Technical Note

Arthroscopic Confirmation of Femoral Button Deployment During Posterior Cruciate Ligament Reconstruction

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Abstract: Posterior cruciate ligament (PCL) ruptures are uncommonly seen in knee ligament injuries. Cconservative treatment is often suitable for isolated tears with mild-to-moderate posterior knee laxity (grades I or II). However, surgical intervention is indicated for symptomatic grade III or multiligament knee injuries. PCL reconstruction has experienced continuous development due to the progress made in arthroscopic techniques and instruments. Abnormal positioning and tensioning of the femoral button result in multiple complications such as residual laxity, loss of quadriceps muscle strength, and joint stiffness. In this Technical Note, we describe direct arthroscopic visualization of the femoral button deployment in PCL reconstruction technique, and we discuss its importance to prevent complications related to button malposition.

Posterior cruciate ligament (PCL) ruptures are relatively rare, with an incidence of approximately 3% of all knee injuries, and are more common with concomitant knee ligament injuries.[1,2] Furthermore, most of the ruptures are amenable to conservative treatment, and surgical treatment is reserved for ruptures with severe instability with concomitant posterolateral corner injuries or for patients in whom conservative measures have not obtained satisfactory results.[3]

Many techniques have been described for PCL reconstruction, and the use of suspensory devices for femoral fixation has been reported in recent years, permitting excellent clinical results.[4] The TightRope II RT (Arthrex, Naples, FL) is an adjustable-loop length suspensory fixation device. It has a knotless mechanism with 4 locking points, which permits enough friction to resist cyclic displacement and slippage, supporting severe tension strength.

However, the adjustable-length design poses a risk of button locking in the muscles and fat tissue over the internal face of the medial condyle. If this problem is recognized during surgery, the button can easily be repositioned, thus avoiding loss of graft tension and suboptimal results during the postoperative period.

We describe a new technique that permits the control of button passing and seating, by direct visualization from the medial gutter of the knee, introducing the arthroscope around the flare of the medial femoral condyle, without the need of any additional portals or equipment (Table 1 and Video 1).

Surgical Technique

Patient Setup

Under general anesthesia, the patient is placed in supine position and a tourniquet is applied on the operative thigh. The knee is checked for full range of motion and confirmed to be stable on the foot roll at 90° of flexion.

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Transseptal Approach and Posterior Portals

A diagnostic arthroscopy is performed through standard anterolateral (AL) and anteromedial portals using a 30° arthroscope to check for any associated intra-articular lesions. Under a transnotch visualization, the posteromedial (PM) portal is established in a standard fashion (Fig 1). With the arthroscope under the ACL, a transnotch view of the lateral side of the septum is obtained to control the septum debridement with the shaver coming from the PM portal (Fig 1). Then, the scope is placed into the PM portal through the transeptal portal to perform the posterolateral portal under direct visualization using transillumination of the skin (Fig 1). A radiofrequency device is then inserted through the posterolateral portal to separate the septum from the capsule and then visualize the PCL tibial footprint.

PCL Tunnel Creation

With the arthroscope in the PM portal, the hook of the PCL tibial guide is introduced through the anteromedial portal toward the PCL tibial footprint (Fig 2). A guidewire is introduced from the hamstring insertion site to the PCL tibial footprint and proper insertion is checked under direct visualization until the tip of the guidewire is seen (Fig 2). The location of the guidewire is confirmed by a fluoroscopic examination before overdrilling with a 9-mm cannulated reamer. A looped suture shuttle is then passed into the tibial tunnel and retrieved from the AL portal. The PCL femoral tunnel is then performed by introducing a guidewire from the medial femoral cortex using a drill guide, piercing the femoral PCL footprint, which is located 10 mm posterior to the distal border of the articular cartilage of the medial femoral condyle (Fig 3). Then, the scope is introduced through the anterolateral portal into the medial gutter to directly visualize the guidewire. At this stage, the synovial tissue around the wire is debrided using a shaver to avoid soft-tissue interposition between the button and the femur (Fig 3). A FlipCutter Drill (Arthrex) is then used to ream the femoral tunnel from outside-in (Fig 3). The loop is

Table 1. Surgical Steps, Pearls, and Pitfalls

Surgical Steps	Pearls	Pitfalls
Transseptal approach	PL and PM portals should be well placed. The shaver should face anteriorly toward the scope, in order to avoid injury of the popliteal neurovascular bundle. The posterior capsule should be detached from the PCL tibial attachment for more than 10 mm below the articular surface. Fluoroscopic control is recommended before over drilling the guidewire with a reamer.	We should use the light source to transilluminate the skin incision while creating the posterior portals to avoid neurovascular injury. We should gently remove the central-inferior septum to avoid injury of the middle genicular vessels. The PCL tibial attachment is retained to help setting the orientation of the center of the PCL tibial attachment.
Fixation of the graft	The ACL should be tensioned to provide accurate information about the reduction of the knee joint	With a knee flexion of 90°, the proximal tibia is pulled anteriorly, to maintain the tibia reduced while fixing the PCL graft.
Button seat preparation (femoral tunnel outlet)	A 2.4-mm pin is introduced through the FlipCutter sleeve inside the bone in the femoral tunnel. The sleeve is removed, and the synovial tissue is shaved around the pin in order to improve the visualization.	If the shaving of the synovial tissue is inadequate, this will result in poor button visualization and seating.
Flipping of button onto medial cortex	The arthroscope is placed in the medial gutter, the button suture thread emerging at the medial femoral cortex is identified; the suture thread is pulled gently while the button emerges from the FlipCutter pinhole. An arthroscopic probe is used through the femoral stab incision as a soft-tissue retractor to create enough room to flip the button. The graft is pulled on the tibial side for the button to be well applied onto the cortex.	Poor arthroscopic control with forced suture pulling may result in button emergence at the femoral stab incision.
Graft advancement in femoral tunnel and gradual tensioning	A gentle countertraction should be applied on the tibial end of the graft, as this will prevent the displacement of the button during final tensioning of the graft. The proper button positioning on the femoral cortex is verified after final fixation.	Without countertraction of the tibial end of the graft, the result could be the mobilization of the button and its migration into the FlipCutter pinhole.

ACL, anterior cruciate ligament; PCL, posterior cruciate ligament; PL, posterolateral; PM, posteromedial.

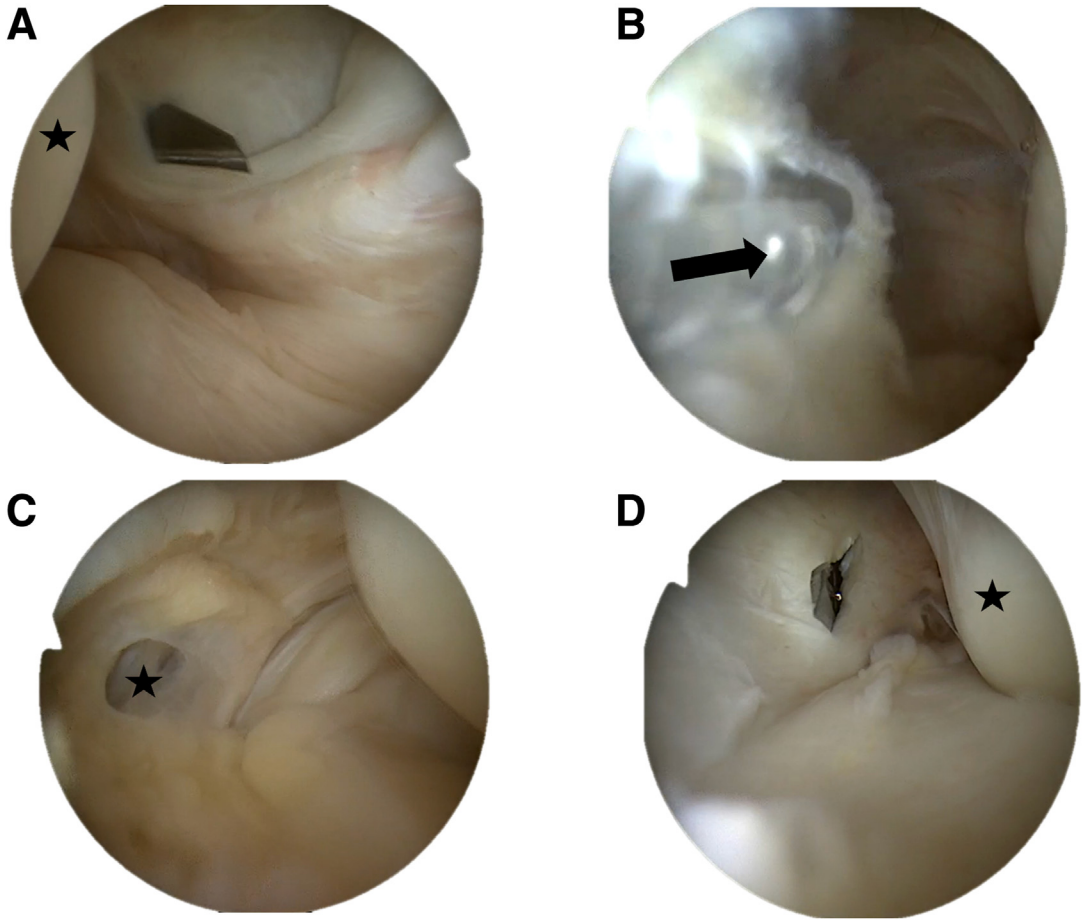

Fig 1. Left knee in 90° of flexion. Arthroscopic views showing: (A) Posteromedial portal is established under a transnotch visualization. (Black star: Medial femoral condyle); (B) transnotch view of the lateral side of the septum showing the septum debridement with the shaver coming from the posteromedial portal (Black arrow: shaver coming from de posteromedial portal towards the posterior lateral compartment); (C) A view of the septum hole with the arthroscope inserted in the posteromedial portal (Black star: transeptal portal); (D) the scope is placed into the posteromedial portal passing through the septum to perform the posterolateral portal (Black star: Lateral femoral condyle).

then grasped using a FiberStick (Arthrex) and pulled out the femur. The FiberStick is now filling the PCL tunnel from its exit in the tibia to its entry into the femur.

Graft Passage and Fixation

The PCL graft is prepared and looped with the TightRope II RT (Arthrex). The knee is maintained at 90° of flexion, the arthroscope is placed in the AL portal, and the suture attached to the PCL graft is tied to the PCL suture loop and pulled through the tibial tunnel, exiting from the femoral tunnel. Then, the arthroscope is introduced in the posterolateral compartment to confirm the graft passage. The femoral graft fixation is achieved using the TightRope II RT (Arthrex). The graft is then fixed to the tibia with another button while the knee is kept in a reduced position at 90° of flexion.

Confirmation of Femoral Button Deployment

With the knee in extension, the arthroscope is introduced into the medial gutter to see the exit point of the button on the medial cortex of the femur (Fig 4). A probe can be used to assist the maneuvering of the device (Fig 4). Under arthroscopic control, the complete removal of the soft-tissue interposition between the button and the femur is verified (Fig 4). Gentle countertraction should be applied on the tibial end of the graft in order to prevent button displacement. Postoperatively, a radiograph of the knee is obtained in all patients to verify the correct positioning of the button (Fig 5).

Postoperative Protocol

The protocol developed by Edson et al.[5] is used in the postoperative rehabilitation program. A PCL brace is used while the patient is supine to minimize the gravitational forces on the tibia, and this brace is locked in extension during ambulation. The patient can immediately start prone, passive knee flexion to 90°. Partial weight-bearing is allowed with crutches and the brace locked in extension for 6 weeks. Progressive weight-bearing is allowed after 6 weeks with crutches and the brace unlocked.

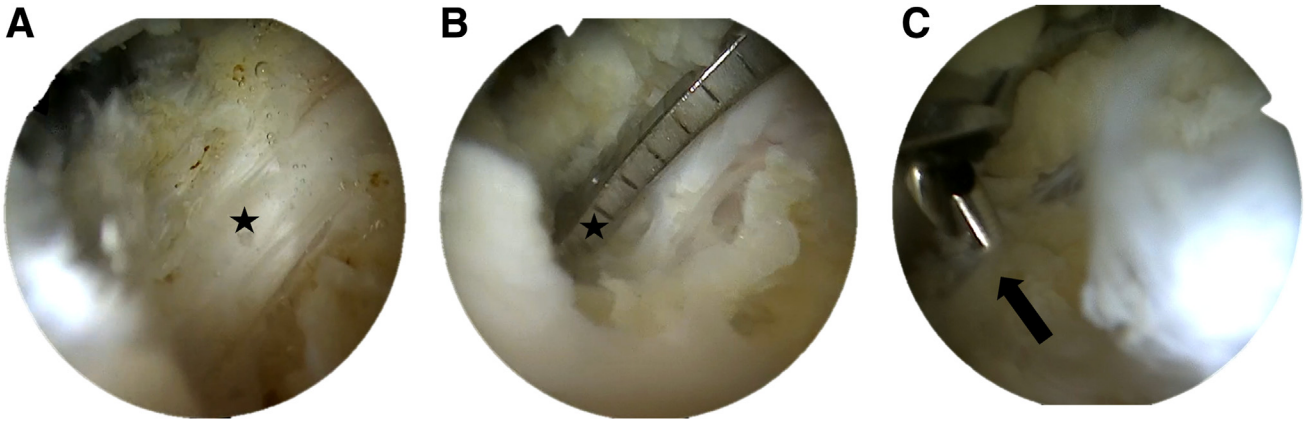

Fig 2. Left knee in 90° of flexion under posterolateral portal visualization. Arthroscopic views showing: (A) the PCL tibial footprint (Black star: PCL distal insertion in the posterior aspect of the tibia); (B) the hook of the PCL tibial guide which is inserted through the anteromedial portal towards the PCL tibial footprint (Black star: Tibial PCL hook arm); (C) the tip of the guidewire which is introduced from the hamstrings insertion site to the PCL tibial footprint (Black arrow: Guidewire at the PCL tibial footprint). (PCL, posterior cruciate ligament.)

Discussion

It has been shown by Yuanjie et al.[6] that button malposition in PCL reconstruction was around 17.0%. In addition, this study found that male sex, low surgical volume, concomitant ligament reconstruction, and the use of a fixed-loop button were identified as independent risk factors for femoral cortical button malposition during PCL Reconstruction. Male sex was a major independent risk factor for femoral cortex button malposition in PCL Reconstruction with 13.86 times greater risk of button malposition compared with the female group, and an explanation of this result is that a greater volume of the vastus medialis muscle in male patients could result in increased soft-tissue interference between the femoral cortex and the button.[6]

The use of the TightRope as fixation technique in PCL reconstruction simplifies the surgical technique;, however, care should be taken to avoid complications related to the proper position of the femoral button on the medial femoral cortex. Soft-tissue interposition between the femoral button and the lateral femoral condyle was found to be the major complication to avoid in anterior cruciate ligament reconstruction surgery leading to button migration during flexion−extension movement of the knee.[6,7] The same principle can be attributed to PCL reconstruction surgery, where the lack of direct contact between the button and the medial femoral cortex secondary to soft-tissue interposition contributes to femoral-side fixation weakness and loosening of the graft before integration. Furthermore, button

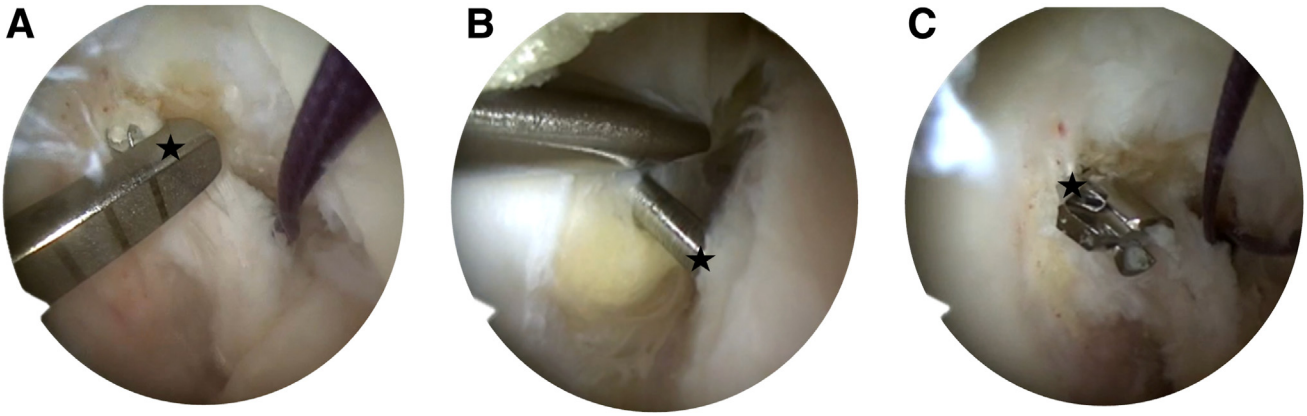

Fig 3. Left knee in 90° of flexion. Arthroscopic views showing: (A) Viewing from the anterolateral portal. The position of the femoral guide with the tip of the guidewire from the medial femoral cortex, piercing the femoral PCL footprint (Black star: Femoral PCL hook arm); (B) Viewing of the medial gutter. Debridement of the synovial tissue around the wire in the medial gutter (Black star: Guidewire in the medial gutter); (C) Viewing from the anterolateral portal. Reaming of the femoral tunnel using a Flipcutter (Black star: FlipCutter Drill, Arthrex). (PCL, posterior cruciate ligament.)

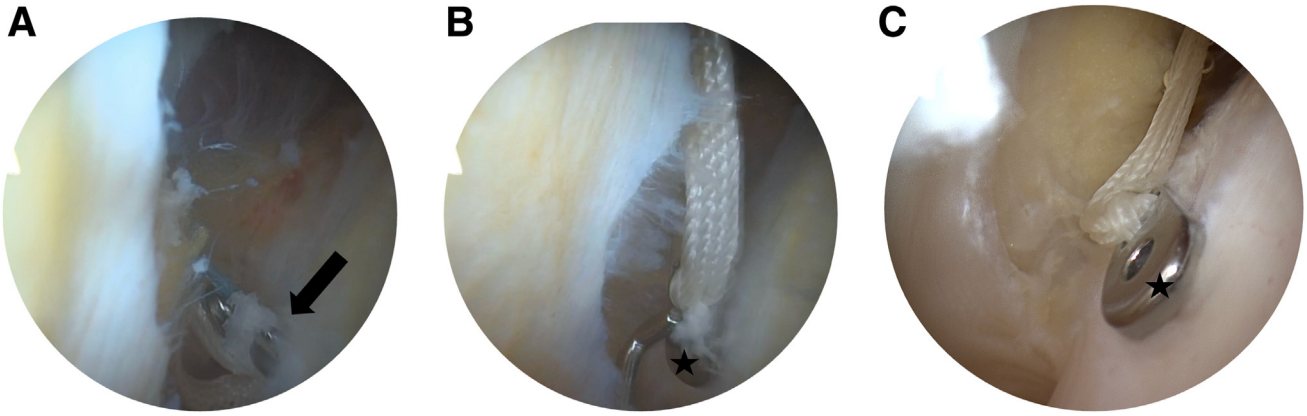

Fig 4. Left knee in 90° of flexion. Viewing of the medial gutter: (A) the arthroscope is placed in the medial gutter while the button emerges from the flip cutter pinhole on the medial femoral cortex (Black arrow: button coming out of the femoral tunnel); (B) An arthroscopic probe is used to assist the maneuvering of the button (Black star: button being positioned by the probe in the medial gutter); (C) The button is sitting on the medial cortex of the femur without soft-tissue interposition (Black star: Button well-positioned on the medial cortex).

entrapment within the vastus medialis obliquus muscle can lead to a multitude of complications, including loss of quadriceps muscle strength, arthrogenic muscle inhibition, anterior knee pain, and joint stiffness. Therefore, arthroscopic confirmation of femoral button deployment guarantees that the TightRope button is correctly positioned on the medial cortex of the femur.

Various techniques are described in the literature to ensure accurate button positioning during anterior cruciate ligament reconstruction. Some surgeons advocate for intraoperative fluoroscopy to prevent button malposition and assess its relationship with the femoral cortex.[8] Others use a femoral guide pin incision on the lateral aspect of the femur as an endoscopic

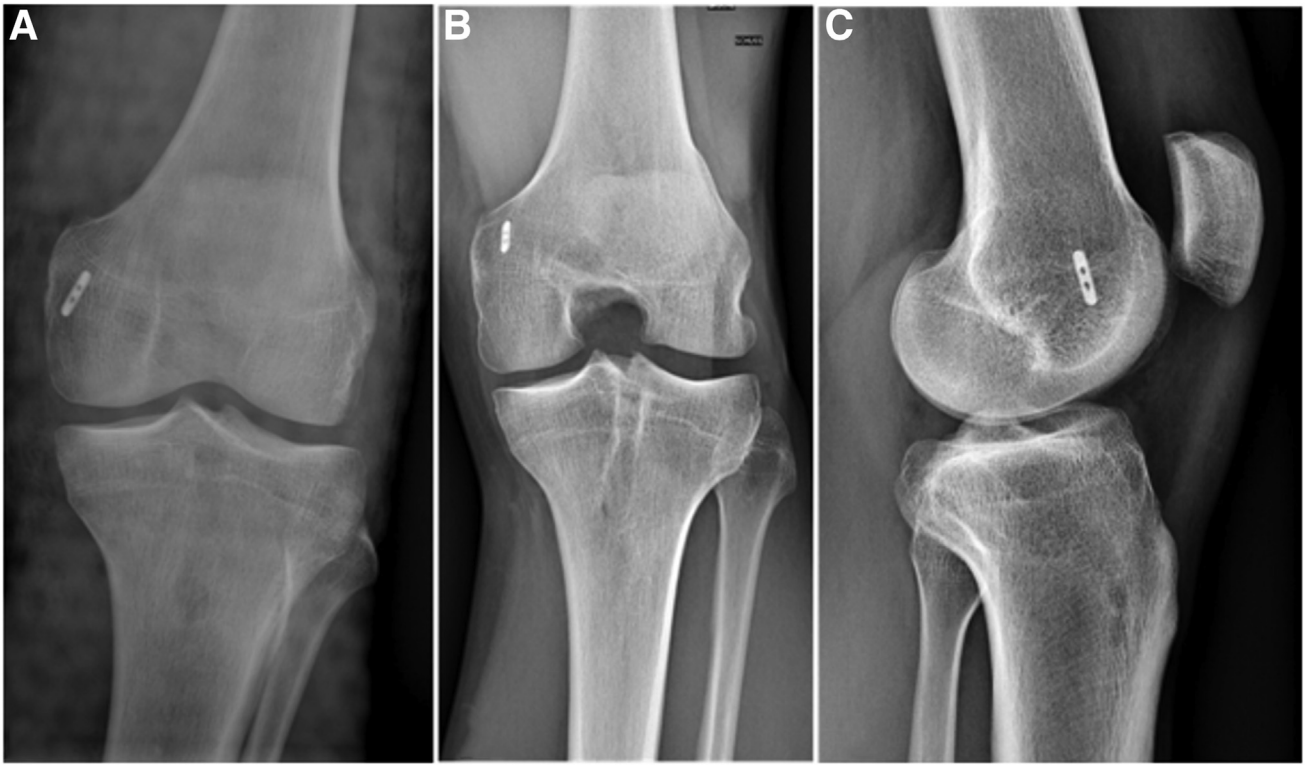

Fig 5. (A) Left knee postoperative X-ray after PCL reconstruction with arthroscopic femoral button deployment. (B and C) X-ray at 2 years follow-up. (PCL, posterior cruciate ligament.)

portal for direct visualization of the cortical button.[9] Nevertheless, opting for an additional surgical approach presents certain drawbacks. It carries the inherent risk of invasiveness, which in turn increases the potential for sepsis. In addition, this approach contributes to an extended overall surgical time, affecting both patient safety and procedural efficiency.[10]

Arthroscopic direct visualization of button deployment has been found to be a more effective and nonirradiating approach for optimal button positioning.[10-12] This approach prevents the button from being accidentally placed over the medial side knee soft tissue and avoids any risk of the device pinching inside the femoral tunnel or being situated too close to the posterior cortex, thus averting any potential for posterior migration. By methodically removing soft tissue from the medial end of the femoral tunnel, the chances of its interposition beneath the implant were reduced. During the procedure, it is necessary to make cyclic movements using the suture attached to the Tightrope button. However, according to Sonnery-Cottet et al.,[12] cycling maneuver during anterior cruciate ligament reconstruction can move the suspensory device from its position, to prevent this complication in PCL reconstruction after the graft is placed in the femoral socket, our current technique involves double-checking the final position of the button on the medial femoral cortex.

In our perspective, we believe that our technique offers a safe approach with a relatively quick learning curve, allowing the surgeon to receive valuable real-time feedback during femoral fixation in PCL reconstruction. The authors encourage one to confirm button position intraoperatively with direct arthroscopic visualization.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: B.S-C. reports financial support by Arthrex and a relationship that includes consulting or advisory and speaking and lecture fees. All other authors (A.A., F.P., A.A., M.B., T.F.O., T.D.V., T.P.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Schlumberger M, Schuster P, Eichinger M, et al. Posterior cruciate ligament lesions are mainly present as combined lesions even in sports injuries. *Knee Surg Sports Traumatol Arthrosc* 2020;28:2091-2098.
2. Bollen S. Epidemiology of knee injuries: diagnosis and triage. *Br J Sports Med* 2000;34:227-228.
3. Pache S, Aman ZS, Kennedy M, et al. Posterior cruciate ligament: Current concepts review. *Arch Bone Jt Surg* 2018;6:8-18.
4. Therrien E, Pareek A, Song BM, et al. Comparison of posterior cruciate ligament reconstruction using an all-inside technique with and without independent suture tape reinforcement. *Orthop J Sports Med* 2022;10:232596712211373.
5. Edson CJ, Fanelli GC, Beck JD. Postoperative rehabilitation of the posterior cruciate ligament. *Sports Med Arthrosc Rev* 2010;18(4).
6. Yuanjie Z, Xing X, Jing W, Xi G, Yanbin P, Yu M. Risk factors for femoral cortical button malposition in posterior cruciate ligament reconstruction. *Orthop J Sports Med* 2022;10:232596712210942.
7. Mae T, Kuroda S, Matsumoto N, et al. Migration of EndoButton after anatomic double-bundle anterior cruciate ligament reconstruction. *Arthroscopy* 2011;27:1528-1535.
8. Uchida R, Mae T, Matsumoto N, Kuroda S, Toritsuka Y, Shino K. The effect of cortical button location on its postoperative migration in anatomical double-bundle anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc* 2014;22:1047-1054.
9. Ohnishi Y, Chang A, Utsunomiya H, et al. Arthroscopic technique to reduce suture button migration during anterior cruciate ligament reconstruction procedure. *Arthrosc Tech* 2017;6:e1927-e1931.
10. Guy S, Carrozzo A, Ferreira A, et al. Arthroscopic confirmation of femoral button deployment prevents soft tissue interposition in ACL reconstruction. *Knee Surg Sports Traumatol Arthrosc* 2022;30:2251-2258.
11. Perumal R, Gunasekaran C, Jacob M, Jepegnanam TS. Alternate method of arthroscopically confirming femoral button deployment for knee anterior cruciate ligament graft suspensory cortical fixation. *Arthrosc Tech* 2018;7:e1295-e1298.
12. Sonnery-Cottet B, Rezende FC, Martins Neto A, Fayard JM, Thaunat M, Kader DF. Arthroscopically confirmed femoral button deployment. *Arthrosc Tech* 2014;3:e309-e312.