

The Importance of Posterior Tibial Slope Correction in the Repair of Posterior Cruciate Ligament Injuries

Pedro Lança ^{1,*}, Joaquim Rodeia ¹, Rita Alçada ¹, Nuno Silva ¹, Miguel Pádua Figueiredo ¹

¹ Dr. José de Almeida Hospital, Cascais, Alcabideche, Cascais, Portugal.

* Correspondence: pedro.lanca@edu.ulisboa.pt.

Abstract: The posterior cruciate ligament (PCL) is the primary structure responsible for limiting posterior translation of the tibia relative to the femur. PCL injuries are associated with anteroposterior instability of the knee joint. In the management of these injuries, increasing emphasis has been placed on correcting coronal (varus or valgus) and sagittal (posterior tibial slope [PTS]) plane deformities. We present the case of an approximately 50-year-old patient with right-sided knee pain localized to the medial compartment, associated with complaints of posterior instability. Imaging studies demonstrated medial chondropathy in a varus knee with a chronic PCL injury. The patient underwent a medial opening-wedge tibial osteotomy combined with an increase in the posterior tibial slope. Postoperatively, the patient showed favorable clinical improvement, with resolution of pain and no residual complaints of sagittal instability. Radiographic evaluation confirmed adequate correction of both coronal and sagittal alignment. This case demonstrates the impact that biplanar periarticular knee osteotomy can have on improving the clinical outcomes of patients with chronic PCL injuries.

Citation: Lança P, Rodeia J, Alçada R, Silva N, Figueiredo MP. The Importance of Posterior Tibial Slope Correction in the Repair of Posterior Cruciate Ligament Injuries. Brazilian Journal of Case Reports. 2026 Jan-Dec; 06(1):bjcr218.

<https://doi.org/10.52600/2163-583X.bjcr.2026.6.1.bjcr218>

Received: 14 July 2026

Accepted: 24 July 2026

Published: 9 August 2026



Copyright: This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0).

Keywords: Posterior Cruciate Ligament; Osteotomy; Posterior Tibial Slope.

1. Introduction

The knee is a bicondylar trochleomeniscoarthrodial joint stabilized by both intra- and extracapsular ligaments. Among the intracapsular ligaments, the anterior and posterior cruciate ligaments play a fundamental role in limiting tibial translation in the sagittal plane and also act as secondary stabilizers of rotational movements. The anterior cruciate ligament (ACL) originates from the lateral aspect of the femoral intercondylar notch and inserts distally into the medial tubercle of the tibial eminence, preventing anterior tibial translation. In contrast, the posterior cruciate ligament (PCL) extends from the posterior meniscal insertions on the tibia to the medial aspect of the femoral intercondylar notch, serving as the primary restraint against posterior tibial translation and as a secondary stabilizer of external rotation [1–4].

PCL injuries occur more frequently in male patients, typically following high-energy trauma, whereas isolated PCL injuries are relatively uncommon [5]. Consequently, particularly in chronic cases, these injuries are frequently underdiagnosed. On physical examination, patients commonly present with nonspecific symptoms of instability. The integrity of the PCL can be assessed using several specific clinical tests that induce posterior tibial translation relative to the femur, including the posterior sag sign, posterior drawer test, and quadriceps active test [6].

In patients with isolated PCL injuries, in addition to the findings on physical examination, a targeted radiographic assessment, including stress radiographs [7], is essential for evaluating and, when indicated, planning surgical correction of coronal and sagittal

knee alignment. Recent evidence has demonstrated that chronic PCL deficiency tends to progress to a varus knee deformity due not only to excessive external tibial rotation and hyperextension but also to disruption of the lateral tibiofemoral compartment. Conversely, a decreased posterior tibial slope (PTS) predisposes patients to PCL injury [8]. The PTS refers to the morphology of the proximal tibial articular surface in the sagittal plane, and variations in its angle are known to influence the tensile forces experienced by both the ACL and the PCL under compressive loading [9].

Several methods have been described for measuring the posterior tibial slope, using different anatomical landmarks, although none has demonstrated clear superiority over the others. In the present case, the anterior tibial cortical line was used as the reference for angle measurement [3,10]. In light of these considerations, corrective osteotomy has gained increasing importance alongside ligament reconstruction procedures. Although opening-wedge high tibial osteotomies for correction of coronal plane deformities are well established, there remains limited experience and robust evidence regarding the importance of sagittal plane anatomy in optimizing the correction of sagittal instability [3].

We present a case in which the surgical management of a chronic PCL injury was based on correction of osseous malalignment rather than ligament reconstruction, using a biplanar proximal valgus tibial osteotomy combined with an increase in the posterior tibial slope.

2. Case Report

We present the case of a patient in his 50s with a history of right anterior cruciate ligament (ACL) reconstruction during adolescence following a motor vehicle accident. The patient presented with a 3-year history of persistent right knee pain without any associated trauma, predominantly localized to the medial compartment and accompanied by gait limitation. Subjectively, the patient had a Knee Injury and Osteoarthritis Outcome Score (KOOS) of 32%. On physical examination, the right knee showed no joint effusion, although tenderness was elicited along the medial joint line. The range of motion was preserved, albeit with pain during resisted terminal extension.

Ligamentous examination revealed positive posterior sag sign and posterior drawer test findings. Plain radiographs demonstrated a varus-aligned right knee with medial compartment osteoarthritis characterized by joint space narrowing and subchondral sclerosis (Figures 1A–1D). Magnetic resonance imaging confirmed medial chondropathy and demonstrated PCL laxity associated with posterior tibial subluxation (Figures 2A and 2B). Based on the diagnosis of medial compartment osteoarthritis in a varus knee secondary to chronic PCL insufficiency, the patient was indicated for a biplanar anteromedial opening-wedge proximal tibial osteotomy with plate-and-screw fixation to correct the varus deformity (Figures 3A and 3B). A distinctive feature of this procedure was that the osteotomy was performed more anteriorly than usual to increase the posterior tibial slope (PTS).

The surgical approach consisted of a longitudinal medial parapatellar incision extending from the knee joint line to the inferior border of the tibial tuberosity. To ensure the correct orientation of the osteotomy, guide wires were inserted into the proximal tibia under fluoroscopic guidance. An opening-wedge osteotomy was then performed from the medial cortex without violating the lateral cortex (Figure 4). Following completion of the osteotomy and according to the preoperative radiographic planning, a bone spreader was positioned in the anteromedial aspect of the tibia (Figure 5), allowing simultaneous correction of both the posterior tibial slope and the varus deformity. The correction was maintained using a medial anatomical locking plate (Figures 6A–6C).

Postoperatively, the patient experienced a favorable clinical course, with progressive pain relief and gradual recovery of knee range of motion. Reassessment using the KOOS questionnaire demonstrated an improvement from 32% preoperatively to 60% postoperatively. Radiographic evaluation confirmed appropriate implant positioning, correction of the varus deformity, and an increase in the posterior tibial slope, resulting in anterior

translation of the tibia and correction of the posterior tibial sag previously observed (Figures 7A and 7B). At the most recent follow-up, performed 1 year after surgery, the patient demonstrated a knee range of motion from 0° to 120° , with complete resolution of the preoperative pain and instability symptoms.

Figure 1. (A, B) Preoperative full-length standing radiographs of the lower limbs. Weight-bearing anteroposterior (A) and lateral (B) radiographs of the right knee before surgery.

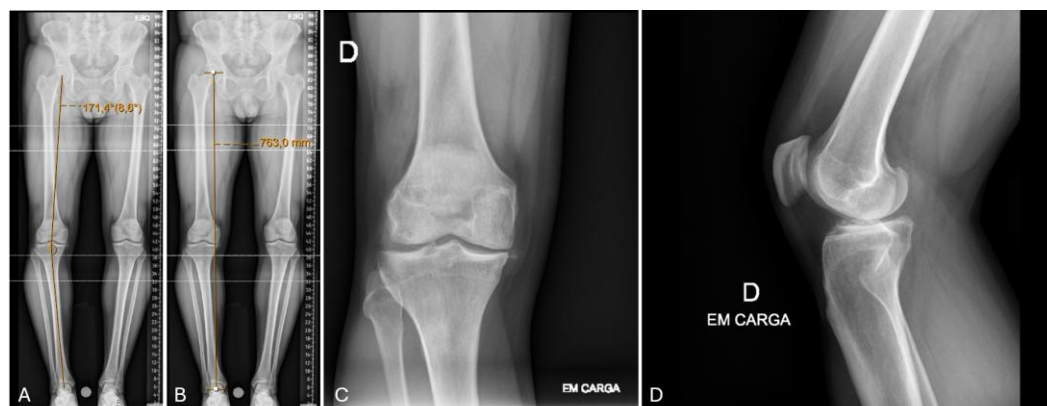
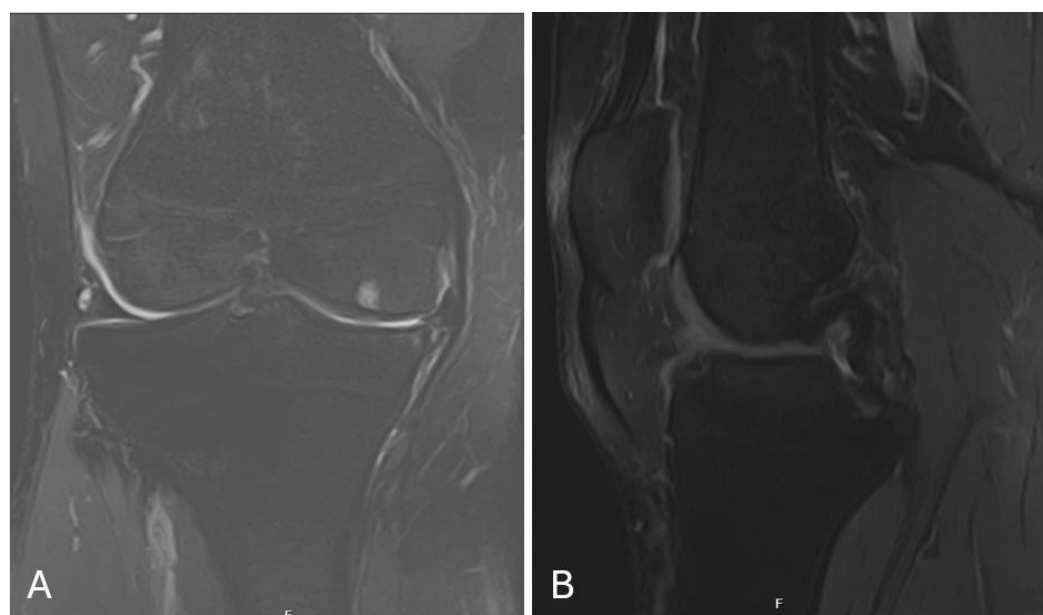


Figure 2. Preoperative T2-weighted magnetic resonance imaging of the right knee in the coronal (A) and sagittal (B) planes.



3. Discussion

PCL injury remains a diagnostic and therapeutic challenge. On the one hand, isolated PCL injuries are relatively uncommon; on the other, their clinical presentation is often nonspecific, leading to underdiagnosis and the frequent use of conservative treatment, with persistence of symptoms [5]. Growing evidence highlights the crucial role of the PCL in knee biomechanics, and in chronic injuries associated with malalignment, the failure rate of isolated ligament reconstruction remains high [3,11–13]. Indeed, as demonstrated by Novaretti et al. [3], up to 56% of patients undergoing isolated PCL reconstruction continue to exhibit residual instability, particularly in the presence of predisposing anatomical factors such as varus alignment and a reduced posterior tibial slope (PTS).

Figure 3. Preoperative measurement of coronal (A) and sagittal (anterior tibial cortical line) (B) osseous malalignment.



Figure 4. Medial parapatellar incision followed by biplanar proximal tibial osteotomy for simultaneous correction of the coronal and sagittal deformities.



Thus, in patients with chronic isolated PCL injuries, there has been increasing interest in corrective osteotomies, either alone or combined with ligament reconstruction [3,14]. In this context, biplanar anteromedial opening-wedge proximal tibial osteotomy has emerged as a reliable surgical strategy. By simultaneously increasing the posterior tibial slope and correcting the varus deformity commonly observed in these patients, this procedure promotes anterior tibial translation while restoring coronal alignment. Consequently, it improves knee stability under compressive loading and reduces the mechanical stress placed on the PCL [3,9,14].

Petrigliano et al. [15] investigated the role of medial opening-wedge tibial osteotomy in knee stability using computational modeling. Ligament stability tests, including the posterior drawer and reverse pivot-shift tests, were performed in ten cadaveric knees following complete PCL transection. Medial and lateral compartment translations were

measured before and after osteotomies producing either a 5° increase or a 5° decrease in the posterior tibial slope.

Figure 5. Placement of a bone spreader on the anteromedial aspect of the proximal tibia to achieve biplanar correction.



Figure 6. Fixation of the osteotomy using a plate-and-screw construct (A), with intraoperative confirmation of appropriate implant positioning under fluoroscopic guidance (B, C).

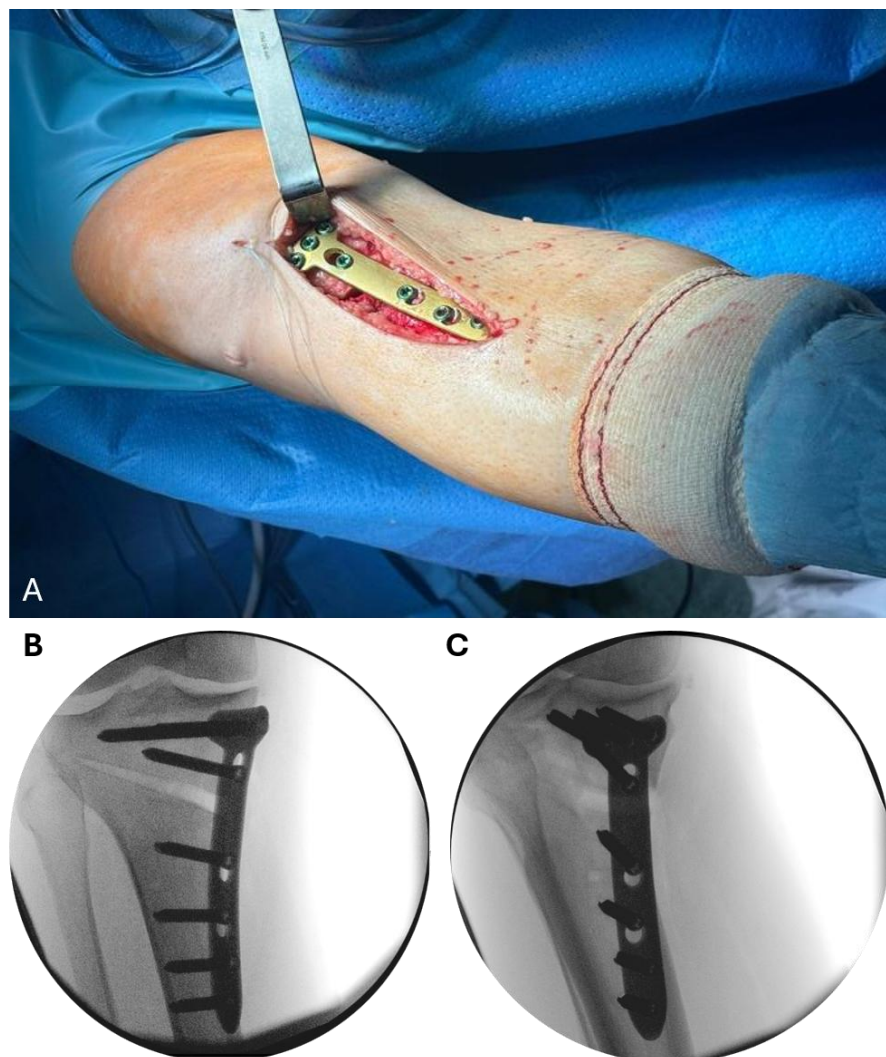


Figure 7. Weight-bearing anteroposterior (A) and lateral (B) radiographs of the right knee one year after surgery.



The authors demonstrated that reducing the PTS by only 5° significantly increased posterior tibial translation in both compartments, whereas increasing the slope produced the opposite effect. Regarding the optimal timing of surgery, current evidence supports medial opening-wedge proximal tibial osteotomy as a stand-alone procedure for selected patients with chronic PCL insufficiency, with favorable clinical outcomes. Clinical progression and knee stability should be reassessed over a period of 3–6 months, and if residual instability persists, ligament reconstruction may subsequently be performed as a staged procedure [15,16].

In the present case, the decision to adopt a personalized surgical strategy based on a biplanar valgus-producing proximal tibial osteotomy with simultaneous increase of the posterior tibial slope, rather than primary ligament reconstruction, resulted in immediate anatomical correction of the underlying osseous malalignment. This correction reduced the mechanical load acting on the deficient PCL and contributed to substantial functional recovery. The favorable postoperative evolution observed in this patient reinforces the importance of a comprehensive biomechanical assessment when planning surgical treatment for chronic PCL insufficiency.

Following careful clinical and imaging evaluation, isolated correction of the osseous deformity, without concomitant ligament reconstruction, may be sufficient to reduce stress on the injured PCL, decrease progressive mechanical overload and cartilage degeneration, and ultimately alleviate pain and instability. This case demonstrates that biplanar medial opening-wedge proximal tibial osteotomy represents an effective surgical option tailored to the complex biomechanics of the knee, providing satisfactory clinical outcomes and constituting a valuable therapeutic alternative in the management of chronic PCL injuries.

Funding: None.

Research Ethics Committee Approval: Written informed consent was obtained from the patient for publication of this case report and the accompanying clinical images. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Acknowledgments: None.

Conflicts of Interest: All other authors declare no conflicts of interest.

References

1. Henri Rouviere. Anatomie generale : origines des formes et des structures anatomiques. Paris: Masson Et Cie; 1939.

2. White TO, Mackenzie SP, Gray AJ, McRae R. McRae's orthopaedic trauma and emergency fracture management. Edinburgh: Elsevier Ltd.; 2015.
3. Novaretti JV, Sheean AJ, Lian J, De Groot J, Musahl V. The Role of Osteotomy for the Treatment of PCL Injuries. *Current Reviews in Musculoskeletal Medicine*. 2018 May 5;11(2):298–306.
4. Li G, Papannagari R, Li M, Bingham J, Nha KW, Allred D, et al. Effect of posterior cruciate ligament deficiency on in vivo translation and rotation of the knee during weightbearing flexion. *The American Journal of Sports Medicine* [Internet]. 2008 Mar 1 [cited 2021 Feb 20];36(3):474–9.
5. Skyhar MJ, Warren RF, Ortiz GJ, Schwartz E, Otis JC. The effects of sectioning of the posterior cruciate ligament and the posterolateral complex on the articular contact pressures within the knee. *The Journal of Bone & Joint Surgery*. 1993 May;75(5):694–9.
6. Çullu E, Aydoğdu S, Alparslan B, Sur H. Tibial slope changes following dome-type high tibial osteotomy. *Knee Surgery, Sports Traumatology, Arthroscopy*. 2004 Mar 25;13(1):38–43.
7. 1.LaPrade R. Objective Use of Stress Radiographs [Internet]. Robert LaPrade, MD | Minnesota Knee Specialist | Twin Cities, Minneapolis-St.Paul, Edina, Eagan. 2015 [cited 2025 May 15]. Available from: <https://drrobertlaprademd.com/objective-use-of-stress-radiographs/>
8. Elalfy A, Fawzy M. Combined posterior cruciate ligament and chronic posterolateral corner deficiency in varus knee, two-stage reconstruction. *The Egyptian Orthopaedic Journal*. 2020;55(2):72.
9. Giffin JR, Vogrin TM, Zantop T, Woo SL-Y, Harner CD. Effects of Increasing Tibial Slope on the Biomechanics of the Knee. *The American Journal of Sports Medicine*. 2004 Mar;32(2):376–82.
10. Lee J, McCormick JR, Credille K, Dandu N, Wang Z, Trasolini NA, et al. Patient Age and Activity Level, Posterior Tibial Slope, and Use of Allograft Are Significant Risk Factors for Anterior Cruciate Ligament Reconstruction Failure: A Systematic Review. *Arthroscopy, sports medicine, and rehabilitation* [Internet]. 2025 Autumn;7(2):101075. Available from: <https://pubmed.ncbi.nlm.nih.gov/40297067/>
11. Vivekanantha P, Aziz A, Ali M, Martin R, Tapasvi S, de Sa D. The Commonest Indication For Performing a Slope-Reducing Osteotomy with an Anterior Cruciate Ligament Reconstruction is Graft Failure with a Posterior Tibial Slope 12 Degrees or Greater: A Systematic Review of Indications, Techniques, and Outcomes. *Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association* [Internet]. 2025 Winter;S0749-8063(25)002907. Available from: <https://pubmed.ncbi.nlm.nih.gov/40286998/>
12. Dean RS, Larson CM, Waterman BR. Posterior Tibial Slope: Understand Bony Morphology to Protect Knee Cruciate Ligament Grafts. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*. 2021 Jul 1;37(7):2029–30.
13. Hiranaka Y, Muratsu H, Tsubosaka M, Matsumoto T, Maruo A, Miya H, et al. Influence of posterior tibial slope on sagittal knee alignment with comparing contralateral knees of anterior cruciate ligament injured patients to healthy knees. *Scientific Reports*. 2022 Aug 18;12(1).
14. Petrigliano FA, Suero EM, Voos JE, Pearle AD, Allen AA. The Effect of Proximal Tibial Slope on Dynamic Stability Testing of the Posterior Cruciate Ligament– and Posterolateral Corner–Deficient Knee. *The American Journal of Sports Medicine*. 2012 Mar 16;40(6):1322–8.
15. Naudie DDR, Amendola A, Fowler PJ. Opening Wedge High Tibial Osteotomy for Symptomatic Hyperextension-Varus Thrust. *The American Journal of Sports Medicine*. 2004 Jan;32(1):60–70.
16. Badhe NP, Forster IW. High tibial osteotomy in knee instability: the rationale of treatment and early results. *Knee Surgery, Sports Traumatology, Arthroscopy*. 2001 Oct 16;10(1):38–43.