off the articular margin and the posteromedial tunnel at the 2:30 position, 4 to 5 mm off the articular margin. Chhabra et al. described the anterolateral tunnel at the 1 o’clock position, 5 to 6 mm off the articular margin, and the posteromedial tunnel at the 3 to 4 o’clock position, approximately 4 mm off the articular margin.

The graft is usually autogenous and typically harvested from the hamstring. Alternatively, a patellar tendon autograft or Achilles tendon allograft can be used. In any case, the allograft tendon should be longer than 40 mm to ensure adequate length for fixation.

Several studies have been conducted to evaluate the biomechanical efficacy of one versus two bundle reconstruction. Harner compared single versus double bundle reconstruction using 10 cadaveric knees. The knees were subjected to a 134-N posterior tibial load at five flexion angles. In single-bundle reconstruction, there was up to 3.5 mm more posterior translation than in the intact knee. However, with double-bundle reconstruction, the posterior tibial translation did not differ significantly from the intact knee at any flexion angle tested. The authors concluded that the result of double bundle grafts is more consistent with an intact PCL.

In another study, Bergfeld et al. compared single to double bundle Achilles tendon reconstruction with the tibial inlay technique in eight cadaveric knees. The knees were subjected to six cycles from a 40-N anterior reference point to a 100-N posterior translational force at 10 degrees, 30 degrees, 60 degrees and 90 degrees of flexion. Testing was performed for the intact and PCL-deficient knees as well as for both reconstructed conditions. There were no differences in translation between the single and double bundle grafts at any position. Therefore, the authors concluded that the use of a double-bundle graft may not, in fact, offer any advantages over a single-bundle graft for tibial inlay PCL reconstruction. Further clinical studies are required to determine whether the double bundle tibial inlay procedure could result in...
better clinical outcomes than the single bundle transtibial technique. This distinction is significant because the single bundle technique is a less time-consuming and less technically-demanding technique.

Postoperative Rehabilitation
The aim of postoperative rehabilitation after PCL reconstruction is to restore range of motion without putting excessive stress on the graft. Limited weight-bearing with crutches is permitted provided that the knee brace is locked in full extension and that exercises that could produce a posterior tibial translation are avoided. In the first post-operative day, quadriceps exercises are started with active knee extension. Passive knee flexion exercises are used to achieve normal knee flexion slowly over six weeks. Running can begin after five months and a full return to sports is allowed when adequate quadriceps and hamstring strength is achieved.

Fanelli stated that presently, PCL reconstructive surgery often results in excellent function with a return to the patient’s pre-injury level of activity. However, slow and deliberate postoperative rehabilitation is recommended to allow early healing after PCL reconstructive surgery, which is in contrast to accelerated rehabilitation after ACL reconstructive surgery.

Conclusion
PCL injuries are less common compared to the other ligamentous injuries of the knee. Nevertheless, they can result in significant morbidity and limitation for the injured patient. The physician should have a high index of suspicion for PCL injuries when examining patients presenting with knee injuries. Mild, isolated PCL injuries (grade I and II) can be treated with conservative management. In patients with severe degrees of laxity or multiligament injuries, surgical reconstruction is mandatory.

Recent double bundle and tibial inlay procedures may have significant theoretical benefits, but additional studies are needed to determine the most beneficial surgical procedure for patients requiring surgical reconstruction of the PCL.

References


