Posterior cruciate ligament tears: description of MRI findings with arthroscopic correlation

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Learning objectives

1. Describe the appearance on magnetic resonance imaging (MRI) of posterior cruciate ligament (PCL) tears proven by arthroscopy, with special emphasis on the different planes (sagittal, axial and coronal) on T2-weighted sequences.
2. Revise both isolated PCL tears and those associated with other abnormalities, such as ligament injuries or bony avulsions, according to the different etiology.
3. Evaluate the ability of MRI to differentiate the stage of tears, partial or complete, in correlation with arthroscopy.
Background

PCL tears are much less common than other ligament injuries of the knee, since LCP is twice as strong and resistant as the anterior cruciate ligament (ACL). Its incidence is difficult to determine because many of these injuries go unnoticed in the acute phase. They represent a 5-20% of ligamentous injuries of the knee according to different series (1, 2).

Contrary to what happens with the ACL, the descriptions of PCL tears in the radiology literature are scarce, but not so its importance for the stability of the knee; a torn and unrepaired PCL can lead to chronic instability and early osteoarthritis (3).

In addition, the clinical diagnosis in the acute phase of these injuries can be difficult because of the presence of hemarthrosis, pain, inflammation, and eventually other associated lesions (5, 6). It is not uncommon for the physical examination to be normal after an acute PCL tear, and patients don’t usually refer the characteristic click of ACL tears (4). Therefore, the diagnosis of these lesions often depends on the radiologist.

We will describe the MRI findings of PCL tears, both interstitial as partial or complete, and give some brief hints of the findings in arthroscopy.

The PCL can be difficult to assess arthroscopically using the usual anterior approach, as it is covered by the ACL (unless the latter is also torn). Therefore, it is important to have a preoperative diagnosis of these tears, to properly plan a posterior approach, which makes it more accessible.
Imaging findings OR Procedure details

The normal PCL is a fibrous band that runs obliquely from the lateral aspect of the medial femoral condyle to its distal insertion on the posterior margin of the tibia, approximately 1 cm below the articular surface (1). It is thicker and stronger than the ACL, and has a more important role in the stability of the knee (8).

Normal ligament appears on MRI as a well-defined fibrillar structure of decreased signal intensity on all pulse sequences within the posterior intercondylar notch. It has been compared with a hockey stick in the sagittal images and with a hockey puck in the coronal plane (Fig. 1) (2).

The meniscofemoral ligaments of Humphry and Wrisberg run adjacent to PCL from the medial femoral condyle to the posterior horn of the lateral meniscus, anterior and posterior to PCL respectively.

The most common mechanisms of PCL injuries are:

- Forced posterior tibial translation with flexed knee: this mechanism is common in motor vehicle accidents, the knee colliding with the dashboard (so called "dashboard injury"), or falls on flexed knee. The tibia is pushed posteriorly, its anterior margin striking the femur, often along the lateral condyle: hence the association with bone contusions or fractures in these locations (Fig. 2). Posterior joint capsule may be disrupted.

- Hyperextension injury: may cause avulsion of the tibial insertion site of the PCL, with or without bony avulsion of the posterior tibial spine (Fig. 3). In this case the bone contusions show symmetrical distribution ("kissing fractures"), usually identified in the anterior portion of the tibia and in the anterior aspect of the femoral condyles.

- Torsion / rotation, in association with adduction or abduction forces (knee dislocation): in this case multiple abnormalities are usually seen, with involvement of the collateral ligaments and both cruciate ligaments (Fig. 4).

PCL tears are classified according to their extension in interstitial, partial or complete.

- Interstitial tears correspond to grade I sprain: there is an intraligamentous injury without joint laxity.

- Partial tear (grade II sprain) represent a moderate tear of some of the fibers while others are intact. In this case the degree of joint laxity depends on the extension of the tear and integrity of other ligamentous structures.
- Complete tears or grade III sprain result in a full thickness disruption, with or without bone avulsion. As with the ACL, when some time has passed after the lesion the portions may horizontalize.

The first sign of PCL tear on MRI is diffuse thickening in the region of the PCL in the sagittal plane, measuring 7 mm or more (3).

In interstitial tears we can also see increased intraligamentous signal intensity, without clear disruption of the fibers (Fig. 5).

In partial tears we observe heterogeneous fibrillar structure with increased signal intensity; some fibers are partially intact.

In complete tears there may be a focal full thickness defect (Figs. 7 and 8), or complete failure to identify the PCL, its location being occupied by an amorphous mass of high signal intensity on T2-weighted sequences.

Note the possibility of posterior translation of the tibial longitudinal axis relative to femoral; this finding often correlates with clinical evidence of instability with positive posterior drawer test (Fig. 9).

The central portion of the PCL is best visualized in the sagittal plane, while the horizontal and vertical portions are well studied in the coronal and axial planes: we should follow the ligament structure at all planes to make sure to identify the defect.

In arthroscopic surgery the visualization of the PCL can be difficult when using the anterior approach, since its lower insertion is covered by the ACL. With posterior approach, however, the two bundles may be clearly identified (antero-lateral and postero-medial) (Figs. 10 and 11). In partial tears physical examination is often helpful, performing the posterior drawer test intraoperatively to check for laxity and confirm the PCL tear.

The treatment of PCL tears depends on the grade and the presence or not of other associated ligament injuries. Conservative therapy was classically proposed for isolated PCL tears (8), and is still used for many partial tears; but isolated PCL reconstructions are more and more frequent (for more information about surgical treatment of PCL tears we suggest to see our poster Imaging of posterior cruciate ligament (PCL) reconstruction: normal postsurgical appearance and complications. A. Alcalá-Galiano Rubio, M. Baeva Trunina, F. Buendía Gómez, M. J. Argüeso Chamorro).
Fig. 1: Normal MRI appearance of the PCL.

Normal appearance of PCL has been compared with a hockey stick in the sagittal plane and with a hockey puck in the coronal plane.
Fig. 2: Dashboard injury: Full-thickness tear of the postero-medial bundle of the PCL. Note the characteristic pattern of bone contusions in the anterior aspect of the tibia and both femoral condyles.
Fig. 3: Avulsion fracture of the tibial insertion site of PCL in the posterior tibial spine.

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Fig. 4: Severe multiligamentous injury in a patient with knee dislocation.

50 year old male with severe multiligamentous injury after knee dislocation. We fail to identify the PCL as a sign of complete rupture (white arrows).

There is also a high grade sprain of the ACL (red arrows), and grade II/III sprains of both medial and lateral collateral ligaments (blue arrows for MCL and green arrows for LCL). Note also the presence of extensive bone contusions in the lateral compartment.

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**Fig. 5:** Interstitial or intraligamentous PCL tear.

40 year old male, football player, with a history of fall on flexed knee. We can see diffuse thickening of the PCL and increased intraligamentous signal intensity without clear disruption of the fibers, compatible with interstitial tear (arrows). In arthroscopy partial rupture was observed and no PCL reconstruction was performed (conservative therapy).
Fig. 11: Arthroscopic findings: Complete PCL tears.

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Arthroscopic findings:

**Image A** shows the normal arthroscopic appearance of the PCL, visualizing both bundles intact (white arrows).

**Image B** shows complete tear of both bundles of the PCL, identifying only the two stumps (black arrows).

In this case there is also a complete tear of the ACL (blue arrow).

**Fig. 10:** Arthroscopic findings: Normal appearance (A) and complete tear of both bundles of the PCL (B).
Fig. 6: Partial PCL tear with integrity of the posterior bundle.

46 year old sailor that receives a direct blow on the knee with a piece of the boat. Note the diffuse thickening and loss of fibrillar structure of the PCL at all planes (arrows); the posterior bundle remains intact (arrowheads).

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**Fig. 9:** Posterior tibial translation as an indirect sign of instability.

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Fig. 8: Complete tear of the PCL with a full-thickness focal defect in the distal portion.

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Fig. 7: Complete isolated rupture of the PCL.

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POSTERIOR CRUCIATE LIGAMENT TEARS: Description of MRI findings with arthroscopic correlation

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Fig. 12

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Conclusion

It is important to identify PCL tears with MRI imaging, as they often go unnoticed in the initial diagnostic evaluation, given the difficulty of the clinical assessment especially in isolated lesions in the acute phase.

MRI provides adequate visualization of the PCL using standard knee study protocols. The spectrum of PCL injuries is well demonstrated, including interstitial injury, partial or complete tears, as well as other associated ligamentous or meniscal injuries or bone contusions.

MRI imaging is a valuable tool for evaluation of these lesions, and radiological diagnosis is essential for planning surgical or conservative treatment.
References