Technical Note

Nonanatomic Posterolateral Tenodesis for Posterior Ligament Reconstruction Augmentation

Emiliano Álvarez-Salinas, M.D., Leandro Civetta, M.D., Javier Reparaz, M.D., Joan Carles Monllau, M.D., Ph.D., Prof., and Rodolfo Morales-Avalos, M.D., M.Sc., Ph.D.

Abstract: A successful posterior cruciate ligament (PCL) reconstruction depends on multiple factors. Various techniques have been described for PCL reconstruction. Despite the constant evolution of reconstructive techniques, 26% of residual laxity cases with grade I and II positive posterior drawer tests have been reported in the literature in patients undergoing PCL reconstruction. Part of these failures is associated with the lack of control of the posterior translation of the tibia and the increase in external tibial rotation. We describe a surgical technique in which a posterolateral tenodesis augmentation associated with a single-bundle reconstruction of the PCL is performed. It is proposed for use in isolated reconstructions of the PCL in cases of grade III ruptures associated with or unassociated with low-grade posterolateral corner injuries.

Posterior cruciate ligament (PCL) injuries represent 38% of all knee injuries and are rarely isolated.[1] Various techniques have been described for PCL reconstruction. However, none of them has been shown to be significantly superior in terms of the functional clinical results in the medium and long term. Moreover, there are discrepancies in the latest clinical trials, meta-analyses, and recently published systematic reviews.[2-6]

Persistent posterior laxity is the most common complication after PCL reconstruction.[7] The most common causes of residual laxity are concomitant undiagnosed ligament injuries such as that of the posterolateral corner (PLC), technical errors in the reconstruction technique, a decreased tibial slope, varus malalignment, aggressive rehabilitation protocol, and noncooperation in recovery on the part of the patient.[7] A 26% rate of residual laxity with a grade I and II posterior drawer has been reported in the literature in patients undergoing PCL reconstruction.[8]

It is well described in the literature that cases with residual laxity after isolated PCL reconstruction associated with low/intermediate or ambiguous PLC lesions (less than grade III) can be controlled successfully with PLC reconstruction.[9-11]

Lateral extra-articular tenodesis associated with anterior ligament reconstruction has been shown to decrease rates of re-rupture and has brought about a clinically significant improvement by reducing the rates of rotational instability.[12-17]

Although the current knowledge of PCL anatomy and biomechanics has been refined, the ideal type of PCL reconstruction is still under debate. The aim of the present study is to describe a new surgical technique that is suggested for use as a kind of posterolateral tenodesis (PLT) in primary PCL reconstructions (isolated or associated with low-grade posterolateral corner lesions).

Surgical Technique

General Preparation

Patients receive standard preoperative antibiotics and regional anesthesia and are placed in a supine position

From Sanatorio del Norte, Corrientes, Argentina (E. Á., L.C., J.R.); Universidad Nacional del Noreste, Argentina (E. Á., L.C., J.R.); Department of Orthopedic Surgery and Traumatology, Hospital del Mar, Universitat Autonoma de Barcelona, Barcelona, Spain (J.C.M.); ICATKnee, (ICATME), Hospital Universitari Dexeus, Universitat Autonoma de Barcelona, Barcelona, Spain (J.C.M.); Laboratory of Biomechanics, Department of Physiology, School of Medicine, Universidad Autónoma de Nuevo León, Monterrey, Mexico (R.M-A.); and Department of Traumatology, Medical Services of the Autonomous University of Nuevo Leon, Monterrey, Mexico (R.M-A.).

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Address correspondence to Rodolfo Morales-Avalos, M.D., M.Sc., Ph.D., Laboratory of Biomechanics, Department of Physiology, School of Medicine, Universidad Autonoma de Nuevo León (U.A.N.L.), Av. Francisco I. Madero and Av. Dr. Eduardo Aguirre Pequeño, s/n, Col. Mitras Centro, CP 66460, Monterrey, Nuevo León, Mexico. E-mail: rodolfot59@hotmail.com

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Fig. 1. Regular setting for arthroscopic posterior cruciate ligament reconstruction. Note the lateral post high in the thigh and a foot stopper. Left knee is shown.

Fig 2. Clinical image of 2 cases using the first technique with 2 independent tendon grafts for the reconstruction of the posterior cruciate ligament (short grafts) and doing the posterolateral tenodesis (long grafts). (A) Anterior tibialis tendon allografts used for the posterolateral tenodesis technique. (B) Hamstring tendon autografts used for the posterolateral tenodesis technique.

with the knee free to move from full extension to 90° of flexion with the help of a lateral and distal support (Fig 1). A tourniquet is applied to the proximal thigh on the affected side. The contralateral limb is slightly lowered to allow the C-arm to execute anteroposterior and true lateral radiographs.

Graft Preparation

To perform the PLT, we describe 2 techniques for graft preparation. The first is performed using 2 independent tendon grafts (autografts or allografts), one with a diameter of 8 to 9 mm with a length of 12 cm to be used for the PCL single-bundle (SB) technique and the other with a 7 to 8 mm diameter and greater than 16 cm length for the PLT (Fig 2).

The second technique for preparing the graft consists of using a "Y"-shaped Achilles tendon allograft. The common limb of the graft is used on the tibial side and the other limb is split into two for the PCL reconstruction and the PLT (Fig 3).

In both cases, the use of tendon grafts without a bone plug is suggested. It is important to note that the technique could also be adapted to the use of tendon autografts. A tendon graft with a minimum length of 12 cm and 8 to 9 mm in diameter can be used for the femoral PCL side. Another with a 7 to 8 mm diameter can be used for the PLT. In the tibia, the combined compacted diameter of both grafts can vary between 11 and 14 mm. In this technique, 4 cases are presented using each of the 2 options proposed. The distal end of the tendon grafts is prepared with a Bunnell-type nonabsorbable suture. The tendon is then wrapped in gauze that has been presoaked in vancomycin and stored for later use. The diameter of both grafts placed together is measured to determine the tibial tunnel (only in the first graft preparation technique).

PLT Technique

First, routine arthroscopic examination of the knee joint is performed using the standard anterolateral and anteromedial portals. The posteromedial portal is created under direct arthroscopic visualization by transillumination and is guided by introducing a spinal needle. The tibial tunnel preparation uses the same technique classically described in the literature to perform the PCL reconstruction. Fluoroscopy is used to confirm proper positioning (Fig 4). The tibial tunnel diameter must be wide enough to contain both graft ends (between 11 and 14 mm).

Femoral Tunnel Preparation for PLT and PCL

A 4- to 5-cm longitudinal incision at the level of the lateral epicondyle of the femur is required to be able to make the femoral tunnel for PLT (Fig 5A). The iliotibial band is also incised longitudinally until the bone plane is reached (Fig 5B). The femoral tunnel for the PLT should be created 3 mm proximal and 5 mm anterior to the lateral epicondyle of the femur. An incomplete tunnel of the diameter of the graft, ranging from 20 to 25 mm in depth, should be created for subsequent fixation using an interference screw (Milagro Advance [DePuy Mitek, J&J, Warsaw, IN] or Botón FLOOP UP, SAI Medicine [Buenos Aires, Argentina]). Alternative fixation can be done by using spiked ligament staples

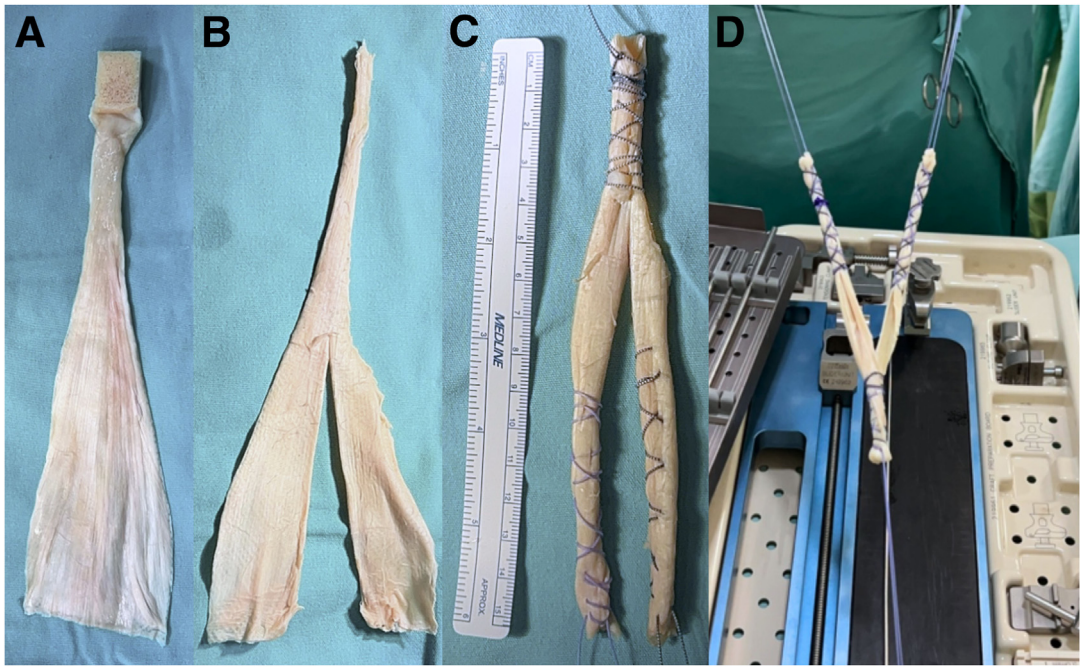

Fig 3. Image of the second type of graft preparation technique. An Achilles tendon allograft is divided, and a "Y"-shaped configuration is obtained. (A) Achilles tendon allograft as delivered by the tissue bank. (B) Removal of the bone block and division of the graft. (C) Preparation of the ends of the graft with high-strength sutures. (D) Final appearance of the allograft prior to being inserted.

Fig 4. Fluoroscopic sagittal view of the knee showing the position of a regular posterior cruciate ligament guide in position and the k-wire before drilling the tibial tunnel (left knee, 90°of flexion).

(Arthrex [Naples, FL] or SAI Medicine). The femoral tunnel for the PCL is then created using the classic technique.

Graft Passage and Fixation

The passage of both grafts (technique 1) or the 2 arms (technique 2) is performed retrogradely in the same tibial tunnel (Video 1). To pass both graft ends, a wire loop is inserted into the tibial tunnel through the posterior compartment and recovered through the anteromedial portal with a suture retriever. Then, both grafts are introduced into the tibia in a retrograde fashion using a PassPort Button Cannula (12 mm internal diameter × 5 cm; Arthrex). Once both grafts are introduced into the tibia, the proximal end of the PCL graft is fed into the femoral tunnel through the wire loop retrieved through the same portal (Fig 6B) and then fixed with an interference screw (Milagro Advance) or a cortical suspension system.

A double utility clamp is placed from the lateral incision passing behind the lateral condyle in the direction of the posterior compartment of the knee (Fig 5C). It brings a thread from extra-articular to intra-articular in an "over-the-top" fashion. It is recovered through the anteromedial portal (Fig 5D). Under arthroscopic visualization from the posteromedial portal (Fig 6A), the thread from the proximal end of the PLT graft is introduced through the anteromedial portal and the graft is pulled retrogradely with the thread. This brings the proximal end of the PLT graft from intra-articular to extra-articular in an "over the top" direction (Fig 5E and F, Video 1).

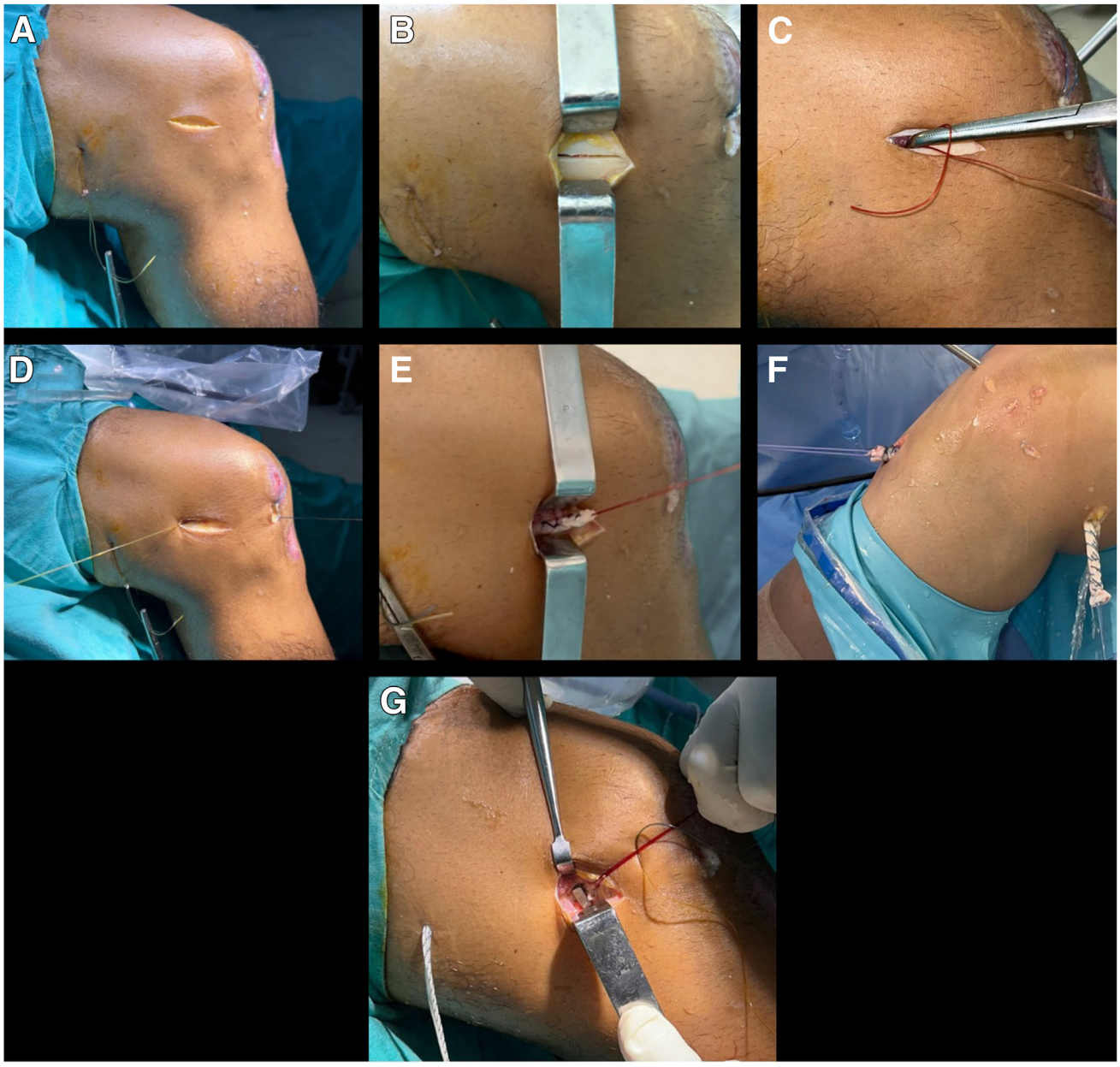

Fig 5. (A) Site of skin incision at the level of the lateral epicondyle. (B) Incision over the fascia in a horizontal manner. (C) Retrograde "over-the-top" passage of thread. (D) Thread recovered through the anteromedial portal. (E) Exit of the graft behind the lateral condyle of the femur. (F) Clinical image showing the distal end of the Achilles tendon graft corresponding to the posterolateral tenodesis when recovered through a skin incision just ventral to the head of the lateral gastrocnemius. (G) Definitive fixation with a staple on the lateral cortex of the femur. Images of a right knee at 90°of flexion.

The femoral fixation of the PCL graft is performed first, under arthroscopic guidance, using an interference screw or a cortical suspensory system (Botón FLOOP UP). Subsequently, tibial fixation was done with an interference screw, with the knee at 90° flexion, maximal anterior drawer, and neutral foot rotation. Finally, the proximal end of the PLT graft is fixed with a spiked ligament staple (Fig 5G) with the knee in full extension and neutral foot rotation. We recommend adding a double fixation in the tibia with a knotless anchor (SwiveLock SP 4.75 mm; Arthrex) or a spiked ligament staple using the free thread ends in the tibia. In all cases, fluoroscopic and radiological images should be taken as a postoperative control (Fig 7).

The advantages and disadvantages of the present technique as well as some pearls and pitfalls of this

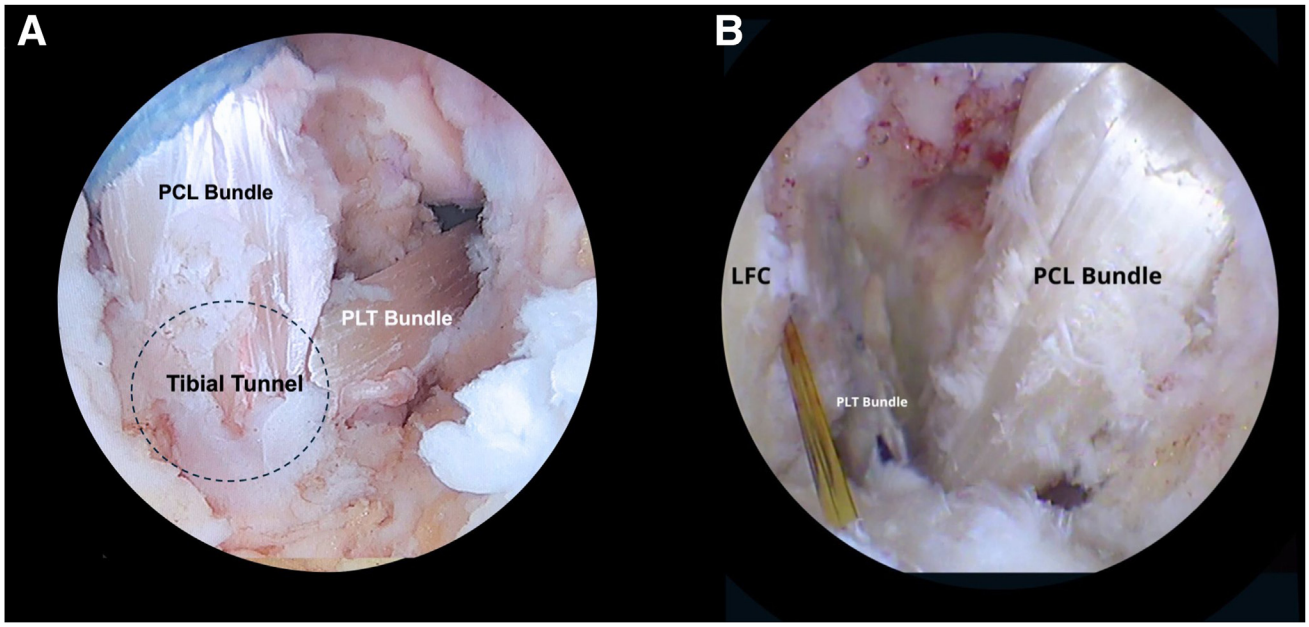

Fig 6. (A) Arthroscopic image from the posteromedial portal in a right knee. The PLT graft can be seen on the right, at the point where it leaves the tibial tunnel and goes in a superolateral direction behind the lateral femoral condyle. On the left side, the graft corresponding to the PCL can be seen at the point where it leaves the tibial tunnel and goes a vertical direction to reach the lateral wall of the medial femoral condyle. (B) Arthroscopic image from the anterolateral portal of a right knee with a combined anterior cruciate ligament and PCL injury. The PCL graft is visualized in place with the proximal end in its femoral tunnel. See rear-left, the graft corresponding to the posterolateral bundle or tenodesis exiting from the common tibial tunnel. (LFC, lateral femoral condyle; PCL, posterior cruciate ligament; PLT, posterolateral tenodesis.)

technique are presented in Tables 1 and 2, respectively.

Postoperative Rehabilitation Protocol

A PCL dynamic knee brace (M.4s; medi, Bayreuth, Germany) is put in place postoperatively for the first 8 weeks (Fig 8). Weight-bearing with the brace and crutches is allowed, as tolerated, on the first postoperative day. Range-of-motion exercises start 2 weeks after surgery. Full range of motion is usually obtained by a maximum of 6 weeks after surgery. Sports activities are allowed at 10 months postoperatively. The schematic representation of the technique presented in this paper is seen in Figure 9.

Discussion

The PLT augmentation technique for PCL reconstruction using a nonanatomic extra-articular bundle fixed at the lateral epicondyle is presented. This technique is presented as a variant of the SB PCL reconstruction technique already described in the literature. It is proposed to be used in isolated reconstructions of the PCL in cases of grade III ruptures associated with or unassociated with low-grade PLC injuries.[18]

Regarding the technique used in the PCL reconstruction, 2 of the most-used approaches in SB PCL reconstruction are the transtibial and the tibial inlay approaches. However, there is no consensus as to which of the 2 is superior in terms of clinical outcome.[18] Double-bundle (DB) techniques are also presented as an option to restore the stability of the PCL reconstruction.[3-5,19] From a biomechanical point of view, both DB and SB PCL reconstruction techniques do not limit external rotation at 30° of flexion like a native PCL.[5]

Residual laxity after PCL reconstruction is one of the most common complications in the follow-up of this type of procedures.[7,18] There is no consensus as to whether surgical treatments are advisable for ambiguous PLC injuries with posterolateral knee laxity less than grade III in patients with external rotational instability.[20] We suggest that performing the PLT technique proposed in this Technical Note can reduce residual laxity in posterior tibial translation and stabilize external rotation by limiting knee flexion in the first 30°.[21-23]

Recent data indicate that the incidence of subjective failure in patients undergoing isolated PCL reconstructions at 2 and 5 years of follow-up is high.[2] As such, the search for new techniques and strategies to improve this is justified. This study had several limitations. It is a Technical Note with no comparable group of patients and with a small

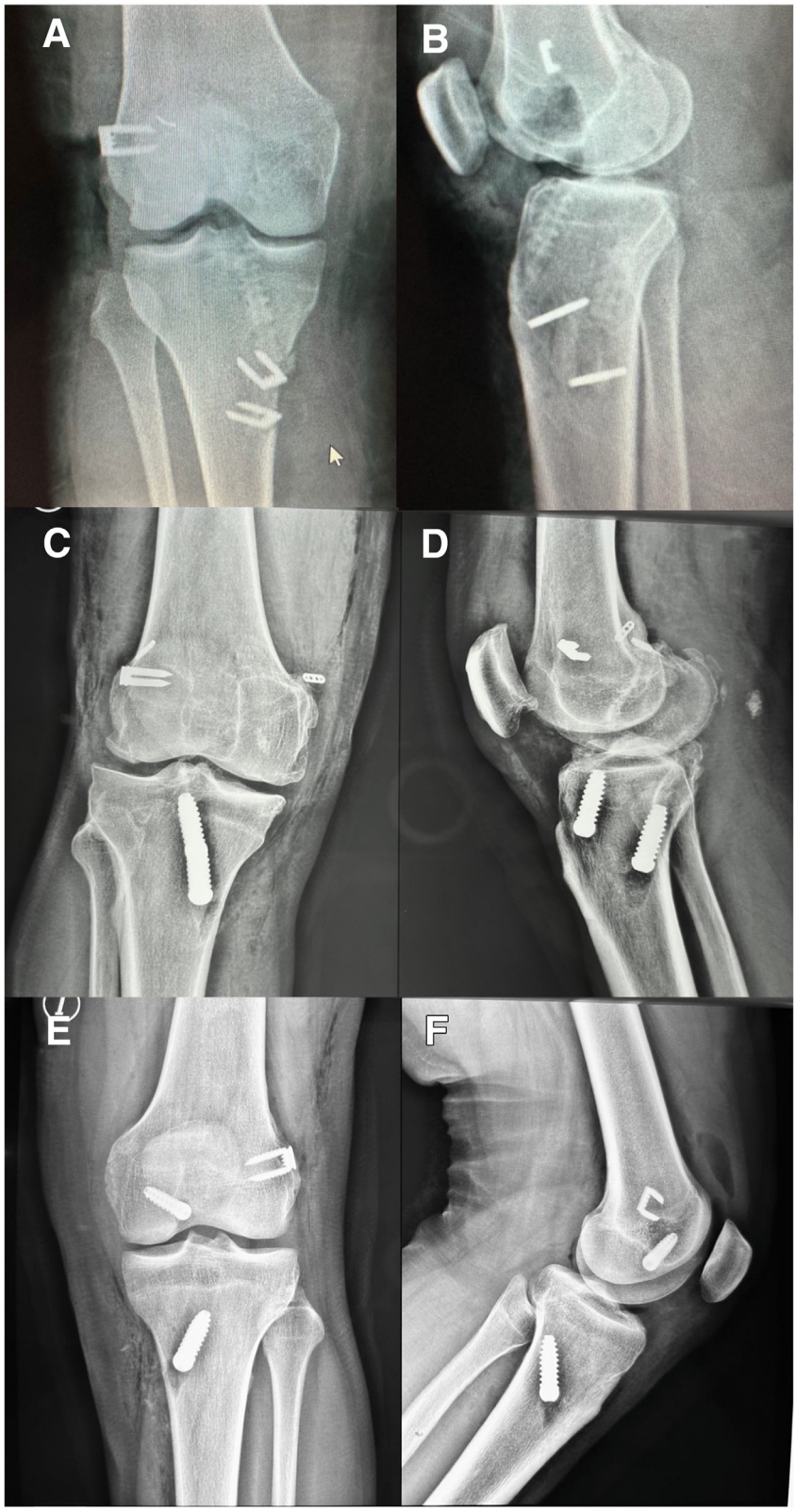

Fig 7. Immediate postoperative radiographs of 2 cases (right knees) with anterior cruciate ligament and posterior cruciate ligament reconstructions with the addition of a posterolateral tenodesis (A-D) and a case of an isolated complete posterior cruciate ligament injury (left knee) (E-F). In all cases, the tenodesis was fixed with staples.

Table 1. Advantages and Disadvantages of the Posterolateral Tenodesis Technique for PCL Reconstruction

Advantages	Disadvantages
PLT adds an extra restriction for PTT and the external rotation of the tibia.	Needs an extra lateral incision in isolated grade III PCL injuries.
Arthroscopic approach permits good visualization of the "over-the-top" passage of the PLT graft.	Cost of allograft in multiligamentary reconstruction.
PLT can be combined with all multiligamentary techniques.	Donor-site morbidity with autograft.
No tunnel conflict with other reconstructions and minimal soft-tissue dissection and no need for extensive approaches.	

PCL, posterior cruciate ligament; PLT, posterolateral tenodesis; PTT, posterior tibial translation.

Table 2. Pearls and Pitfalls of the Posterolateral Tenodesis Technique for PCL Reconstruction

Pearls	Potential Pitfalls
Wide AM and AL portals for easy graft passage.	Grafts get stuck in the portals (use a PassPort Button Cannula).
Adequate diameter of the tibial tunnel to host the common graft.	Inadequate tensioning of the graft.
First do the femoral fixation of the PCL limb of the graft at 90°. Then, fix the tibial common graft and, finally, the PLT graft in knee extension and the neutral foot position.	Different colors for sutures for better graft identification.
Use high-resistance sutures at the graft ends.	

AL, anterolateral; AM, anteromedial; PCL, posterior cruciate ligament; PLT, posterolateral tenodesis.

Fig 8. Clinical photographs of the dynamic knee brace used after posterior cruciate ligament reconstruction in a left knee. (A) Side view. (B) Back view.

sample. Regarding future perspectives, a biomechanical study on human cadaveric knees and a comparative clinical trial comparing isolated PCL reconstruction with SB and DB techniques with and without associated posterolateral tenodesis are planned to determine whether this technique can be incorporated as a standard procedure during PCL reconstruction.

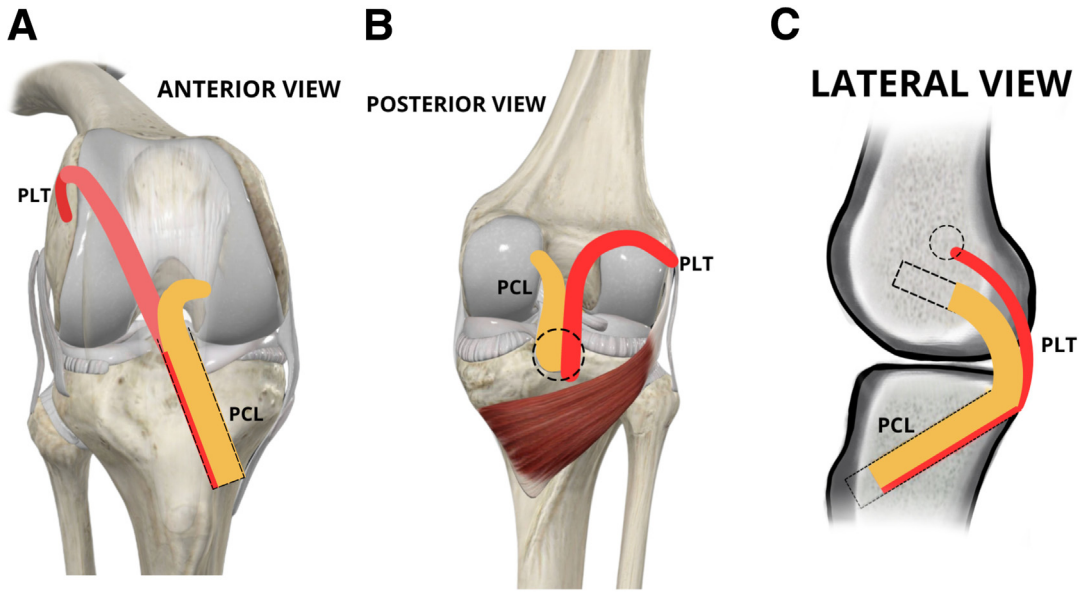

Fig 9. The PLT technique seen from the anterior view (A), posterior view (B), and lateral view (C) in a right knee. The PCL graft is shown in yellow and the posterolateral tenodesis graft is shown in red. (PCL, posterior cruciate ligament; PLT, posterolateral tenodesis.)

Disclosures

All authors (E.Á-S., L.C., J.R., J.C.M., R.M-A.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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