Peek screw displacement after PCL reconstruction: A radiographic red herring solved by MRI

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ABSTRACT

Posterior cruciate ligament (PCL) repair has been increasingly performed as opposed to conservative management of PCL tears, in order to protect against future osteoarthrosis and meniscal degeneration. Fixation of the graft to bone can be done with interference screws, of which those composed of a bioresorbable material such as polyetheretherketone (PEEK) are preferred, owing to their inertness, good fixation strength and superior MR imaging compatibility. However, PEEK screws (unlike titanium screws) are radiolucent, and can make accurate post-operative evaluation by radiographs challenging. This is the first reported case of loosening of PEEK screw post-PCL repair, which highlights the importance of MRI and potential pitfall of radiography in evaluating post-surgical ligament laxity.

CASE REPORT

CASE REPORT

A 37-year-old female sustained a motor vehicular accident 2 years ago, following which she was diagnosed with isolated tear of the posterior cruciate ligament (PCL) of right knee, and underwent PCL reconstruction surgery utilizing polyetheretherketone (PEEK) interference screws. Approximately a year following the procedure, she complained of increasing pain in her right knee, with difficulty of flexion, radiation over ipsilateral calf and limitation of daily activities of living. On examination, tenderness over the medial joint line, anterior proximal tibia and retropatellar surface was present. Range of motion was 100 degrees, with pain experienced terminally. No neurovascular deficits were detected. Posterior drawer test was positive (grade 2), with negative anterior drawer and varus/valgus stress tests.

A PCL graft injury was suspected, and further investigation was performed with a lateral stress radiograph of the implicated knee (Figure 1), which revealed significant posterior translation of the tibia (by approximately 10mm) in both the neutral and stress positions. The endobuttons and bony tunnels were seen in their normal positions, and the PEEK screws previously used in fixation were not seen, owing to their radiolucency. This led to the suspicion of graft tear. MRI was performed to assess graft status (image acquisition parameters as specified in table 1) which instead revealed a displaced femoral screw within the posterior aspect of the right knee with a lax (but intact) PCL (Figures 2a-c). Furthermore, this screw was seen to impinge upon the adjacent tibial nerve (Figure 3), which would explain the neuropathic pain the patient had experienced. Patient was offered arthroscopic repair, however due to poor visualization of the screw open surgery and fixation was performed. There was resolution of pain and limitation of motion in the post-surgical follow-up period.

DISCUSSION

The PCL is the primary deterrent of posterior tibial instability of the knee, and aids in rotational stability.

Etiology & Demographics:

PCL injuries are less common compared to those of the ACL (Anterior Cruciate Ligament) [1], and typically arise due to pretibial trauma, hyperflexion, or hyperextension of the knee [2]. Isolated PCL injuries are rare; the PCL is more commonly injured as part of a multiligamentous injury or with knee dislocations. Chung showed that the highest prevalence of PCL injuries occurred in those in their 2nd and 3rd decades, followed by those in their 5th and 4th decades. This has been attributed to more frequent sports-related injuries of this age-group [3], and due to vehicular accidents. A greater prevalence was seen in males [4].

Clinical & Imaging Features:

Acute PCL injuries present with knee pain, swelling and limitation of flexion. Clinical maneuvers such as the anterior drawer test (which elicits posterior tibial laxity) and dial test (which attempts to differentiate between isolated PCL injury and combined PCL and posterolateral complex injury). It is also important to clinically assess neurovascular injury (i.e. to the popliteal artery and tibial nerve), but this can be made challenging by periarticular soft-tissue swelling. Chronic injuries usually present as pain in the anterior and medial aspects of the knee, and less frequently as instability [5]. Severity of PCL injury is graded based on posterior tibial translation respect to the femoral condyles in 90 degrees flexion as such: grade I being 1–5mm of translation, grade II as 6–10mm, and grade III as >10mm.

Post-operative radiological assessment of PCL injury and excessive posterior laxity includes stress radiographs in which posterior tibial translation of >10mm was specific for PCL injury [6]. However, radiographic interpretation is variable [7]. Further the status of the screw cannot be assessed due to radiolucent property of the PEEK screw. Hence, MRI is the modality of choice [8, 9, 10], which allows for assessment of the graft itself, the femoral and tibial tunnels, condition of adjacent bone and potential complications [11]. An intact PCL graft is expected to show similar post-reconstruction characteristics as its ACL counterpart, and shows an intermediate signal on T1- and T2W imaging in the first post-operative year, and assumes low signal on both sequences henceforth. Other features to be assessed in post-operative imaging of PCL reconstruction are arthrofibrosis, loose bodies, femoral and tibial tunnel position and graft integrity [12].

Treatment & Prognosis:

Since the PCL has a significant potential for self-healing [13], grade I and II instability, especially in the elderly and inactive, is generally managed conservatively [14, 15]. Operative management is indicated in grade III injury or combined posterolateral complex injuries which affect daily living [16]. It has been shown that operative management, when compared to conservative management, results in lower risk for further meniscal tears and osteoarthrosis [17]. This has led to a recent interest in PCL reconstruction. The PCL was managed surgically in the above patient as she was young and had subjective instability that affected daily functioning.

There is significant evolution of the concept of PCL repair, primarily of the graft material choice, fixation method and devices. PCL grafts may be autografts or allografts. Autografts are bone-tendon-bone grafts, utilizing the patellar tendon, hamstrings or quadriceps tendon. Allografts (more commonly used) include the tendoachilles, and anterior or posterior tibial tendons [18]. Two popular techniques exist for PCL reconstruction: transtibial and tibial inlay techniques, the latter being more prevalently performed. The transtibial technique involves passing a graft retrograde through a tibia tunnel and attaching it to the femur after taking a perpendicular “killer turn” at the intra-articular tibial aperture. This was seen to increase shearing of the graft and eventual failure [19]. To avoid this, the tibial inlay technique utilizes an open posteromedial approach with fixation of graft to the native insertion of PCL onto the tibia.

Fixation of graft to bone is essential for normal biomechanical function. This may be achieved through compression (via interference screws), expansion (cross-pin technique) or securement via button. The use of interference screws has been shown to be reproducible and successful regarding long term outcomes. Titanium screws were seen to lead to progressive tunnel enlargement and graft injury [20]. They have been increasingly replaced by bioresorbable screws composed of material such as poly-L-lactic acid with hydroxyapatite (PLLA-HA) and polyetheretherketone (PEEK). PEEK screws are advantageous in being chemically inert, providing comparable fixation strength, superior post-operative MRI assessment due to absence of susceptibility artifact given by titanium [21]. The major disadvantage of the PEEK screw is its radiolucent property which poses the challenge in post-operative evolution using radiographs.

The technically demanding nature of PCL reconstruction and potential injury to adjacent structures raises the risk of per- and post-operative complications, such as neurovascular injury (to the popliteal artery and tibial nerve), tibial fracture, heterotopic ossification, compartment syndrome, and residual posterior laxity [22]. An important cause of residual posterior laxity is screw loosening, which though uncommon, may result due to size mismatch, screw divergence, poor bone quality, abnormal bone resorption and local inflammatory response elicited by PEEK [23,24]. With repeated knee motion, the graft pulls the screw beyond the tunnel, more commonly intra- than extra- articularly [25].

In the presented case, the posterior tibial laxity was diagnosed initially by stress radiographs based on increased translation. The endobuttons and bony tunnels were seen in their expected post-operative positions; however, the status of the PEEK screw could not be determined. Also, graft tear didn't correlate with the patient's complaints of articular and neuropathic pain. An MRI done subsequently revealed the presence of the screw within the posterior aspect of the knee joint, still attached to a lax (but intact) PCL graft and impinging upon the adjacent tibial nerve.

A similar diagnostic red herring was reported by Fang et al [17], which concerned PEEK screw displacement post ACL reconstruction. To our knowledge, this is the first description of screw displacement after PCL reconstruction in literature. MRI plays crucial role not only to detect the status of the screws but provides information on the graft status and also on the integrity of rest the structures.

TEACHING POINT

Owing to the radiolucency of PEEK screws, screw displacement may be invisible on radiographs of post-operative knees with residual ligament laxity. Hence, MRI is the modality of choice, which can reveal the screw position, status of graft, condition of bony tunnels and relevant complications.

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FIGURES

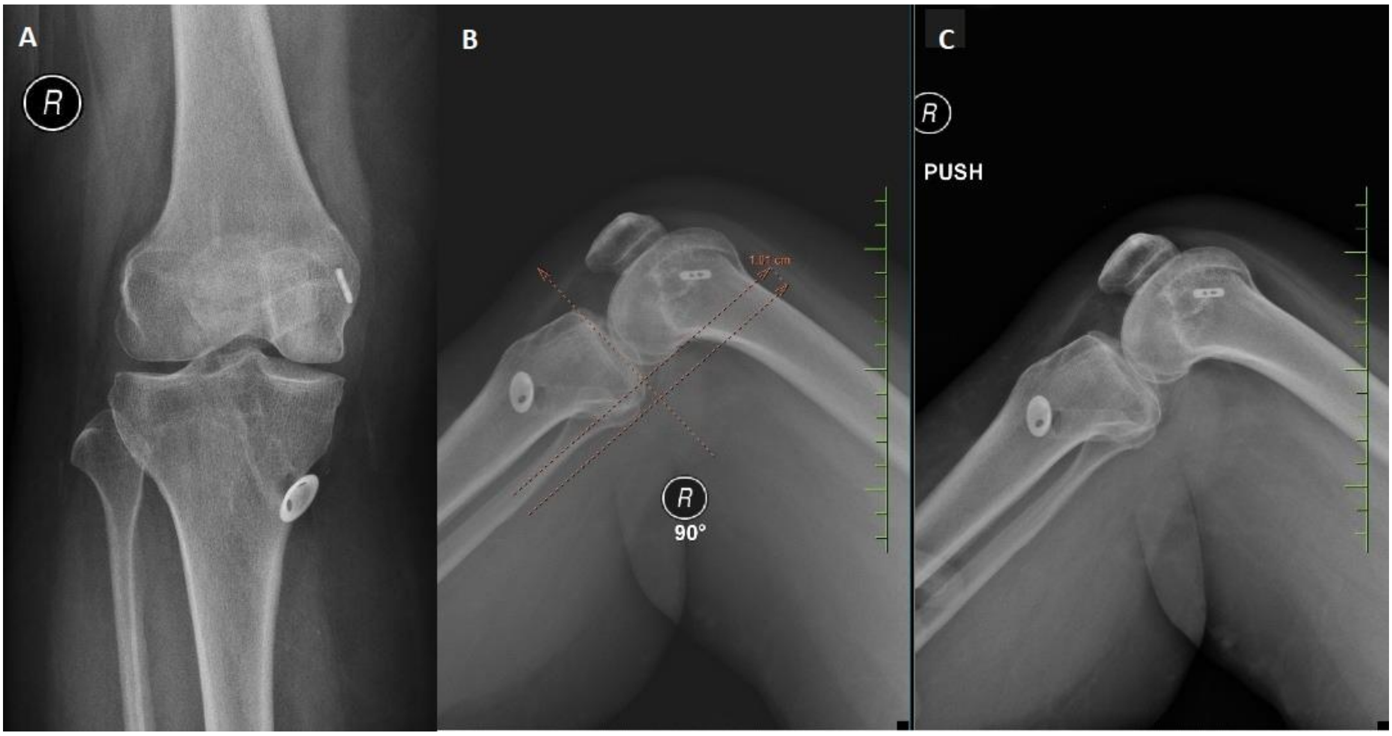

Figure 1: 37-year-old female with residual tibial laxity following PCL reconstruction.

FINDINGS: Anteroposterior (A) and lateral radiographs of the right knee in neutral position (B) and with posterior tibial stress (C), showing significant posterior translation in both positions. Endobuttons and bony tunnels are seen in their expected locations, with the radiolucent PEEK screw being invisible.

TECHNIQUE: Lateral projections of right knee in neutral and posterior stress positions. 66kV, 800mAs.

Figure 2: 37-year-old female with residual tibial laxity following PCL reconstruction.

FINDINGS: Sagittal Proton-Density Fat-Saturated (PDFS) images of right knee revealing the displaced radiolucent screw, previously invisible on radiographs, within the posterior aspect of knee (white arrow) with the attached intact PCL graft (black arrow).

TECHNIQUE: 3T Sagittal Proton-Density Fat-Saturated (PDFS) (TE: 15, TR:3550).

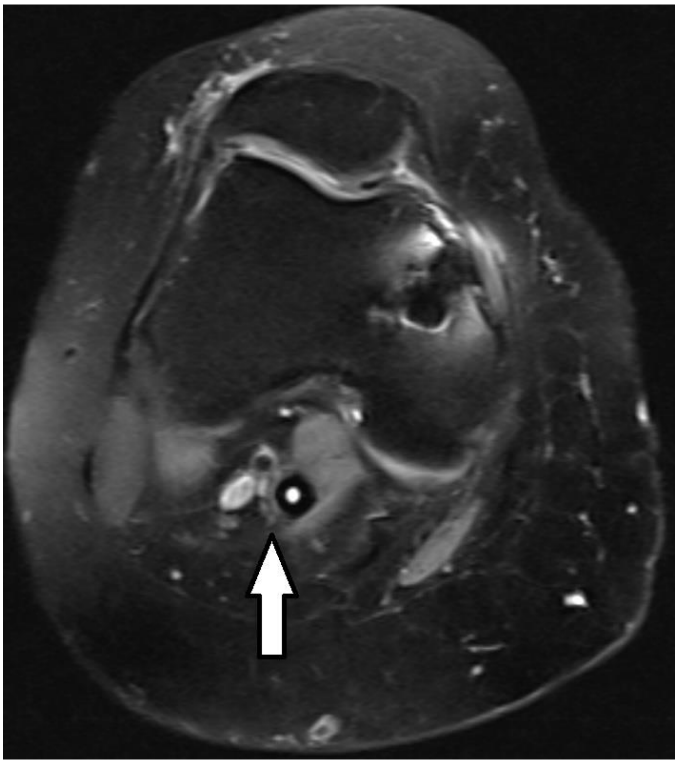

Figure 3 (left): 37-year-old female with residual tibial laxity following PCL reconstruction.

FINDINGS: Axial PDFS image of right knee showing the screw within the posterior aspect of knee, impinging upon the adjacent tibial nerve (arrow).
TECHNIQUE: 3T Sagittal Proton-Density Fat-Saturated (PDFS) (TE: 15, TR:3550).

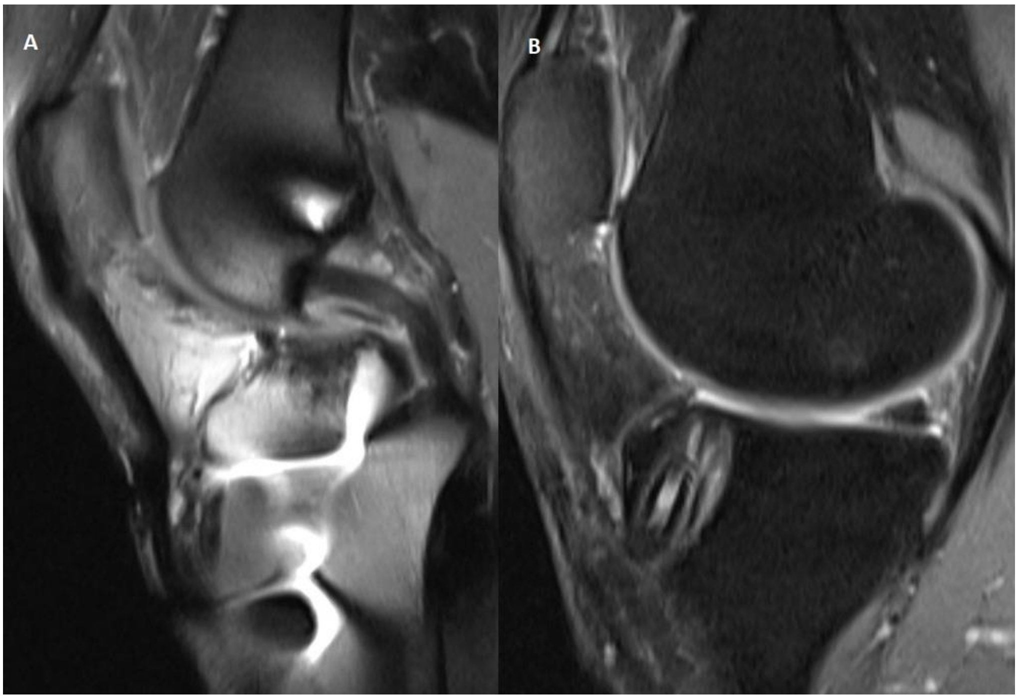

Figure 4: 37-year-old female with residual tibial laxity following PCL reconstruction.

FINDINGS: Sagittal Proton-Density Fat-Saturated (PDFS) images of right knee of two patients showing MRI appearance of titanium (A) versus polyetheretherketone (PEEK) screws. Titanium screws generate significantly greater susceptibility artefact and hinder accurate post-operative imaging assessment.

TECHNIQUE: 3T Sagittal Proton-Density Fat-Saturated (PDFS) (TE: 15, TR:2750).

SEQUENCE	PLANE	TE (msec)	TR (msec)	FOV (cm x cm)	MATRIX	SLICE THICKNESS (mm)
T1W	Sagittal	11	350	18 X 18	256 X 256	3.5
T2W	Sagittal	103	4620	18 X 18	384 X 384	3
PDFS	Sagittal	14	2760	19 x 16	270 x 320	3
	Axial	14	3360	16 x 16	320 x 320	3.5
	Coronal	15	3000	15 x 19	320 x 256	3

Table 1: Magnetic resonance imaging (MRI) acquisition parameters performed to assess graft status.
Legend: T1W - T1-weighted, T2W - T2-weighted, PDFS - Proton Density Fat Saturation

Etiology	Pretibial trauma, hyperflexion, or hyperextension of the knee
INCIDENCE	7.5 – 47% of ligamentous injuries of knee (wide range due to epidemiological variations)
GENDER RATIO	Slight male predilection
AGE PREDILECTION	3rd decade
RISK FACTORS	Age, gender, activity (sports-related)
TREATMENT	Grade I and II injury – conservative, grade III and above – surgical repair in young/active individuals
PROGNOSIS	Adequate fixation with screws, endobuttons ensures low recurrence. However, incidence of post-operative PCL graft or implant failure is not known due to rarity of cases
IMAGING FINDINGS	XRAY/CT: posterior tibial laxity >10mm Possible displacement of endobuttons/ radio-opaque screws MRI: location of displaced screw, graft integrity, condition of bone tunnels and surrounding bone, complications to neurovascular structures (popliteal artery, tibial nerve)

Table 2: Summary table of PCL injury.
Legend: PCL - Posterior Cruciate Ligament, CT - Computed Tomography, MRI - Magnetic Resonance Imaging

Differential Diagnoses on X-RAY/CT	Differential Diagnoses on MRI
PCL graft tear	**Implant failure (i.e. screw loosening/ fracture, osteolysis) ± graft tear**
Implant failure (i.e. screw loosening/ fracture, osteolysis)	
Inadequate surgical graft tensioning	

Table 3: Differential diagnosis table for residual posterior tibial laxity.
Legend: CT (Computed Tomography), MRI (Magnetic Resonance Imaging)

ABBREVIATIONS

ACL = Anterior Cruciate Ligament
MRI = Magnetic Resonance Imaging
PCL = Posterior Cruciate Ligament
PEEK = Polyetheretherketone
PLLA-HA = Poly-L-lactic acid with hydroxyapatite

KEYWORDS

PCL; Reconstruction; PEEK; MRI; Graft

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