



Arthroscopic Fixation of a Posterior Cruciate Ligament Avulsion Fracture: A Case Report

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Article History :

Received date : 2026/03/02
Revised date : 2026/04/18
Accepted date : 2026/05/21
Published date : 2026/06/06



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E-ISSN :

ISSN 3048-1368



P-ISSN

ISSN 3048-1376



ABSTRACT

Introduction: Avulsion fractures of the posterior cruciate ligament (PCL) are relatively uncommon injuries, particularly in the adolescent population. These injuries involve detachment of the ligament from its tibial insertion and may result in persistent posterior knee instability if not properly managed. Accurate diagnosis and appropriate fixation are essential to restore normal knee kinematics and prevent long-term complications.

Case Illustration: This report presents the case of a 16-year-old female patient with a 3-month history of left knee pain and instability following a fall during training. Clinical examination revealed positive posterior drawer and valgus stress tests. Magnetic Resonance Imaging (MRI) confirmed a displaced tibial avulsion fracture of the PCL (Meyers-McKeever Type III) and a concomitant full-thickness MCL tear. The patient underwent a single-stage procedure: arthroscopic suspensory button fixation for the PCL avulsion and an anatomic reconstruction of the MCL.

Discussion: Surgical management is superior to non-operative treatment for displaced PCL avulsions, citing improved union rates and better objective stability (Gopinath et al., 2023). The rationale for selecting an arthroscopic suspensory fixation technique (Kan et al., 2020) over traditional open or arthroscopic suture methods is discussed, highlighting its minimally invasive nature, robust fixation, and avoidance of complications associated with other techniques (Hu et al., 2025).

Conclusion: Arthroscopic suspensory fixation represents an effective and reliable treatment option for displaced PCL tibial avulsion fractures in adolescents. This technique enables stable fixation, supports early rehabilitation, and contributes to satisfactory restoration of knee stability, even in chronic cases.

Keywords: Posterior Cruciate Ligament; PCL Avulsion Fracture; Arthroscopic Fixation; Adolescent; Case Report

INTRODUCTION

Background: Biomechanical Context and Epidemiology

The posterior cruciate ligament (PCL) serves as the primary restraint to posterior tibial translation and a secondary restraint to varus/valgus and external rotation. The medial collateral ligament (MCL) complex is the primary restraint against valgus stress (Sleem et al., 2025). Injuries to the PCL are far less common than those to the anterior cruciate ligament (ACL), with PCL tibial avulsion fractures representing a specific and rare subgroup of these injuries (Gopinath et al., 2023).

This injury pattern is exceptionally rare in the pediatric and adolescent populations (Ross & Chesterman, 1986; Guimarães et al., 2017). Pediatric anatomy, specifically the open physis (growth plate), often leads to different injury patterns than in adults (Kim et al., 2010). In this 16-year-old patient, radiographic imaging demonstrated that the distal femoral and proximal tibial physes were closed. This classifies her as skeletally mature, which advantageously removes the significant comorbidity of iatrogenic growth disturbance from physeal-crossing tunnels—a major concern in pediatric PCL surgery (Kim et al., 2010). Nonetheless, the avulsion injury pattern is characteristic of this age group, where the recently fused apophysis remains a biomechanical weak point compared to the ligament's substance.

The Diagnostic and Treatment Challenge

The Meyers-McKeeever classification is the traditional standard for PCL avulsion fractures, categorizing them by displacement (Meyers & McKeeever, 1959). Type I is non-displaced, Type II is displaced with an intact posterior hinge, and Type III is completely displaced from the fracture bed. This classification is critical, as Types II and III are typically indications for surgical intervention (Hu et al., 2025; Gopinath et al., 2023).

This case highlights several key challenges:

1. **Chronic Presentation:** The 3-month delay from injury to presentation classifies this as a chronic injury. This implies significant fibrous scar tissue, fragment retraction, and potential

non-union, which complicates surgical reduction.

2. **Technical Complexity of Fixation:** Achieving stable fixation in displaced PCL avulsion fractures—particularly in delayed cases—can be technically demanding. Factors such as fragment size, bone quality, and accessibility of the posterior tibial footprint influence the choice of fixation technique.
3. **Rarity of the Condition:** Chronic PCL tibial avulsion fractures in adolescents are rarely reported in the literature, especially those requiring advanced arthroscopic fixation strategies. This creates a relative lack of consensus regarding optimal management.

This report aims to describe the diagnostic approach, surgical management using arthroscopic suspensory fixation, and immediate postoperative outcomes in a chronic adolescent PCL avulsion fracture. We hypothesize that arthroscopic suspensory fixation can provide stable fixation and effectively restore posterior knee stability, even in delayed presentations.

CASE ILLUSTRATION

Table 1: Patient Demographics and Clinical Findings

Parameter	Detail
Age/Sex	16 / Female
Admission	26/10/2025
Chief Complaint	Pain in the left knee for 3 months.
Mechanism of Injury	Patient fell during <i>Paskibraka</i> (flag-bearing team) practice at school.
History	No significant past medical or surgical history.

Diagnosis	PCL Avulsion + MCL Tear + Difficulty on walking
Physical Examination	Look: No swelling (-), No bruising (-) Feel: Tenderness (+), Crepitation (-), Distal AVN (Artery/Vein/Nerve) status: Good Move: Range of Motion (ROM) limited by pain
Stability Tests	Anterior Drawer Test: Negative (-) Posterior Drawer Test: Positive (+) Lachman Test: Negative (-) Valgus Stress Test: Positive (+)
Pre-Op Imaging	X-Ray Left Knee AP/LAT, MRI Left Knee
Surgical Plan	Pro PCL repair + MCL reconstruction (Scheduled 27/10/2025)

Anamnesis and Clinical Examination

A 16-year-old female presented to our institution on October 26, 2025, with a chief complaint of left knee pain and instability persisting for three months. The mechanism of injury was a fall during training.

Physical examination of the left knee revealed tenderness on palpation but no significant swelling or ecchymosis. Distal neurovascular status was intact. Active range of motion was limited

by pain.

Stability testing was pathognomonic for a multi-ligament injury. A positive Posterior Drawer Test indicated PCL insufficiency. A positive Valgus Stress Test indicated a complete (Grade III) tear of the MCL. Negative Anterior Drawer and Lachman tests suggested an intact ACL.

Diagnostic Imaging

- **Radiography:** Standard anteroposterior (AP) and lateral X-rays of the left knee were obtained. The AP view was largely unremarkable. The lateral view suggested a subtle, displaced bone fragment in the posterior aspect of the tibial plateau, consistent with an avulsion fracture.
- **Magnetic Resonance Imaging (MRI):** An MRI was performed for definitive diagnosis. A T2-weighted sagittal sequence clearly confirmed the diagnosis. It demonstrated a large, displaced bone fragment avulsed from the tibial PCL insertion, consistent with a **Meyers-McKeever Type III fracture**. The fragment was retracted and flipped superiorly. The MRI also confirmed a concomitant, full-thickness MCL tear.
- **Intra-operative Arthroscopy:** Diagnostic arthroscopy revealed the chronic nature of the injury. The avulsed fragment and its tibial bed were not fresh bone; they were covered in a layer of fibrous, scar-like non-union tissue.



Figure 1 and 2. X-Ray Pre-Operative

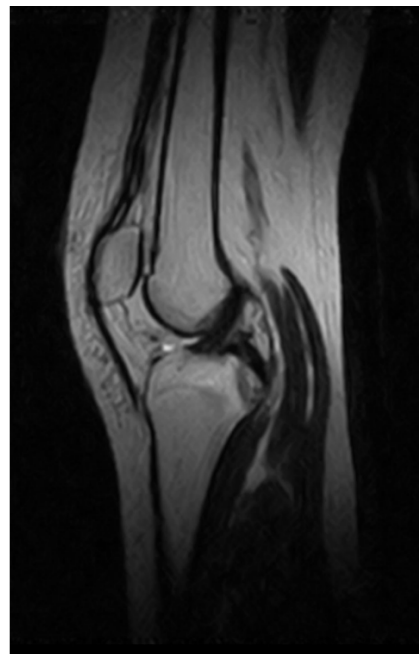


Figure 3. Magnetic Resonance Imaging (MRI)

Surgical Intervention (Date: 27/10/2025)

The patient was placed in the supine position under general anesthesia (Kan et al., 2020). A high-thigh tourniquet was applied. The procedure was performed as a single-stage combined PCL repair and MCL reconstruction.

- **1. Diagnostic Arthroscopy & Debridement:** Standard anterolateral and anteromedial portals were established. A posteromedial portal was also created for posterior compartment visualization and instrumentation (Kan et al., 2020).
 - The intercondylar notch confirmed an intact ACL.
 - Visualization of the posterior compartment revealed the large, displaced PCL avulsion fragment. A motorized shaver was used via the posteromedial portal to debride the chronic fibrous tissue from the fragment and the tibial bed. This debridement is a critical step in a chronic case to expose a viable, bleeding bone surface to facilitate healing (Kan et al., 2020).
- **2. Arthroscopic PCL Avulsion Repair:**
 - *Tibial Tunnel Drilling:* A PCL guide was used to pass a guidewire from the anterior tibia to the center of the PCL footprint (the fracture bed). A cannulated drill was used to create a 4.0 mm bone tunnel (Kan et al., 2020).
 - *Fragment Reduction & Fixation:* A suspensory fixation device (such as a RIGIDLOOP with artificial ligaments, as described by Kan et al., 2020) was chosen. A suture passer was routed through the tibial tunnel and retrieved. This was used to shuttle the suspensory device's button into the posterior compartment.
 - The button was flipped to sit securely *on top* of the avulsed bone fragment.
 - *Final Fixation:* The sutures were tensioned from the anterior tibia, pulling the fragment down and anatomically reducing it onto its debrided bony bed. The device was secured on the anterior tibial cortex with a secondary button or staple.
- **3. Medial Collateral Ligament (MCL) Reconstruction:**
 - Given the chronic valgus instability (a positive valgus stress test), a simple repair was insufficient. An open, anatomic MCL reconstruction was performed.

- **4. Intraoperative Confirmation:**

- Fluoroscopy (C-arm) was used to confirm anatomic reduction. The AP and lateral C-arm images clearly demonstrate the metallic suspensory button in its final position, holding the PCL fragment reduced against the posterior tibia.
- Crucially, the lateral C-arm image visualizes the hardware for *both* procedures: the posterior button for the PCL and a second implant (staple or button) on the medial metaphysis, confirming the tibial fixation
- **Final Assessment:** After both procedures, the knee was taken through a range of motion. Stability was tested on the table. The Posterior Drawer and Valgus Stress tests were both negative, confirming a successful and stable anatomic reconstruction.

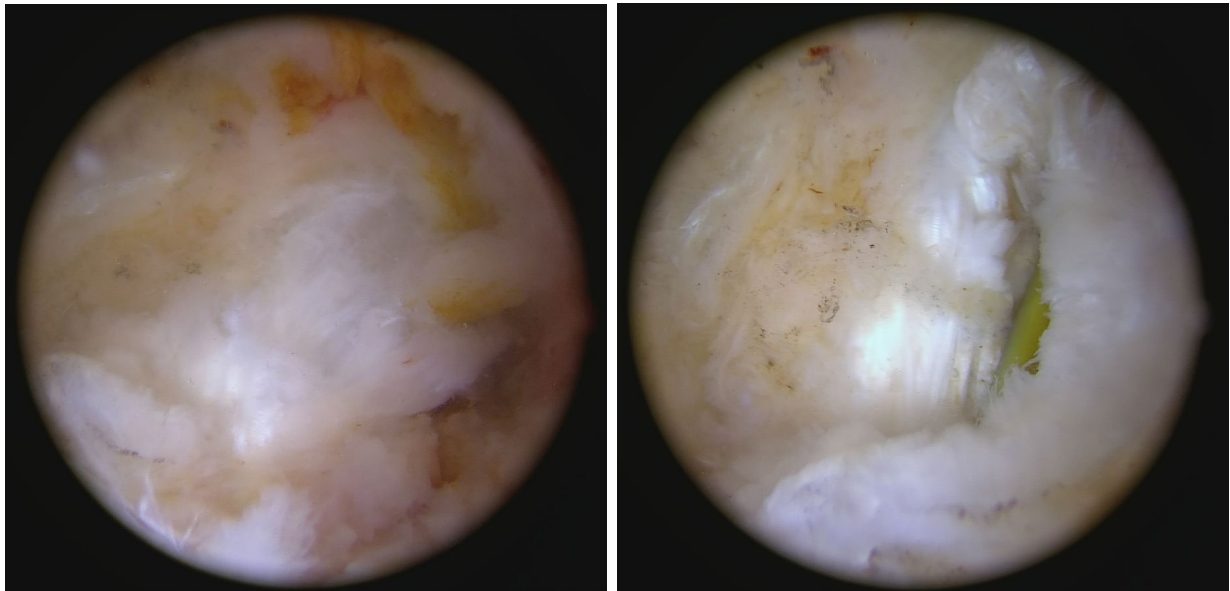


Figure 4 and 5 : Arthroscopy

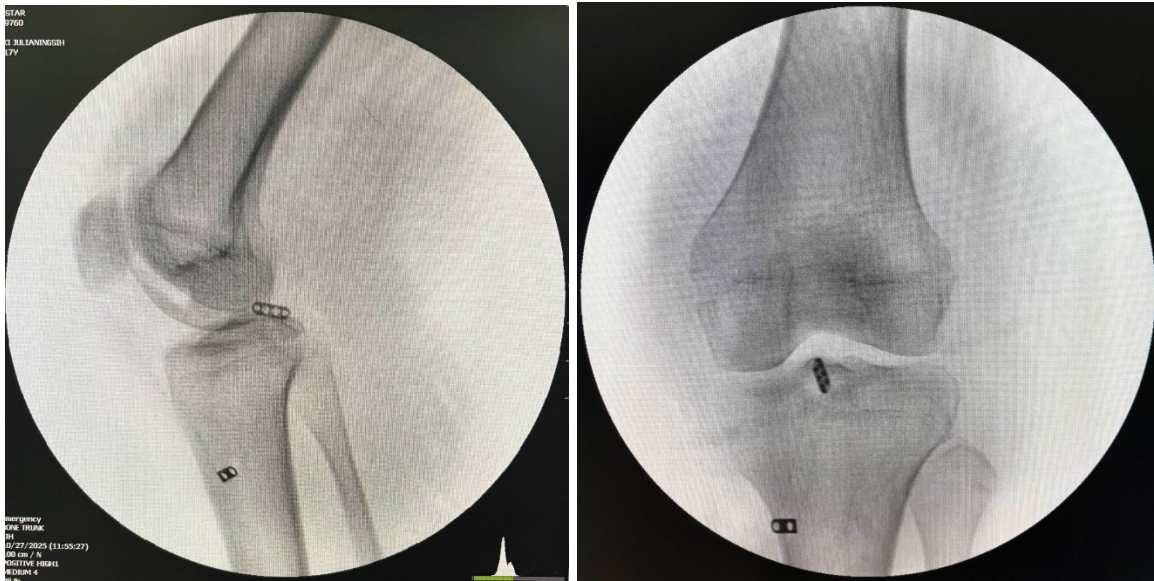


Figure 6 and 7 : C-Arm Post Operative

Post-Operative Course (Post-Op H0)

The patient was transferred to the recovery unit. On post-operative day 0 (H0), the patient reported controlled pain at the surgical site (VAS 3-4), managed with analgesics.

- **Clinical Examination (H0):**
 - **Look:** Surgical dressing was clean and dry (+), no soak-through (-).
 - **Feel:** Localized tenderness at surgical sites. Distal neurovascular (AVN) status was "good."
 - **Move:** Active ROM limited by pain.
 - **Stability Tests (H0):** All stability tests were **negative** (Anterior Drawer -, Posterior Drawer -, Lachman -, Valgus Stress -).
- **Immediate Success:** The conversion of the positive Posterior Drawer and Valgus Stress tests to negative is the most critical immediate outcome. It confirms the surgical construct is biomechanically sound and has immediately restored joint stability.
- **Initial Management Plan (H0):**
 - Ceftriaxone 2x1 gr IV (H1)

- Analgesics (per Anesthesia service)
- Ice compress: 15 minutes every 2 hours
- KIE (Education) on brace use (locked in extension)
- Left leg elevation
- Ankle pumping exercises
- Wound care as needed

DISCUSSION

Surgical Rationale: Operative vs. Non-Operative

The patient's diagnosis as a Meyers-McKeever Type III fracture made surgical intervention mandatory (Hu et al., 2025; Gopinath et al., 2023). Non-operative management for displaced PCL avulsions is associated with significantly poorer outcomes.

A 2023 systematic review and meta-analysis by Gopinath et al. provided Level 1 evidence for this decision. The review found that non-operative management resulted in a **significantly lower fracture union rate (87%)** compared to operative management (99.1%). Furthermore, non-operative treatment led to **greater post-operative posterior tibial translation (4.9 mm)**, indicating persistent, objective instability (Gopinath et al., 2023). Therefore, the decision to operate was evidence-based and necessary to achieve fracture union and restore stability.

Surgical Technique: The Arthroscopic vs. Open Debate

This case highlights the evolution of PCL avulsion fixation from traditional open approaches to modern, minimally invasive arthroscopic techniques. The literature presents a nuanced conflict regarding the optimal method.

Table 2: Comparison of Surgical Approaches for PCL Avulsion Fractures

Comparison	Key Findings
Operative vs. Non-	- Union Rate: Operative (99.1%) >> Non-Operative (87.0%)

Operative	- Stability: Operative management results in significantly less posterior translation (instability).
Arthroscopic vs. Open Surgery	- Functional Scores: Arthroscopy associated with <i>greater improvement</i> in Lysholm scores and <i>higher</i> post-op Tegner scores. - Return to Sport: Arthroscopy associated with a <i>higher</i> rate of return to sport (100% vs 89.5%).
Technique Complications	- Arthroscopic Suture Fixation: Highest complication rate (34.6%) and slowest early ROM recovery. - Open (Anchor Bridge): Lowest complication rate (0%) and shortest operative time.

A systematic review (Gopinath et al., 2023) found that, as a group, **arthroscopic procedures yield superior functional outcomes** (Lysholm, Tegner) and higher rates of return to sport compared to open surgery.

However, a 2025 comparative study (Hu et al., 2025) provided a critical warning: one specific technique, arthroscopic *suture* fixation, had an alarmingly high complication rate (34.6%) and the slowest early ROM. This suggests that *how* the arthroscopic repair is performed is paramount.

This case, and the technical note by Kan et al. (2020), illustrates the solution: **arthroscopic suspensory button fixation**. This technique avoids the technical demands and potential failure points of complex suturing (Hu et al., 2025). The suspensory device provides a simple, biomechanically robust "pullout" fixation that is minimally invasive and technically less complex than suture-only methods (Kan et al., 2020; Gwinner et al., 2014). This approach captures the functional benefits of arthroscopy (per Gopinath et al., 2023) while avoiding the high complication

rates of more complex arthroscopic methods (per Hu et al., 2025).

Evidence-Based Rehabilitation Protocol

The immediate post-operative plan (brace, cryotherapy, ankle pumps) is standard. However, the long-term, phased rehabilitation protocol is arguably as important as the surgery itself for a PCL (Nassar et al., 2025).

The most important principle in PCL rehabilitation is the **strict avoidance of active hamstring contraction** (i.e., resisted knee flexion) in the early phase (Romeyn et al., 2008). The hamstrings are *antagonists* to the PCL. They attach to the posterior tibia near the PCL insertion. When they contract, they create a posterior shear force, pulling the tibia backward. This action places direct tensile stress on the PCL repair site. Allowing active hamstring curls would be iatrogenic, pulling the newly fixed bone fragment away from its healing bed (Romeyn et al., 2008).

Conversely, quadriceps exercises (e.g., open-chain knee extension from 90-0 degrees) are *safe* and *encouraged*, as they pull the tibia *anteriorly*, thereby unloading the PCL (Romeyn et al., 2008).

Table 3: Proposed Phased Rehabilitation Protocol (Evidence Synthesis)

Phase	Timeframe	ROM	Weight-Bearing	Key Exercises & Precautions
I. Protection Phase	0-6 Weeks	- 0-90° (Passive ROM <i>in prone</i>) - Brace locked at 0° for ambulation	NWB (Non-Weight-Bearing)	- Ankle pumps, Patellar mobilization - Quadriceps sets (OKC ext 90-0° is safe) - PRECAUTION:

				NO active hamstring flexion (Romeyn et al., 2008; Nassar et al., 2025)
II. Early Motion	6-12 Weeks	- Progress to full ROM as tolerated - Wean off brace	- Progress to FWB (Full Weight-Bearing) from 6-8 weeks	- Begin closed-chain (CKC) exercises (e.g., mini-squats 0-60°) - PRECAUTION: <i>Still NO resisted hamstring flexion*</i>
III. Strengthening	12-18+ Weeks	- Full ROM	- FWB	- Increase intensity of CKC exercises - Begin <i>light</i> resisted hamstring flexion (OKC) <i>only after</i> 12-18 weeks, pending surgeon approval (Romeyn et al., 2008)

IV. Return to Sport	6-9+ Months	- Full	- FWB	- Agility, proprioception, and sport-specific drills - Return to play based on functional testing
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CONCLUSION AND CLINICAL IMPLICATIONS

Conclusion

Chronic posterior cruciate ligament (PCL) tibial avulsion fractures remain diagnostically and technically challenging, particularly in delayed presentations. This case demonstrates that arthroscopic reduction with suspensory fixation can achieve stable anatomical fixation and effectively restore posterior knee stability, even at 3 months post-injury.

This technique offers a minimally invasive and biomechanically reliable solution, supporting its use as a preferred surgical option for displaced PCL avulsion fractures in adolescent patients.

Clinical Implications:

Displaced posterior cruciate ligament (PCL) tibial avulsion fractures require early recognition and surgical fixation to restore stability.

Arthroscopic suspensory fixation offers a minimally invasive and biomechanically reliable solution, even in delayed presentations.

Strict PCL-specific rehabilitation is essential to protect fixation and optimize functional outcomes.

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