Technical Note

Arthroscopic Transseptal Single-Tunnel Posterior Cruciate Ligament Refixation

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Abstract: Posterior cruciate ligament avulsions are relatively rare and often go undiagnosed. However, they need to be fixed to restore knee biomechanics. Fixation techniques vary from open to arthroscopic with comparable results. Arthroscopic techniques are less invasive; however, they are technically demanding. This Technical Note describes one such relatively low-cost arthroscopic suture tape pull-out technique using both an anterior and transseptal portals to fix the posterior cruciate ligament avulsion fragment.

Posterior cruciate ligament (PCL) injuries constitute 20% of ligament injuries around the knee. The most common mechanism of injury is dashboard injuries. Bony avulsions of the PCL are relatively rare. They most frequently occur in South Asian regions due to a greater number of 2-wheeler related accidents.[1] They are best treated surgically to restore the biomechanics of the knee.[2,3] Surgical treatment involves open or arthroscopic, with each having distinct advantages. Although technically demanding, arthroscopic fixation has the advantage of being minimally invasive with fewer wound-related problems, potentially making rehabilitation faster. Previously described arthroscopic techniques used tightrope[4] and pull-out sutures tied over a button/using a suture bridge technique.[5] However, the fixation technique should not only be effective but economical. In this paper, I describe an arthroscopic technique that involves a suture tape (Arthrex, Naples, FL) passed through the PCL after drilling a tunnel from the anteromedial aspect of the tibia to the posterior aspect and fixed anteriorly using the TightRope Attachable Button System (ABS; Arthrex).

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Preoperative Workup

The avulsion is diagnosed on a standard lateral radiograph (Fig 1) and magnetic resonance imaging (Fig 2). The size of the fragment is determined to decide which fixation technique should be used. Clinical examination via a posterior drawer test is performed to evaluate the degree of posterior laxity.

Surgical Technique (With Video Illustration)

The surgical technique is shown in Video 1. The patient is placed in a supine position with a tourniquet

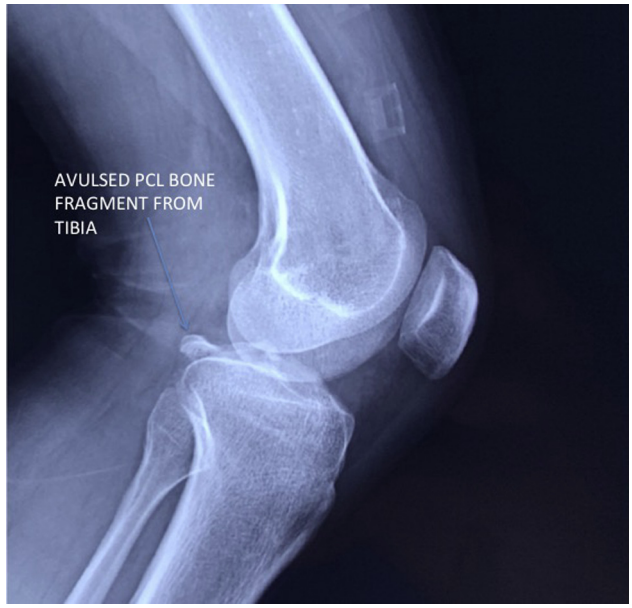

Fig 1. Lateral-view radiograph of the left knee showing a PCL avulsion from the tibia posteriorly. (PCL, posterior cruciate ligament.)

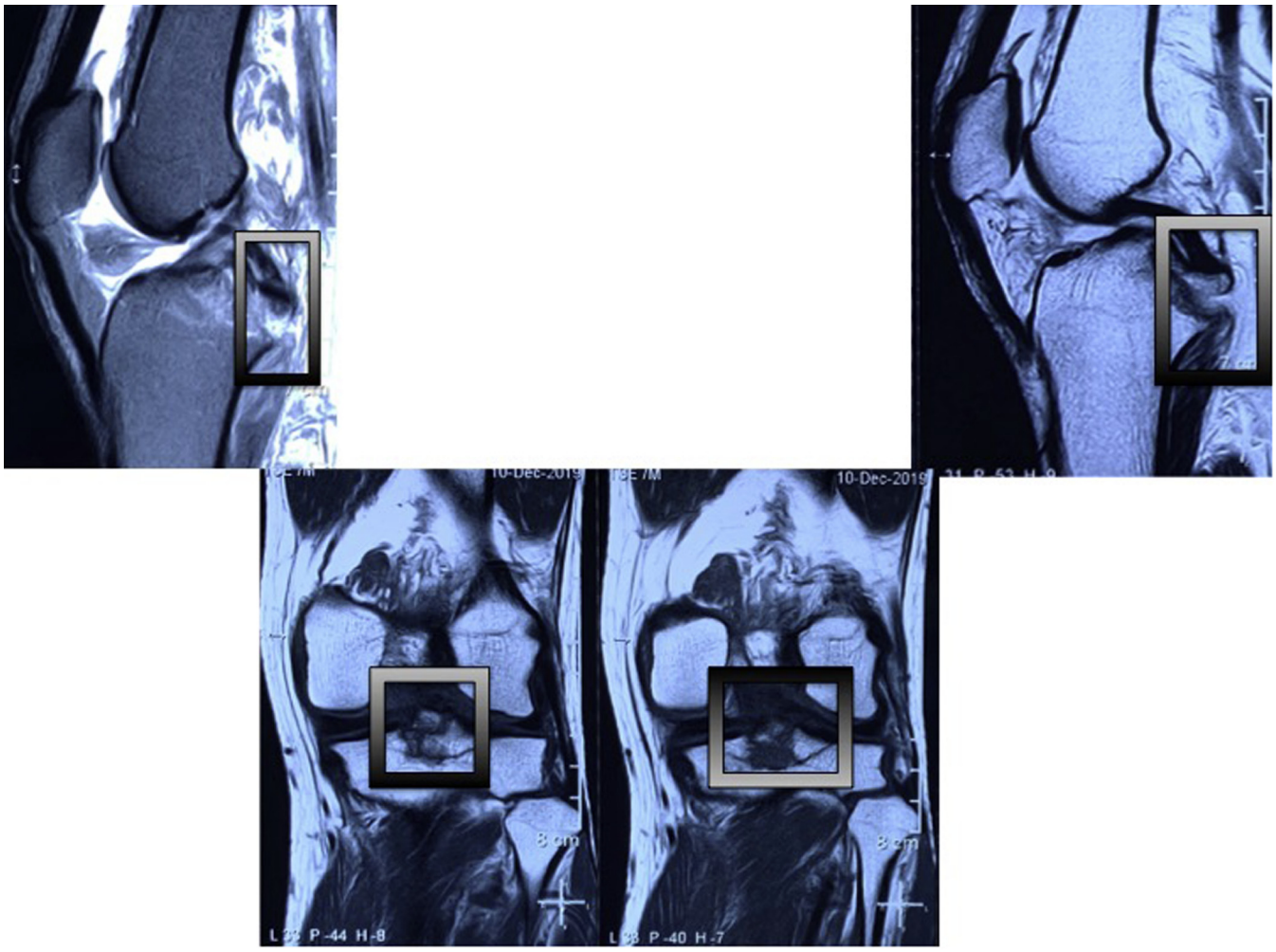

Fig 2. MRI of the left knee, coronal and sagittal sections, showing the PCL avulsion from the tibia posteriorly. (MRI, magnetic resonance imaging; PCL, posterior cruciate ligament.)

tied at the thigh with a side support laterally and knee in 80° of flexion on the operating table. Step 1: A standard anterolateral (AL) viewing portal and an anteromedial (AM) working portal through the soft spot are made. Step 2: The arthroscope is introduced into the posteromedial (PM) compartment through the AM portal between the PCL and medial femoral condyle (Fig 3).

Step 3:A high PM portal (Fig 4) is made and a 5-mm cannula introduced through it (Fig 5). Step 4: Again viewing through the AL portal and working in the anterior aspect, a shaver is introduced through the AM portal and a space is created between the anterior cruciate ligament (ACL) and PCL and the septum is removed (Fig 6).

Step 5: Making a transseptal portal: While viewing the PM compartment through the AL portal from between the ACL and PCL, a Wissinger rod is introduced through the PM portal and then advanced to the posterolateral (PL) compartment such that the rod is against the lateral femoral condyle bone. The knee is kept in full flexion while advancing the rod. The tip of the rod is projected through the skin and an incision made on the skin over tip of the rod and a 5-mm cannula passed over the rod into the PL compartment (Fig 7 A and B).

Step 6: While viewing from the PL portal, the shaver and the radiofrequency device are introduced through the PM portal and used to isolate the fragment and clear the footprint (Fig 8 A and B). Step 7: The PCL jig (Arthrex), fixed at 70°, is introduced from the AM (Fig 9A) portal and between the ACL and PCL to just below the PCL insertion on the tibia and a guidewire

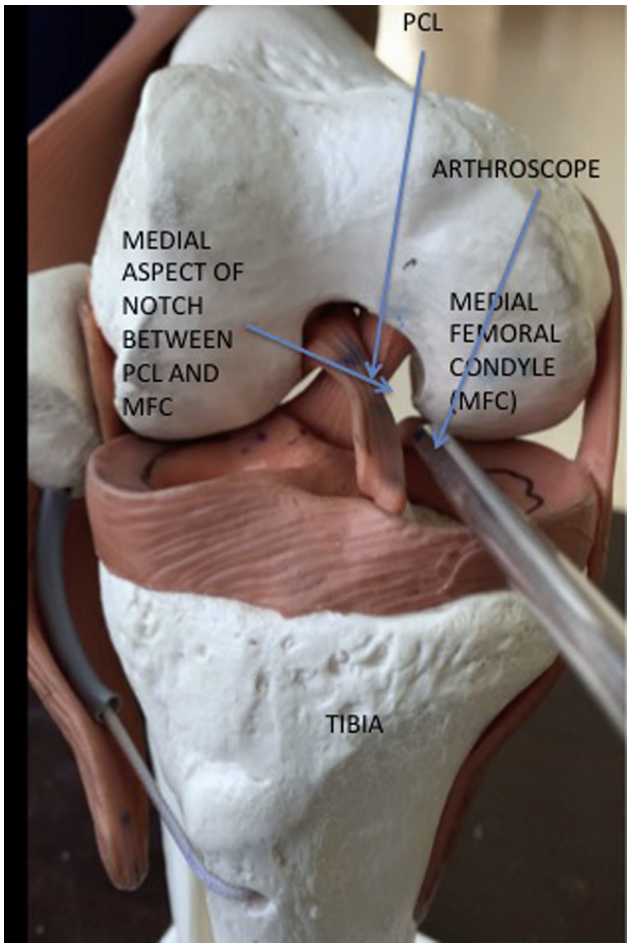

Fig 3. Model representation of introducing the arthroscope between the PCL and the MFC. (MFC, medial femoral condyle; PCL, posterior cruciate ligament.)

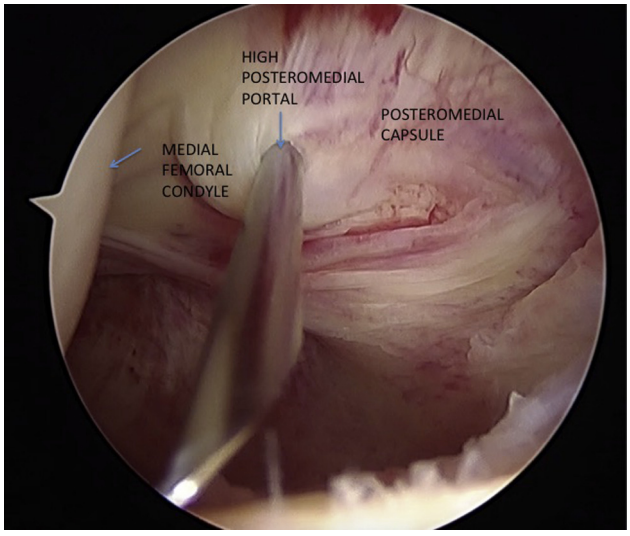

Fig 4. Arthroscopic image of making a high PM portal by introducing a lumbar puncture needle while viewing the PM aspect of the knee through the AM portal with left knee in 80° flexion and the patient supine. (AM, anteromedial; PM, posteromedial.)

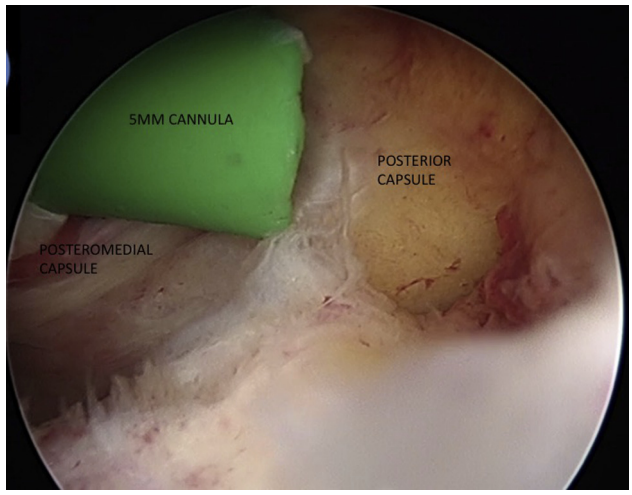

Fig 5. Arthroscopic image of 5-mm cannula through the PM portal while viewing from the AM portal with left knee in 80° flexion and the patient supine. (AM, anteromedial; PM, posteromedial.)

drilled until it exits through the PCL footprint (Fig 9 B and C).

Step 8: While placing a curette over the guidewire tip posteriorly, it is overdrilled with a 4.5-mm drill bit (Fig 10 A and B). A Beath pin loaded with a No. 5 ETHIBOND (Ethicon, Somerville, NJ) loop is passed through the tibial tunnel from anterior to posterior and loop retrieved through the PM portal (Fig 11).

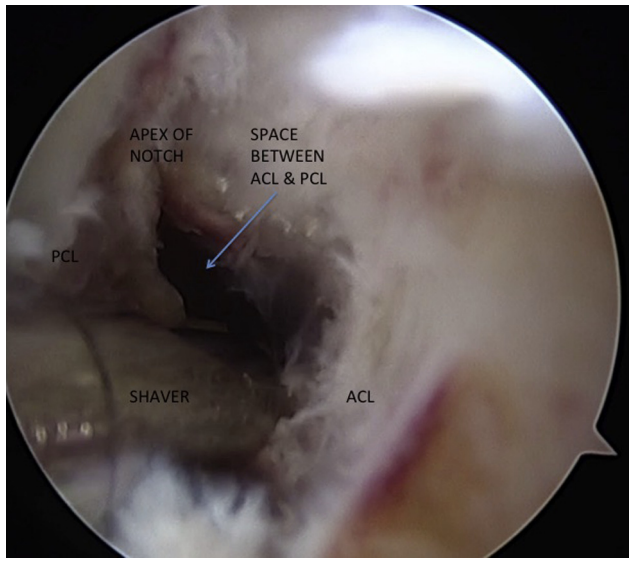

Fig 6. Arthroscopic image of creating a space between the ACL and PCL and excising the septum with a shaver in the AM portal while viewing from the AL portal with left knee in 80° flexion and the patient supine. (ACL, anterior cruciate ligament; AL, anterolateral; AM, anteromedial; PCL, posterior cruciate ligament.)

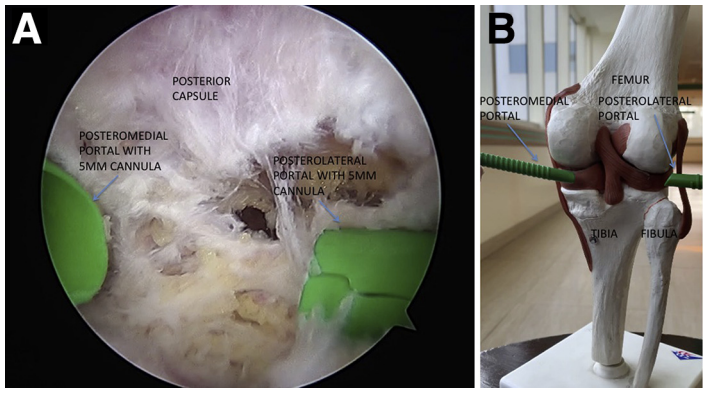

Fig 7. (A) Arthroscopic image of both PM and PL portals with 5-mm cannulas in them viewed between the ACL and PCL while the arthroscope is in the AL portal with left knee in 80° flexion and the patient supine. (B) Model representation of the PM and PL portals with 5-mm cannulas. (ACL, anterior cruciate ligament; AL, anterolateral; AM, anteromedial; PCL, posterior cruciate ligament; PL, posterolateral ligament; PM, posteromedial.)

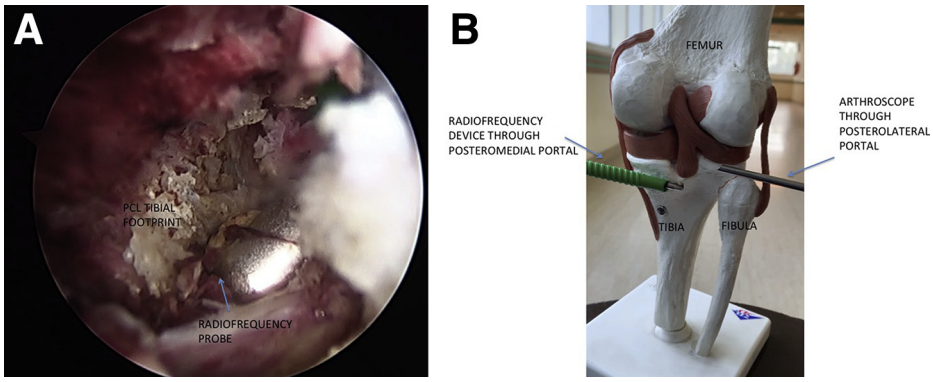

Fig 8. (A) Arthroscopic image of PCL footprint on tibia being cleared using a radiofrequency device introduced through the PM portal while viewing through the AM portal with left knee in 80° flexion and the patient supine. (B) Model representation of PCL footprint on tibia being cleared using a radiofrequency device introduced through the PM portal while viewing through the AM portal with left knee in 80° flexion and the patient supine. (AM, anteromedial; PCL, posterior cruciate ligament; PM, posteromedial.)

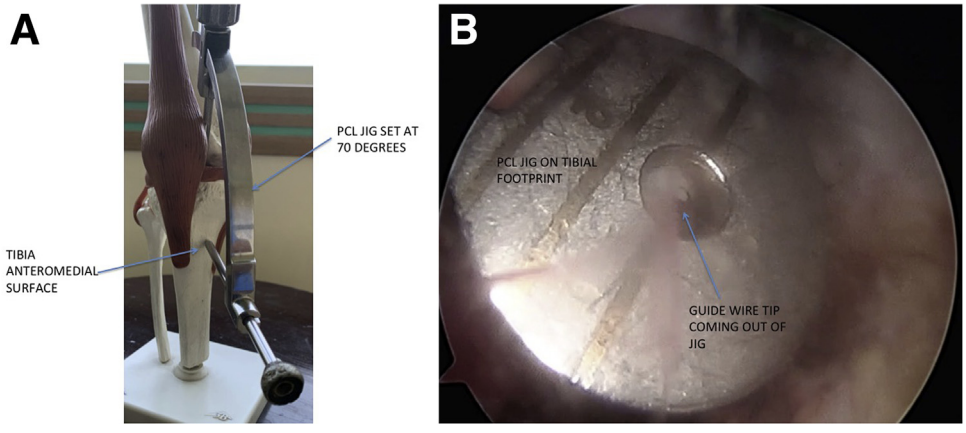

Fig 9. (A) Model representation of the PCL jig introduced from AM portal to the back of the knee from in between the ACL and PCL. (B) Arthroscopic image of PCL jig centered on the tibial footprint with guidewire at its center while viewing from the PL portal and jig introduced from the AM portal and advanced between the ACL and PCL with left knee in 80° flexion and the patient supine. (C) Model representation of the back of the knee showing the PCL jig sitting on the PCL footprint. (ACL, anterior cruciate ligament; AM, anteromedial; PCL, posterior cruciate ligament; PL, posterolateral ligament.)

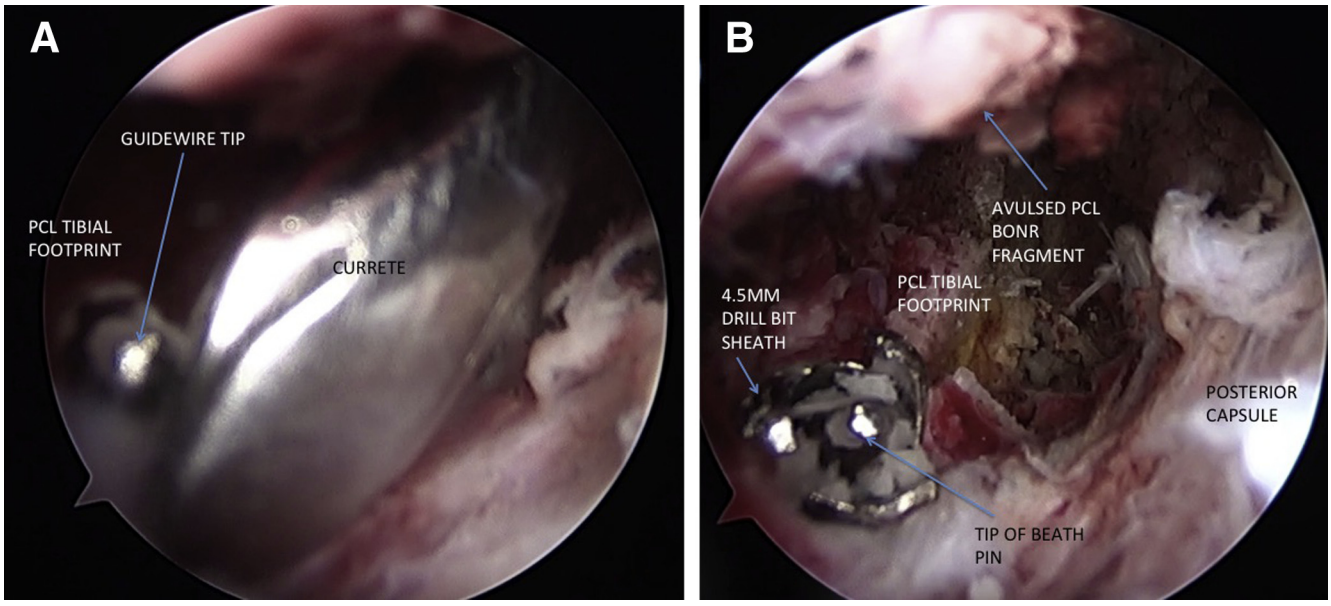

Fig 10. (A) Arthroscopic image while viewing from the PL portal of a curette introduced through the PM portal placed over the guidewire tip while overdrilling with a 4.5-mm drill bit with left knee in 80° flexion and the patient supine. (B) Arthroscopic image of the tibial footprint of PCL while viewing from the PL portal showing the 4.5-mm drill bit tip with left knee in 80° flexion and the patient supine. (PCL, posterior cruciate ligament; PL, posterolateral ligament; PM, posteromedial.)

Step 9: Viewing from the AL portal, a passport cannula is introduced through the AM portal and a bite is taken through the base of the PCL using a Knee Scorpion (Arthrex) loaded with a 2-0 FiberWire (Arthrex) (Fig 12 A and B) that is used to railroad a suture tape (Fig 13) (Arthrex). The suture tape is knotted (Fig 14) and 2 ends passed into the posterior compartment using a grasper. One end is passed between the PCL and medial femoral condyle (Fig 15 A and B) the other between the PCL and ACL (Fig 16 A and B). The 2 ends are retrieved into the PM portal (Fig 17 A and B).

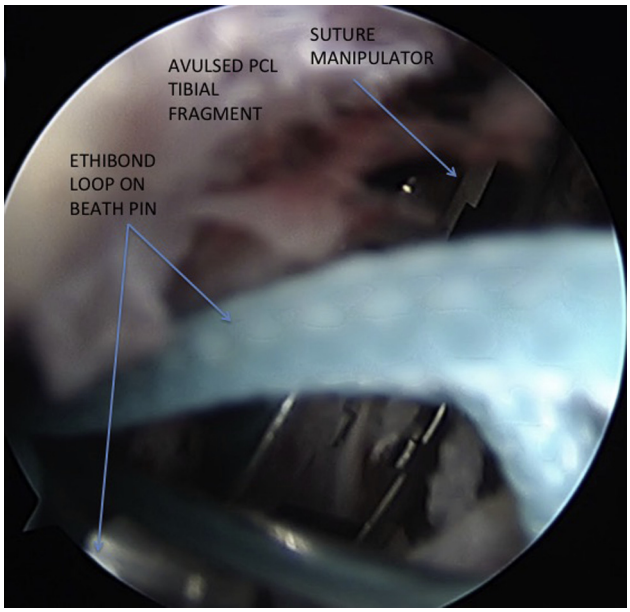

Fig 11. Arthroscopic image of Beath pin with ETHIBOND loop coming out of the drill hole in the PCL footprint while viewing from the PL portal with left knee in 80° flexion and the patient supine. (PCL, posterior cruciate ligament; PL, posterolateral ligament.)

Step 10: Simple knots with 3 throws are made using the 2 ends of the suture tape around the PCL posteriorly using a knot pusher (Fig 18 A and B). Step 11: The 2 ends of the suture tape are looped onto the ETHIBOND loop in the PM portal and pulled through the AM tunnel anteriorly.

Step 12: Viewing through the PL portal, a suture manipulator is used to manipulate the 2 ends of the suture tape over the PCL fragment (Fig 19) such that uniform pressure is exerted onto the fragment. Step 13: While applying traction over the sutures anteromedially with the knee in 90° flexion and an anterior drawer force, the 2 ends are tied over an ABS button, reducing and fixing the avulsed fragment (Fig 20).

Postsurgery Protocol

Radiographs are taken on the table with fluoroscopic guidance to obtain a good lateral view to see that the fragment is well reduced (Fig 21). Computed tomography scan done postoperatively shows anatomical reduction of the fragment posteriorly (Fig 22). The patient is kept in a long knee brace with posterior

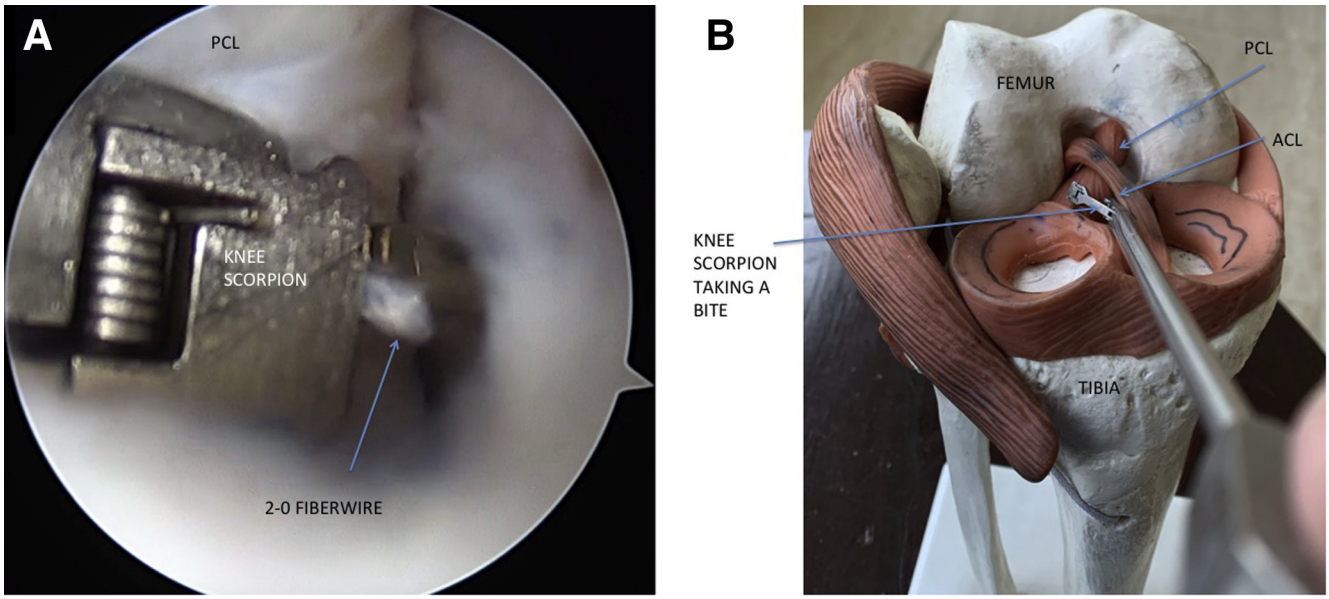

Fig 12. (A) Arthroscopic image of bite being taken on PCL with 2-0 FiberWire while viewing through the AL portal. The Knee Scorpion is introduced through the AM portal with left knee in 80° flexion and patient supine. (B) Model representation of the Knee Scorpion introduced anteriorly to take a bite on the PCL. (AL, anterolateral; AM, anteromedial; PCL, posterior cruciate ligament.)

support for 6 weeks with weight bearing as tolerated on the brace, using a walker. Ranges of motion exercises are done in the prone position starting from day 1 for 6 weeks postsurgery. After 6 weeks, the brace is removed, and the patient is allowed to walk and bend the knee normally.

Discussion

Repairing a PCL avulsion is critical to restore knee biomechanics[2,3]; hence, bony avulsions that have a good healing potential should be repaired. Repairing a PCL avulsion can be either through the conventional

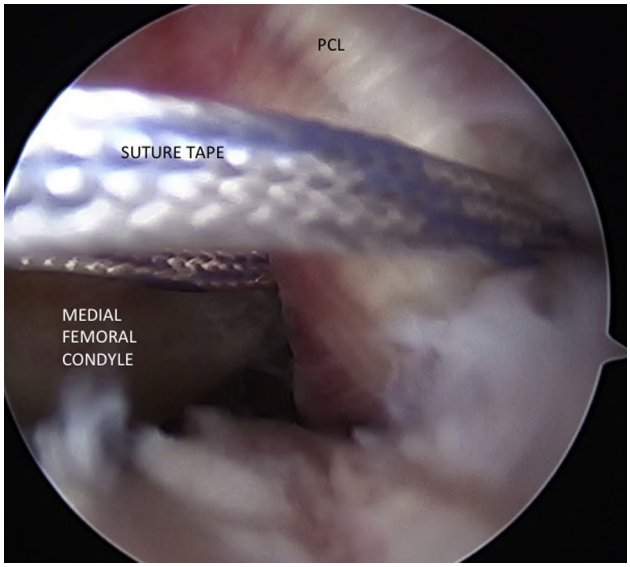

Fig 13. Arthroscopic image of 2 ends of the suture tape after passing through the PCL while viewing from the AL portal with left knee in 80° flexion and the patient supine. (AL, anterolateral; PCL, posterior cruciate ligament.)

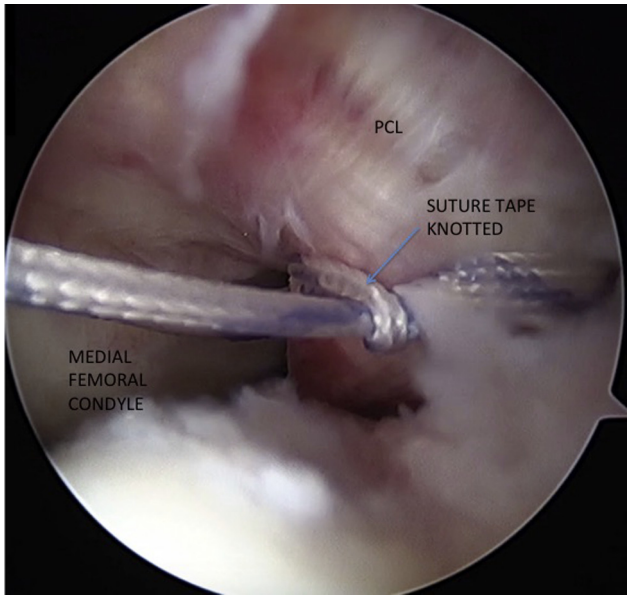

Fig 14. Arthroscopic image of the suture tape knotted anteriorly on the PCL while viewing through the AL portal with left knee in 80° flexion and the patient supine. (AL, anterolateral; PCL, posterior cruciate ligament.)

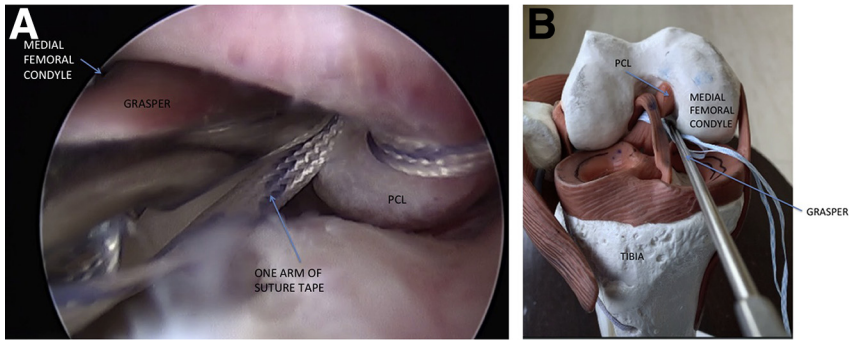

Fig 15. (A) Arthroscopic image of one end of suture tape being passed between the PCL and MFC with a grasper through the AM portal while viewing through the AL portal with left knee in 80° flexion and the patient supine. (B) Model representation of the anterior aspect of knee showing one end of suture tape being passed between the PCL and MFC with a grasper. (AL, anterolateral; AM, anteromedial; MFC, medial femoral condyle; PCL, posterior cruciate ligament.)

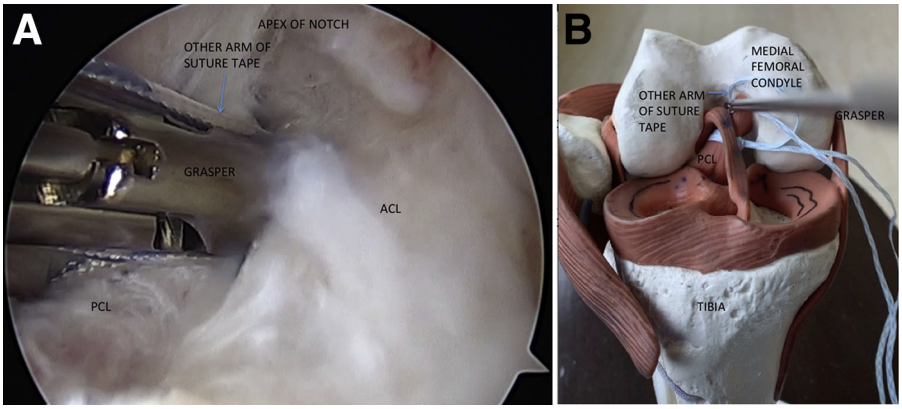

Fig 16. (A) Arthroscopic image of other end of suture tape being passed between the ACL and PCL with a grasper introduced through the AM portal while viewing through the AL portal with left knee in 80° flexion and the patient supine. (B) Model image of the anterior aspect of the knee showing the other end of suture tape being passed between the ACL and PCL. (ACL, anterior cruciate ligament; AL, anterolateral; AM, anteromedial; PCL, posterior cruciate ligament.)

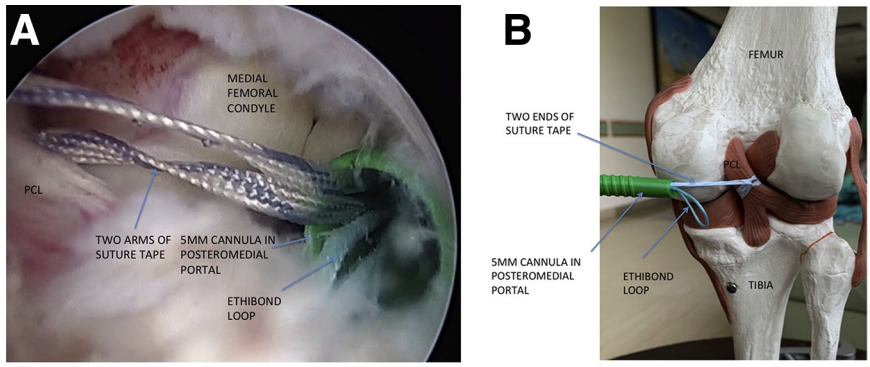

Fig 17. (A) Arthroscopic image of 2 ends of the suture tape and ETHIBOND loop in the PM portal while viewing from the PL portal with left knee in 80° flexion and the patient supine. (B) Model representation of the posterior aspect of the knee showing 2 ends of the suture tape and ETHIBOND loop through the PM portal. (PL, posterolateral ligament; PM, posteromedial.)

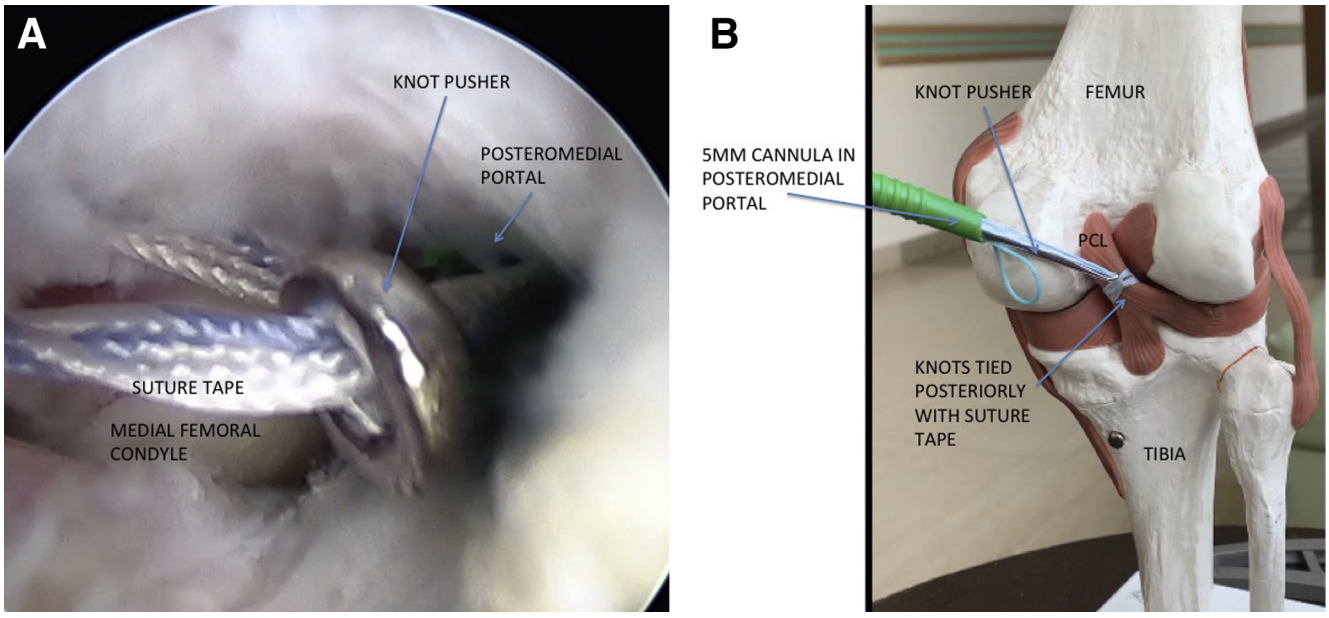

Fig 18. (A) Arthroscopic image of knot pusher coming through PM portal and tying knots with the suture tape around the PCL while viewing from the PL portal with left knee in 80° flexion and the patient supine. (B) Model representation of the posterior aspect of the knee showing a knot pusher from the PM portal tying knots with the suture tape around the PCL. (PCL, posterior cruciate ligament; PL, posterolateral ligament; PM, posteromedial.)

open approach or through arthroscopic surgery. Arthroscopic surgery has the added advantage of being minimally invasive with fewer wound healing problems as compared with open surgery. However, it is technically demanding, and visualizing the fragment properly and fixing it securely is the key to success.[6]

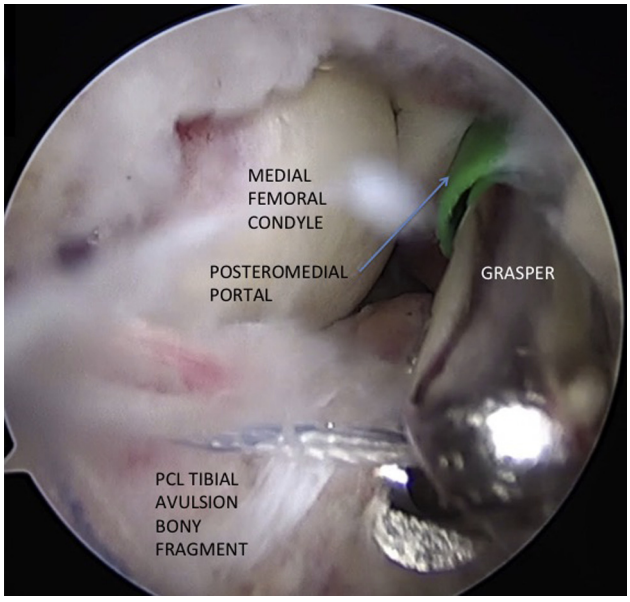

Fig 19. Arthroscopic image of grasper from the PM portal manipulating the 2 ends of the suture tape over the avulsed fragment while viewing from the PL portal with left knee in 80° flexion and the patient supine. (PCL, posterior cruciate ligament; PL, posterolateral ligament; PM, posteromedial.)

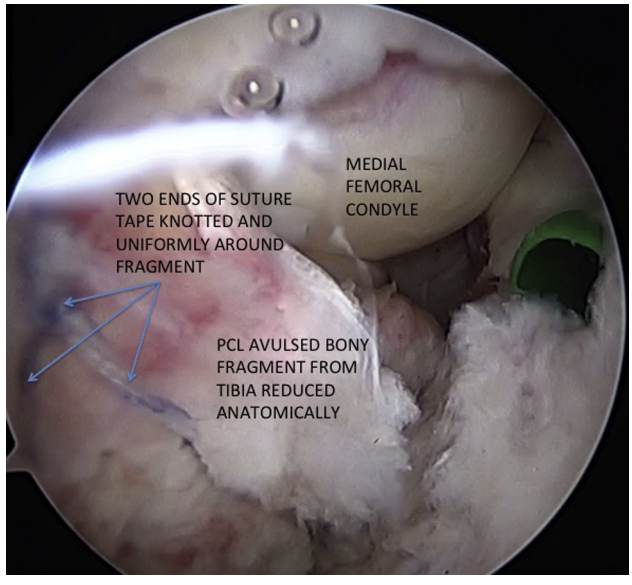

Fig 20. Arthroscopic image of reduced and fixed PCL avulsion fragment while viewing from the PL portal with left knee in 80° flexion and the patient supine. (PCL, posterior cruciate ligament; PL, posterolateral ligament.)

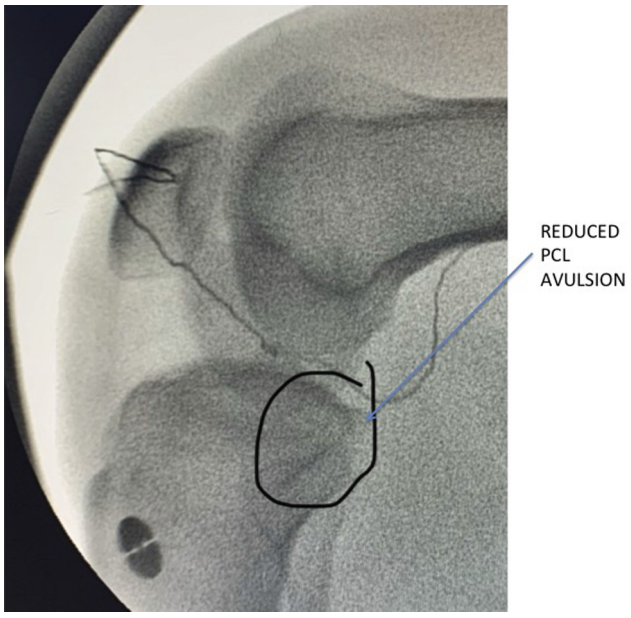

Fig 21. Left knee lateral-view radiograph of reduced PCL avulsion fragment. (PCL, posterior cruciate ligament.)

Using a transseptal approach allows us to work and see posteriorly without any instrument crowding that can potentially occur with using a high and low PM portal. Using suture tape that is traditionally stronger than FiberWire provides stronger fixation as well as has a lesser cheese-grating effect over the ligament as compared with the FiberWire alone. Taking bites through the PCL and tying knots posteriorly provides double security over just encircling the PCL with a suture and tying knots posteriorly over the PCL. Using a transseptal approach also helps us manipulate the 2 ends of the suture tape over the bony fragment so that they exert a uniform force over it while reducing and fixing it. Fixing the avulsion using a tightrope is a more expensive option and can only be used for large fragments where the tightrope can sit over it. Also, there is a chance of comminuting the fragment while drilling through it. Using the 2-tunnel suture bridge technique increases the risk of vascular damage, as the tibial tunnel is drilled twice, and there is also a chance of the tunnel communication with each other as the bone in the upper tibia is cancellous. The advantages and disadvantages as well as the pearls and pitfalls are described in Tables 1 and 2.

ACL, anterior cruciate ligament; PCL, posterior cruciate ligament.

Acknowledgments

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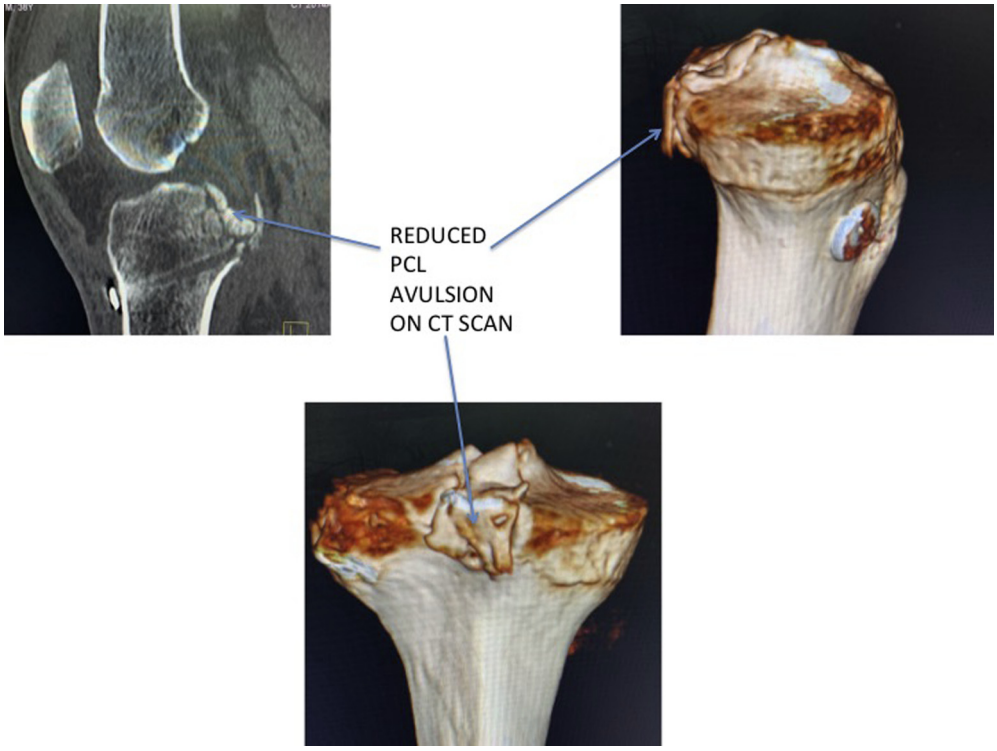

Fig 22. Left knee CT scan images of reduced PCL avulsion fragment, in sagittal and coronal sections. (CT, computed tomography; PCL, posterior cruciate ligament.)

Table 1. Advantages and Disadvantages

Advantages	Disadvantages
Arthroscopic procedure; hence, minimally invasive and more cosmetic	Technically demanding
Suture tape is stronger and has a less cheese-grating effect on the ligament as compared to standard FiberWire described in other techniques	Possibility of injuring the popliteal vessel for those not adept at working in the posterior compartment of the knee
Bite taken through the ligament and a knot tied around it for double security as compared with just tying knots around the ligament, as shown in other techniques	Tying the tape on a button on the anteromedially tibia can potentially have a "bungee effect"
Single tunnel less technically demanding than 2 tunnels	Requires a button anteriorly for fixation, which is an implant

Table 2. Pearls and Pitfalls

Pearls	Pitfalls
Using a transportal technique allows viewing and working concomitantly	Using a high anteromedial and low anteromedial to work in the back of the knee is possible but causes instrument overcrowding
Manipulating the 2 ends of the suture tape around the avulsed bony fragment posteriorly such that they sit all around is critical	If the 2 arms of the suture are not manipulated around the fragment, it could lead to a mal-reduction of the fragment
Clearing the space between the ACL and PCL is critical with the mouth of the shaver pointed upwards so that the PCL can be seen in total and suture bites taken through the whole thickness of the PCL	While clearing the space between the ACL and PCL, it is important to face the mouth of the shaver upwards and not toward the ACL or PCL, as it can cause damage to the fibers
While over drilling the Beath pin with a 4.5-mm drill bit, it is important to protect the tip of the Beath pin with a curette	Not using a pump for this procedure can lead to excess fluid accumulation in the posterior compartment and potential compartment syndrome
Using a pump allows uniform pressure in the joint, allowing the surgeon more time to operate	Not using a pump can impair vision and potentially cause increase in posterior compartment pressure with overzealous pumping

ACL, anterior cruciate ligament; PCL, posterior cruciate ligament.

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