# Iatrogenic Meniscus Posterior Root Injury Following Reconstruction of the Posterior Cruciate Ligament

## A Report of Three Cases

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*Investigation performed at the Steadman Clinic, Vail, Colorado*

The diagnosis of meniscus root tears has become more common as the clinical and radiographic awareness of these injuries has increased[1,2]. Detachment of the meniscal roots from their tibial posterior attachments can cause meniscal extrusion and joint space narrowing, and also has been associated with progressive knee arthritis[3,4]. Meniscal root detachments have been demonstrated to result in a loss of meniscal hoop stress and to subject the articular cartilage to abnormal contact forces, equivalent to those experienced after a total meniscectomy[5,6].

In addition, knowledge about and understanding of the attachment sites of the menisci have been enhanced by quantitative and qualitative anatomic studies[7]. The close proximity of the medial and lateral meniscus root attachments to the tibial footprint of the posterior cruciate ligament (PCL) is pertinent because it renders these structures vulnerable when drilling a transtibial tunnel for a PCL reconstruction[8]. As interest in and enthusiasm for PCL reconstructions increase, it is important to be cognizant of this close relationship since iatrogenic

Fig. 1-A

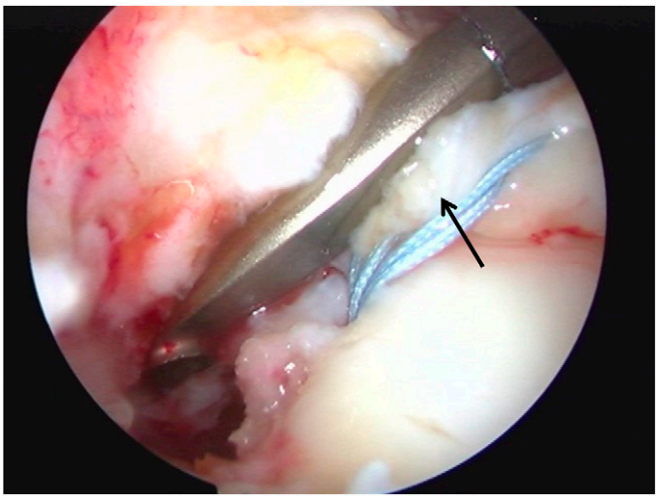

Fig. 1-B

**Figs. 1-A and 1-B** Case 1. **Fig. 1-A** T2-weighted coronal MRI of the right knee shows an intact posterior root of the medial meniscus prior to the initial PCL reconstruction. **Fig. 1-B** An intraoperative arthroscopic image of the repair of the posterior horn of the medial meniscus (arrow) just lateral to its attachment site. A curet demonstrates the position of the tibial tunnel aperture at the anatomic site of the posterior horn of the medial meniscus.

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Fig. 2-A

Fig. 2-B

**Figs. 2-A and 2-B** Case 2. **Fig. 2-A** T1-weighted coronal MRI of the right knee taken at the index injury demonstrates an intact posterior horn of the medial meniscus. **Fig. 2-B** MRI two years following conservative management demonstrates an intact posterior root attachment of the medial meniscus.

detachment of meniscal roots represents a potential risk of this procedure.

We present a series of cases in which posterior horn meniscal roots were detached iatrogenically because of malpositioning of the transtibial PCL reconstruction tunnels.

The institutional review board at the Vail Valley Medical Center in Colorado provided approval for this case series.

The patients were informed that data concerning their cases would be submitted for publication, and they provided consent.

## Case Reports

The three patients described in this case report were originally operated on by a surgeon at an outside institution, and they all were noted to have failed PCL reconstructions at the initial presentation to our facility.

Case 1. A twenty-one-year-old man presented with recurrent right knee instability. The original injury had occurred ten months previously during a football game, following a fall on a flexed knee. The diagnosis of a PCL tear had been made, and he had undergone a single-bundle PCL reconstruction; there was no meniscal root injury detected at the index magnetic resonance imaging (MRI) (Fig. 1-A). Six weeks after surgery, he reported right knee instability and medial joint line pain.

Ligamentous examination revealed a score of 2+ on the pseudo-Lachman test, a score of 3+ on the posterior drawer test, and stable varus and valgus stressing at 0° and 30°. Kneeling PCL stress radiographs[9] demonstrated 13 mm of increased posterior tibial translation compared with the contralateral knee, which was indicative of a complete grade-3 PCL graft tear. The MRI showed signal intensity consistent with a tear of the posterior root of the medial meniscus[10]. Computed tomography (CT) demonstrated that the transtibial tunnel from the PCL reconstruction was enlarged and had passed into the medial meniscal posterior root attachment. At the revision double-bundle PCL reconstruction, it was confirmed that the patient had a medial meniscus root detachment at the PCL tibial reconstruction tunnel position (Fig. 1-B); the medial meniscus posterior horn root tear was repaired.

Case 2. A twenty-nine-year-old man presented with right knee instability. The initial injury had been sustained as a result of hyperextension while landing when playing basketball. The patient had been diagnosed with a PCL tear (Figs. 2-A and 2-B). The original MRI revealed that the meniscal root attachments were normal. He had undergone a single-bundle PCL reconstruction. Two years postoperatively, he developed medial-sided knee pain, and subsequently underwent a microfracture of the medial femoral condyle. However, the medial knee pain persisted.

Examination revealed a posterior sag sign and a score of 3+ on the posterior drawer test. MRI demonstrated a deficient PCL graft and a posterior root tear of the medial meniscus (Fig. 3-A). A CT scan demonstrated that the path of the transtibial tunnel from the PCL reconstruction was located on the proximal anterior half of the PCL facet, passing through the root attachment of the medial meniscus (Figs. 3-B and 3-C). He underwent a staged surgery that consisted of bone-grafting of the PCL reconstruction tunnels and a medial meniscal root repair, followed six months later by a staged revision double-bundle PCL reconstruction.

Case 3. A fifty-five-year-old obese man presented to the clinic for evaluation of right knee instability. The initial damage

Fig. 3-A

Fig. 3-B

Fig. 3-C

**Figs. 3-A, 3-B, and 3-C** Case 2. **Fig. 3-A** T1-weighted coronal MRI of the right knee following PCL reconstruction demonstrates a detachment of the posterior root of the medial meniscus. **Fig. 3-B** Coronal CT scan demonstrating the tibial tunnel coursing into the anatomic location of the posterior root attachment of the medial meniscus. **Fig. 3-C** Sagittal CT scan demonstrating the PCL tibial reconstruction tunnel passing into the root attachment of the posterior horn of the medial meniscus.

had occurred as a result of an ultra-low velocity injury while walking. The knee "gave way, buckled, and dislocated." The MRI revealed that the PCL, the anterior cruciate ligament (ACL), the medial collateral ligament (MCL), and the fibular collateral ligament (FCL) all were torn, and the menisci were intact. He had undergone surgery acutely to reconstruct the ACL and the PCL; the MCL and the FCL had been reconstructed at a later date. Following surgery, he had continued to have instability symptoms, which restricted his activities of daily living and his ability to work.

After musculoskeletal examination and PCL and varus stress radiographs, it was confirmed that the PCL graft was

Fig. 4-A

Fig. 4-B

**Figs. 4-A and 4-B** Case 3. **Fig. 4-A** T2-weighted coronal MRI of the left knee detachment of the posterior horn of the lateral meniscus. **Fig. 4-B** Coronal CT image of the left knee demonstrating a lateral tunnel placement of the tibial tunnel through the anatomical site of the posterior horn of the lateral meniscus. The tunnel placements for the FCL and posterolateral corner reconstruction also are visible.

intact, but the FCL graft was deficient. The MRI demonstrated a posterior root tear of the lateral meniscus (Fig. 4-A). The CT scan revealed that the tibial tunnel for the PCL reconstruction had been placed proximal and lateral to the anatomical location of the PCL footprint, passing through the attachment of the lateral meniscal posterior root (Fig. 4-B). He underwent a lateral meniscal root repair and bone-grafting of the femoral, tibial, and fibular posterolateral corner reconstruction tunnels for osteolysis.

## Discussion

This case series describes three cases of iatrogenic meniscus root injury due to malpositioning of the transtibial tunnel during PCL reconstruction. A number of studies have reported that tears of the posterior root of the medial meniscus lead to early degenerative disease equivalent to that seen following total meniscectomy[1,11-13]. The recognition of these injuries is a relatively recent phenomenon, and, to our knowledge, documentation of an iatrogenic etiology previously has not been reported[4,14]. An awareness of this potential complication of PCL reconstruction is critically important, not only to avoid malpositioning of the tibial tunnel, but also to recognize it as a differential diagnosis in patients with ongoing symptoms following PCL reconstruction.

The primary soft-tissue attachments of the menisci are found at the posterior horns, especially on the medial side (Figs. 5-A and 5-B)[7,15]. The stout attachments prevent anterior tibial translation when the posterior horns of the menisci, with their wedge-shaped cross-section, impact against the posterior femoral condyles[10]. Therefore, the absence of this wedge renders the secondary stabilizers insufficient, causing an increase in articular contact pressures and added strain on the ligament constraints[4,16]. The lack of a posterior attachment can lead to meniscal extrusion, which results in joint space narrowing, and in turn can contribute to rapidly progressive arthritis[2,10,12]. Studies have reported increases in peak contact pressure from 25% to 32% in the medial compartment and 20% decreases in the contact area in the medial compartment after posterior root detachment of the medial meniscus[5,16].

Clinical outcome studies of PCL reconstruction have reported complications that include neurovascular injuries, fractures, loss of motion, residual laxity, heterotopic ossification, pain leading to hardware removal, and compartment syndrome[17-19]. However, to our knowledge, no studies have reported iatrogenic complication involving the posterior roots of the lateral and medial menisci. Accurate tunnel placement to avoid the neurovascular bundle posteriorly or to minimize the "killer turn" to prevent stress on the graft is often discussed in technique papers[20-22], but it is equally important to avoid iatrogenic injury to the posterior meniscal root attachments.

A more thorough understanding of PCL function and injuries has led to an increase in research, awareness, and treatment of these complex injuries[23]. It has previously been reported and well accepted that anatomic PCL graft placement leads to better overall stability when compared with isometric placement[13].

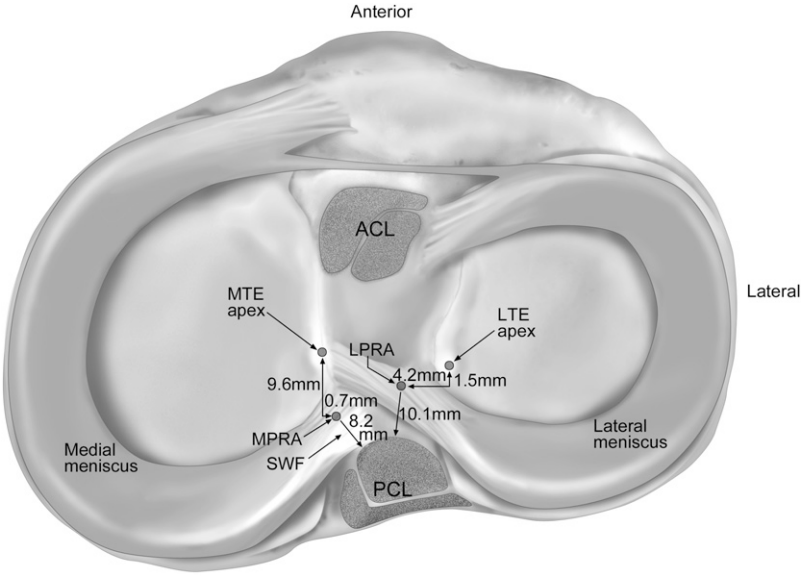


Fig. 5-A

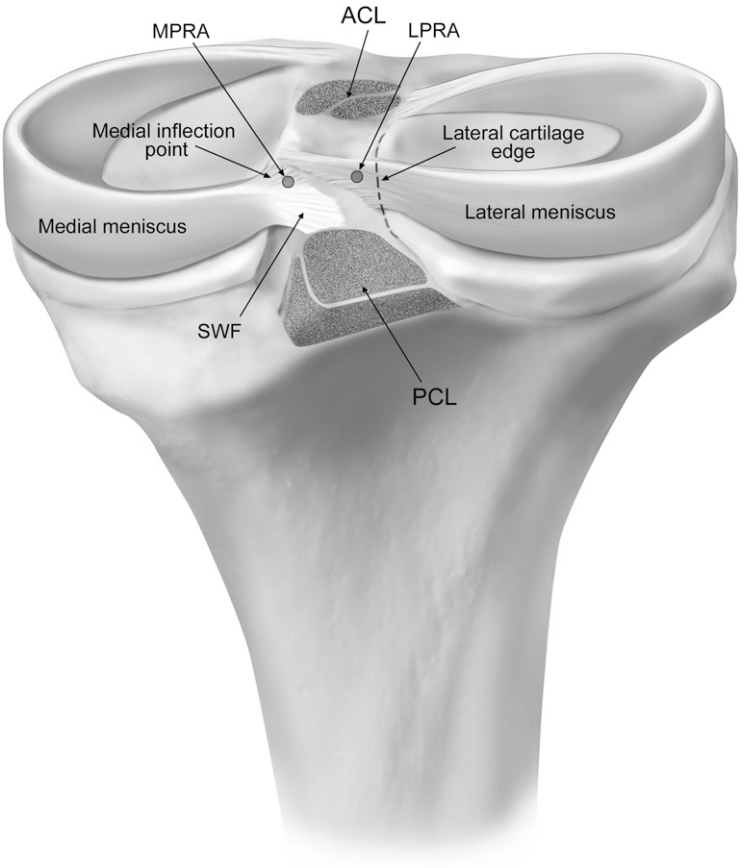


Fig. 5-B

Illustrations demonstrating the superior view (**Fig. 5-A**) and posterior view (**Fig. 5-B**) of the posterior root attachment of the medial and lateral menisci and the tibial attachment of the PCL. ACL = anterior cruciate ligament bundle attachments, LPRA = lateral meniscus posterior root attachment, LTE = lateral tibial eminence, MPRA = medial meniscus posterior root attachment, MTE = medial tibial eminence, PCL = posterior cruciate ligament bundle attachments, and SWF = shiny white fibers of posterior horn of medial meniscus. (Reprinted, 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 Oct;40(10):2342-7.)

The accurate positioning of the transtibial tunnel is critical in this regard; however, this is certainly one of the most challenging elements in the surgery given the restricted visibility, despite the use of accessory posteromedial portals and 70° arthroscopes[24]. A greater appreciation of the anatomy of the PCL and its nearby structures has improved the precision and outcome of PCL reconstruction[7,8,25]. The anatomic location for the division of the two bundles of the PCL on the tibia has been identified as the "bundle ridge"[8,25]. Given that the center of the PCL tibial attachment is located 7.8 mm from the shiny white fibers of the posterior root of the medial meniscus, and 9.8 mm from the lateral articular cartilage[8], there is a very small margin for error when drilling an 11 or 12-mm diameter transtibial reconstruction tunnel, which has been recommended clinically[25]. These previously reported quantitative measurements reaffirm the importance of rigorous attention to detail in optimizing the transtibial tunnel to avoid iatrogenic posterior meniscal root detachments.

We are aware that there are limitations to this study. This case series describes a limited number of patients who had all undergone prior surgery. By obtaining their original preoperative MRI and observing the location of the tunnels arthroscopically, we were able to determine that the meniscus root injuries did not occur at the time of the original index injuries.

To the best of our knowledge, this case series highlights a previously undescribed iatrogenic complication of PCL reconstruction, resulting in detachment of the posterior roots of the menisci due to inaccurate tibial reconstruction tunnel placement. This pathology should be considered in the differential diagnosis of patients with persistent symptoms of instability and pain following PCL reconstruction. Accurate transtibial reconstruction tunnel placement is essential in PCL reconstructive surgery to avoid posterior meniscus root detachment and the associated long-term complications from this pathology. ■

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