Technical Note

Modification of Outside-In Technique In Preparing Femoral Tunnel During Anterior Cruciate Ligament Reconstruction—"PL-Portal Outside-In Technique"

Wai Pan Yau, M.B.B.S., F.R.C.S.Ed., F.R.C.S.Ed. (Ortho), F.H.K.C.O.S., F.H.K.A.M. (Orthopaedic Surgery)

Abstract: We propose modifying the outside-in technique by adopting a posterolateral (PL) portal as the working portal to introduce the anterior cruciate ligament reconstruction (ACLR) aiming guide while keeping the anteromedial portal as the viewing portal, the "PL-portal outside-in technique." This modification facilitates the preparation of an anatomical femoral tunnel, even when preserving a "big" ACL remnant or in small joint scenarios, such as pediatric ACLR. There is a minimal learning curve in adopting this technique because a standard 30° arthroscope is used, and the viewing portal is anterior.

The preparation of the femoral tunnel in anterior cruciate ligament reconstruction (ACLR) is done by 1 of the following 3 methods: transtibial technique (TT), anteromedial portal technique (AMP), and outside-in technique (OI).[1,2] The arthroscope and aiming guide are introduced into the joint through the anterior portals in all 3 techniques: TT, AMP, and OI. The working space within the joint may appear crowded in the scenarios of small joints (e.g., pediatric ACLR), or when there is a need to preserve a "big" ACL remnant (e.g., isolated anteromedial [AM] bundle ACLR or isolated posterolateral [PL] bundle ACLR).[3] The visibility is further limited in the AMP technique because of the need for hyperflexion of the knee during femoral tunnel preparation.[3,4] This leads to difficulty in assessing the correct intra-articular position of the femoral tunnel aperture.[3,5,6] Some surgeons have proposed modifying the viewing portal of the outside-in technique from the AM portal to posterior portals, including viewing through a PL portal with a 70° arthroscope[5] or viewing through a trans-septal portal with a 30° arthroscope.[6] However, these modifications are not popular, probably because of the learning curve involved in adopting posterior portals as the viewing portal.

We propose a modification to the preparation of the femoral tunnel of ACLR with the outside-in technique by introducing the aiming guide through the PL portal while observing the femoral footprint from the front through the AM portal. This modification addresses the problem of joint crowding when all instruments are introduced through anterior portals and avoids the learning curve involved in using posterior portals as the viewing portal, whether posterolateral or trans-septal.

Surgical Technique

This technical note describes the technique of remnant-preserving single-bundle ACLR using the "PL-portal outside-in" technique (Video 1). The same technique can be used in ACLR without remnant preservation and double-bundle ACLR. The surgical tips and pearls are summarized in Table 1.

The patient is placed on the operation table in a supine position. A pneumatic tourniquet may be used at the surgeon's preference. The ipsilateral hamstring autograft is harvested, and a routine diagnostic

From the Department of Orthopaedics and Traumatology, School of Clinical Medicine, Li Ka Shing Faculty of Medicine, The University of Hong Kong.

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received July 1, 2023; accepted August 26, 2023.

Address correspondence to Wai Pan Yau, Room 509, 5/F, Professorial Block, Queen Mary Hospital, No. 102, Pokfulam Road, Hong Kong, Hong Kong Speical Administrative Region, The People Republic of China. E-mail: peterwpy@hku.hk

2212-6287/23931

https://doi.org/10.1016/j.eats.2023.08.016

Table 1. Surgical Tips and Pearls

The knee should be flexed at 90°.
During the opening of the PL portal and preparation of the femoral tunnel, a 30° arthroscope is used, and the viewing portal is the anteromedial portal.
The PL portal should be placed behind the lateral femoral condyle.
If the remnant-preserving technique is adopted, the tip of the aiming guide should be placed at the center of the dissected ACL footprint.
The bullet of the ACLR jig is placed at the anterolateral cortex of the distal femur.
If the femoral tunnel is prepared in a retrograde manner, the corresponding retrograde ACLR aiming guide and reaming instruments need to be used. If the femoral tunnel is prepared in an antegrade manner from outside to inside, the conventional ACLR aiming guide and reaming instruments can be used.
If remnant preservation with repair of the ACL stump is planned, multiple relay sutures should be placed within the femoral tunnel to facilitate the passage of the ACLR graft and repair of the ACL remnant.

ACL, anterior cruciate ligament; ACLR, anterior cruciate ligament reconstruction; PL, posterolateral.

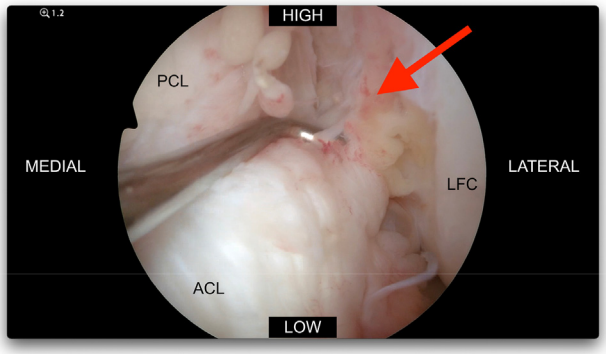

Fig 1. High-grade partial tear of anterior cruciate ligament at its femoral origin. The photo shows a high-grade partial tear of the anteromedial bundle of anterior cruciate ligament at its femoral origin, as indicated by the *red arrow*. Left knee; Patient position: supine; Knee position: 90° flexion. Viewing portal: anterolateral portal; Working portal: anteromedial portal; Arthroscope: 30°. ACL, anterior cruciate ligament; LFC, lateral femoral condyle; PCL, posterior cruciate ligament.

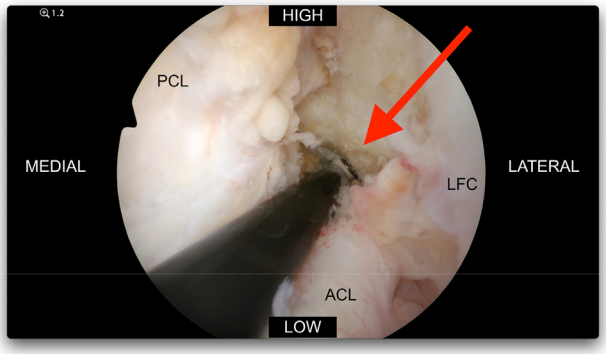

Fig 2. Preparation of femoral footprint. The intraoperative photo shows the left knee flexed at 90°, and the joint is inspected with a 30° arthroscope introduced through the anterolateral portal. The preparation of the "over-the-top" position is indicated by the *red arrow*. The femoral footprint of ACL at the site of the rupture is prepared. The "over-the-top" position is exposed by dissection of the ruptured portion with a radiofrequency probe. Care is taken to preserve as much ACL remnant and its femoral attachment as possible. Left knee; Patient position: supine; Knee position: 90° flexion. Viewing portal: anterolateral portal; Working portal: anteromedial portal; Arthroscope: 30°. ACL, anterior cruciate ligament; LFC, lateral femoral condyle; PCL, posterior cruciate ligament.

arthroscopy is performed. Any meniscus and cartilage lesions are managed accordingly

The ACL injury shown in the video is a high-grade partial ACL tear at its femoral origin (Fig 1). The plan is to perform a single-bundle ACLR with a 4-stranded hamstring autograft and concomitant repair of the ACL remnant to its femoral footprint using the "PL-portal outside-in technique."

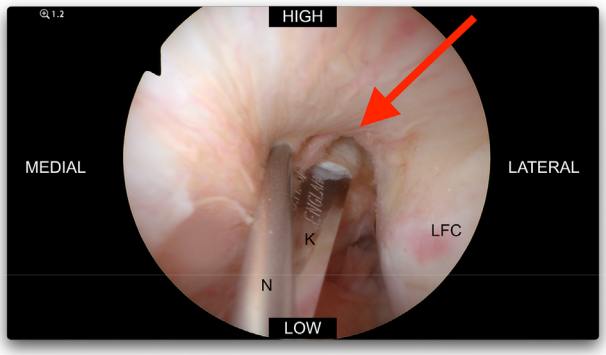

Fig 3. Opening of posterolateral portal. The intraoperative photo shows the posterolateral compartment of the left knee flexed at 90°. A 30° arthroscope is introduced from the front through the anteromedial portal and advanced into the posterolateral compartment through the dissected femoral footprint of the torn anterior cruciate ligament. The *red arrow* indicates the opening of the posterolateral portal with a number 11 knife, and a 16-gauge needle is used to mark the correct trajectory of the knife. With the knee positioned in 90° flexion, the 30° arthroscope is advanced into the posterolateral compartment through the dissected femoral footprint. A standard posterolateral portal is opened. The correct position of the portal is indicated by a 16-gauge needle inserted in an outside-to-inside direction. The external landmark of the needle is positioned anterior to the biceps femoris. The intra-articular landmark of the needle is located posterior to the lateral femoral condyle. A stab wound is made externally at the site of the needle, and the subcutaneous plane is dissected. The posterior-lateral portal is opened under arthroscopic monitoring using a number 11 knife blade. The direction of the knife should be parallel to that of the needle to minimize the chance of damaging the neurovascular bundle. Left knee; Patient position: supine; Knee position: 90° flexion. Viewing portal: anteromedial portal; Arthroscope: 30°. K, number 11 knife blade; LFC, lateral femoral condyle; N, 16-gauge needle.

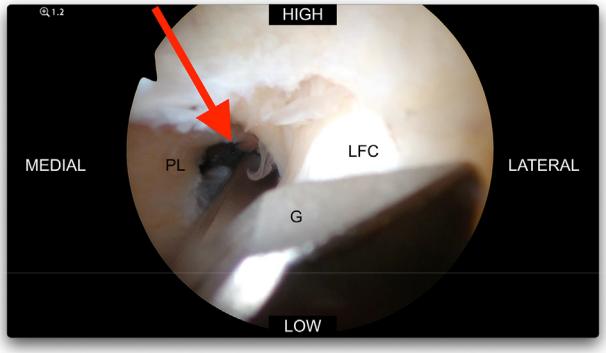

Fig 4. An aiming guide is introduced into the posterolateral compartment through the posterolateral portal. The intraoperative photo shows the posterolateral compartment of the left knee flexed at 90°, and the joint is being inspected with a 30° arthroscope inside the posterolateral compartment. The *red arrow* indicates the introduction of the tip of the aiming guide (G) into the posterolateral compartment through the posterolateral portal (PL) under arthroscopic monitoring. The tip of the aiming guide is advanced anteriorly until it reaches the center of the anterior cruciate ligament's footprint. Left knee; Patient position: supine; Knee position: 90° flexion. Viewing portal: anteromedial portal; Working portal: posterolateral portal; Arthroscope: 30°. G, aiming guide; LFC, lateral femoral condyle; PL, posterolateral portal.

With the knee positioned in 90° flexion, the femoral footprint of ACL at the site of the rupture is prepared. The "over-the-top" position is exposed. Care is taken to preserve as much ACL remnant and its femoral attachment as possible (Fig 2). After confirming that the "over-the-top" position is reached, the desired center of the femoral tunnel is marked with a chondral prick by a "freehand" technique. The viewing portal is then changed to the anteromedial portal, and the position of the future femoral tunnel is checked by measuring its distance from the "over-the-top position." The 30° arthroscope is then advanced into the posterolateral compartment through the dissected femoral footprint. A standard posterolateral portal is opened (Fig 3).

An aiming guide is introduced into the posterolateral compartment through the posterolateral portal under arthroscopic monitoring (Fig 4). The tip of the aiming guide is placed in the desired position of the center of

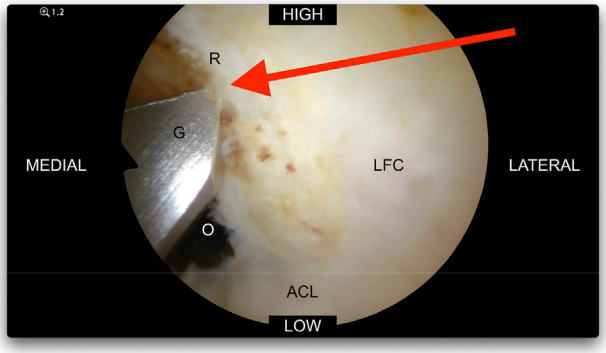

Fig 5. The aiming guide is put in the desired position of the femoral tunnel. The intraoperative photo shows the footprint of the ACL in the left knee flexed at 90°, and the joint is being inspected with a 30° arthroscope that was introduced through the anteromedial portal. The aiming guide is introduced into the knee joint from the back through the posterolateral portal. The tip of the aiming guide (G) is then placed in the desired position at the center of the femoral tunnel. Left knee; Patient position: supine; Knee position: 90° flexion. Viewing portal: anteromedial portal; Working portal: posterolateral portal; Arthroscope: 30°. ACL, remnant of the anterior cruciate ligament; G, aiming guide; LFC, lateral femoral condyle; O, "over-the-top"; R, resident ridge.

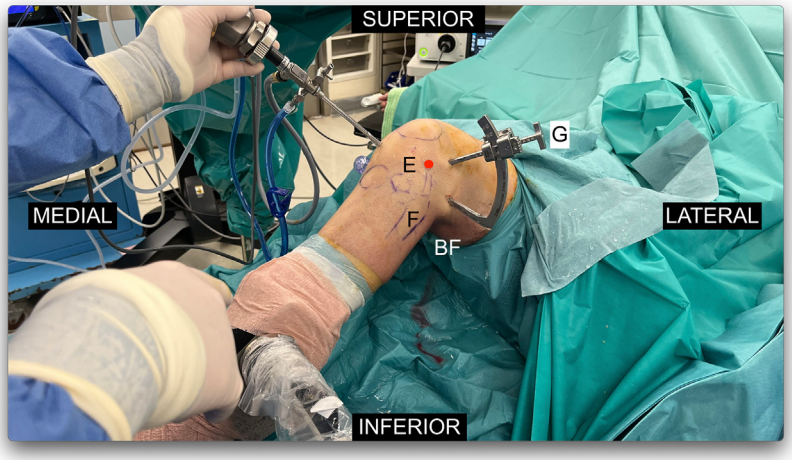

Fig 6. Clinical photo of positioning of ACL aiming guide in "posterolateral-portal outside-in technique." This is a clinical photo showing a left knee in 90° of flexion. The tip of the anterior cruciate ligament (ACL) aiming guide (G) is introduced into the posterolateral compartment of the knee through the posterolateral portal. The posterolateral portal should be positioned anterior to the biceps femoris (BF). Then a stab wound is made in the anterolateral aspect of the distal thigh at a distance from the lateral femoral epicondyle (E) to minimize the risk of lateral collateral ligament injury. The knee joint is inspected using a 30° arthroscope introduced through the anteromedial portal. The tip of the ACL aiming guide is placed at the center of the ACL's footprint. The ACL aiming guide is secured in the correct position by resting the bullet's tip on the anterolateral cortex of distal femur through the stab wound. Left knee; Patient position: supine; Knee position: 90° flexion. BF, biceps femoris; E, lateral femoral epicondyle; F, fibular head; G, aiming guide.

the femoral tunnel (Fig 5). A stab wound is then made in the anterolateral aspect of distal thigh. The ACL aiming guide is secured into the correct position by resting the tip of the bullet on the anterolateral cortex of distal femur through the stab wound (Fig 6).

A guide pin is inserted in an outside-in manner (Fig 7). The femoral tunnel is drilled. Depending on the preference of the surgeon, the tunnel can be prepared either by antegrade drilling or retrograde drilling. In this technical note, the tunnel is prepared by retrograde drilling with an Arthrex FlipCutter III (Arthrex, Naples, FL). After preparation of the femoral tunnel, the integrity of posterior cortex and outer cortex of the femoral tunnel are checked (Fig 8).

Three sutures are put in the femoral tunnel to facilitate subsequent passage of ACLR graft and repair of ACL remnant (Fig 9). Preparation of the tibial tunnel is then performed (Fig 10).

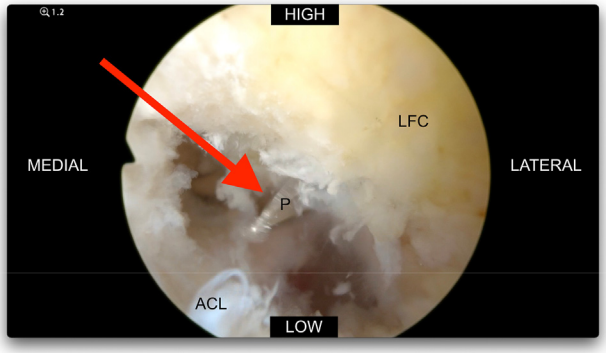

Fig 7. The guide pin is inserted in an outside-in manner. This is an intraoperative photo showing the ACL femoral footprint of a left knee at 90° flexion. The *red arrow* showed the insertion of the guide pin at the center of the ACL's footprint in an outside-in direction. With the knee flexed at 90°, the knee joint is inspected using a 30° arthroscope through the anteromedial portal. The femoral tunnel for anterior cruciate ligament reconstruction is prepared using the outside-in method, where a guide pin is inserted through the aiming guide from outside to inside. Left knee; Patient position: supine; Knee position: 90° flexion. Viewing portal: anteromedial portal; Arthroscope: 30°; Knee position: 90° flexion. ACL, remnant of the anterior cruciate ligament; LFC: lateral femoral condyle; P, guide pin.

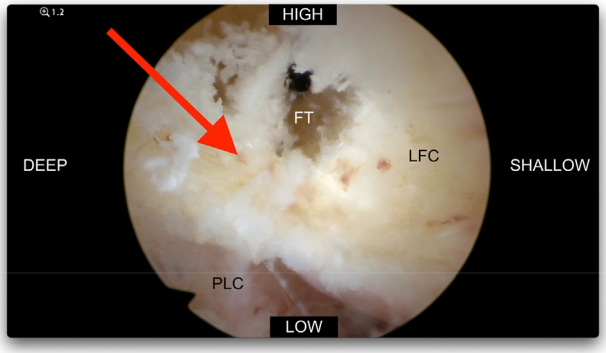

Fig 8. The femoral tunnel is prepared by retrograde drilling. This is an intraoperative photo showing the anterior cruciate ligament femoral tunnel. The knee is flexed at 90° and the intercondylar region of the lateral femoral condyle is inspected with a 30° arthroscope. The red arrow showed that the posterior cortex of the femoral tunnel is intact. With the knee flexed at 90°, the femoral tunnel is prepared using the outside-in retrograde drilling method with the Arthrex FlipCutter III (Arthrex, Naples, FL). After the femoral tunnel is prepared, the integrity of the posterior cortex and outer cortex of the femoral tunnel is checked. Left knee; Patient position: supine; Knee position: 90° flexion. Viewing portal: anteromedial portal; Arthroscope: 30°. FT; femoral tunnel; LFC, lateral femoral condyle; PLC, posterolateral compartment.

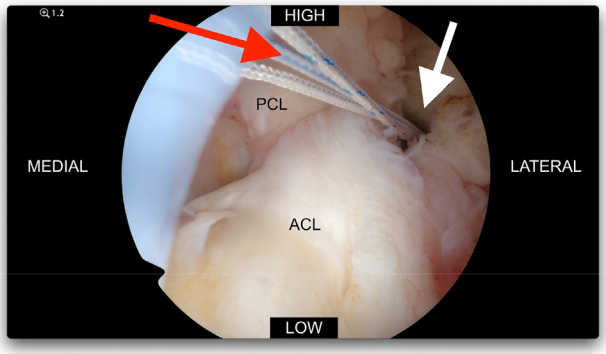

Fig 9. Multiple sutures are put into the femoral tunnel to facilitate subsequent suture relay. This is an intraoperative photo displaying the relationship between the relay sutures (as indicated by the *red arrow*), the femoral tunnel (as indicated by the *white arrow*) and the remnant of the ACL. The knee is flexed at 90° and the joint is inspected with a 30° arthroscope introduced through the anterolateral portal. After drilling the femoral tunnel for ACL reconstruction, three sutures are placed in the femoral tunnel to serve as relay sutures that will facilitate the subsequent passage of the ACL reconstruction graft and the repair of the ACL remnant. Left knee; Patient position: supine; Knee position: 90° flexion. Viewing portal: anterolateral portal; Working portal: anteromedial portal; Arthroscope: 30°. ACL, remnant of the anterior cruciate ligament; PCL, posterior cruciate ligament.

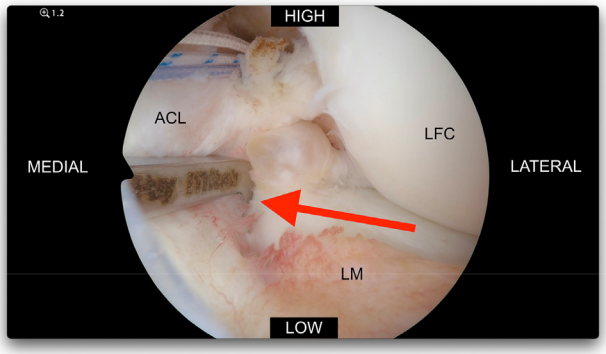

Fig 10. Tibial tunnel preparation. This is an intraoperative photo showing the preparation of the ACL tibial tunnel. The knee is flexed at 90° and tibial footprint of ACL is inspected with a 30° arthroscope. The *red arrow* indicates the position of the tip of the aiming guide. The preparation of the tibial tunnel is performed using an ACL aiming guide, and the knee is flexed at 90°. The aiming guide is introduced into the joint through the anteromedial portal, and the knee joint is inspected with a 30° arthroscope through the anterolateral portal. In cases where a sizeable ACL remnant is being preserved, the targeted center of the tibial tunnel is slightly more posterior than the usual ACL's tibial footprint to facilitate the passage of the graft behind the ACL remnant. Left knee; Patient position: supine; Knee position: 90° flexion. Viewing portal: anterolateral portal; Working portal: anteromedial portal; Arthroscope: 30°. ACL, remnant of the anterior cruciate ligament; LFC, lateral femoral condyle; LM, anterior horn of lateral meniscus.

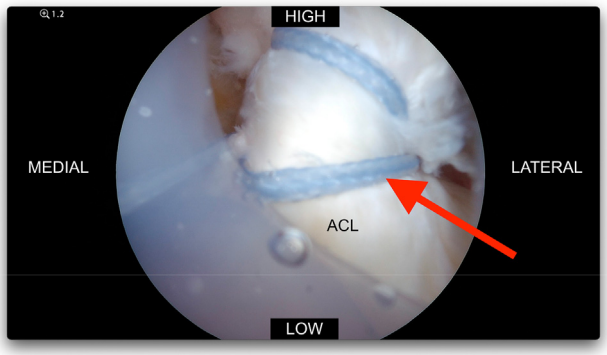

Fig 11. Tension stitch is put into the ACL remnant to facilitate subsequent ACL repair. The intraoperative photo shows the tension stitch in the ACL remnant in a left knee flexed at 90°. The joint is inspected with a 30° arthroscope introduced through the anterolateral portal. To facilitate subsequent repair of the torn ACL remnant back to its femoral footprint, a tension stitch is placed into the remnant. The torn ACL remnant is secured by a number 2 Fibrewire (Arthrex, Naples, FL) in the pattern of a Bunnell suture, as indicated by the red arrow. Left knee; Patient position: supine; Knee position: 90° flexion. Viewing portal: anterolateral portal; Working portal: anteromedial portal; Arthroscope: 30°. ACL, remnant of the anterior cruciate ligament.

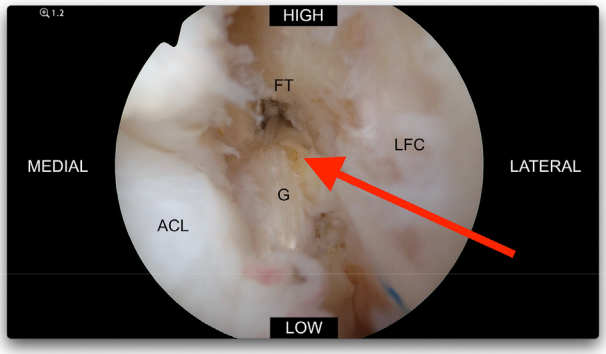

Fig 12. ACLR graft passage. The intra-operative photo shows the left knee flexed at 90°, and the joint is inspected with a 30° arthroscope introduced through the anterolateral portal. ACL reconstruction graft is passed into the FT in an inside-out direction, as indicated by the *red arrow*. The femoral fixation of the ACL reconstruction graft is performed by an adjustable button. The ACL reconstruction graft is passed into the FT, behind the ACL remnant, by shortening the adjustable loop of the button. Depending on the length of the ACLR graft, the tibial fixation can be done by either an adjustable button or an interference screw. Left knee; Patient position: supine; Knee position: 90° flexion. Viewing portal: anterolateral portal; Working portal: anteromedial portal; Arthroscope: 30°. ACL, remnant of the anterior cruciate ligament; FT, femoral tunnel; G, anterior cruciate ligament reconstruction graft; LFC, lateral femoral condyle.

A tension stitch is put into the ACL remnant to facilitate subsequent ACL repair (Fig 11). For the femoral tunnel prepared by retrograde reaming, the ACLR graft is passed into the femoral tunnel in an inside-out direction (Fig 12). Femoral fixation of the ACLR graft is done by an adjustable button. Tibial fixation is performed according to the preference of the surgeons. The ACL remnant is then repaired to its femoral footprint by tying the tension stitch on the ACL

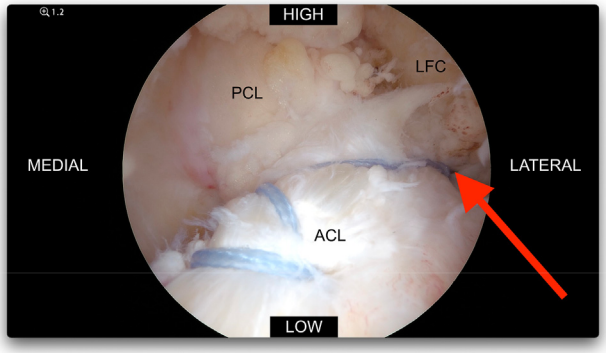

Fig 13. Repair of the ACL remnant to the femoral footprint by tying the tension stitch on the stump to the button on the anterolateral femoral cortex. The intraoperative photo shows the left knee flexed at 90°, and the joint is inspected with a 30° arthroscope introduced through the anterolateral portal. The ACL remnant is repaired to its femoral footprint, as indicated by the *red arrow*. With the help of the second suture relay placed within the femoral tunnel, the tension stitch on the ACL remnant is shuttled to the button docked at the anterolateral cortex of distal femur. The ACL remnant is then repaired to its femoral footprint by tying the tension stitch on the ACL remnant to the button on the anterolateral femoral cortex. Left knee; Patient position: supine; Knee position: 90° flexion. Viewing portal: anterolateral portal; Working portal: anteromedial portal; Arthroscope: 30°. ACL, remnant of the anterior cruciate ligament; LFC, lateral femoral condyle; PCL, posterior cruciate ligament.

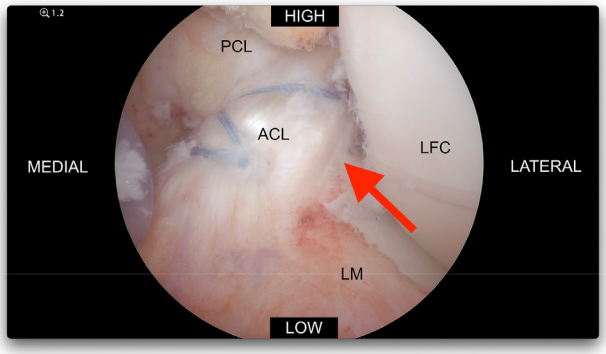

Fig 14. Result of concomitant ACLR and repair of ACL remnant. The intraoperative photo displays the outcome of the concomitant ACL reconstruction and repair of the ACL remnant using the PL-portal outside-in method. It shows the left knee flexed at 90°, and the joint is inspected with a 30° arthroscope introduced through the anterolateral portal. The ACL remnant has already been repaired to its femoral footprint, and the ACLR graft is positioned behind the repaired remnant, as indicated by the *red arrow*. Left knee; Patient position: supine; Knee position: 90° flexion; Viewing portal: anterolateral portal; Arthroscope: 30°. ACL, remnant of the anterior cruciate ligament; LFC, lateral femoral condyle; LM, anterior horn of lateral meniscus; PCL, posterior cruciate ligament.

remnant to the button on the anterolateral femoral cortex (Figs 13 and 14). The postoperative X-ray films are shown in Figures 15 and 16.

Discussion

There are differences among the 3 ACLR femoral tunnel preparation techniques (TT, AMP, OI) in terms of the length and obliquity of the femoral tunnel,[2,7-10] the rate of complication, and possibly the clinical outcomes after ACLR[2,9,11] (Table 2). In spite of these, the choice of femoral tunnel preparation technique is usually a preference of the surgeon.[12]

A recent network meta-analysis suggested that the AMP technique was superior to the TT technique in terms of functional recovery and knee stability.[2,11] This is likely related to the ability of placing the femoral tunnel in its anatomical position when the AMP technique is used.[2,12] However, the use of the AMP technique is associated with the disadvantages of posterior-wall blowout, short or bicortical sockets, difficulty in passing the reamer, and iatrogenic damage to the cartilage of the medial femoral condyle. These are likely secondary to the limited working space and difficulty in visibility when the knee is put in hyperflexion during the AMP technique.[4,9] Similar to the

Fig 15. Postoperative X-ray film (anteroposterior view) of a left knee that displays a single-bundle anterior cruciate ligament reconstruction performed using the posterolateral portal outside-in method. The femoral fixation is accomplished by an adjustable titanium button, and the tibial fixation is done using a bioabsorbable interference screw. Left knee; Patient position: supine; Knee position: 0° extension.

Fig 16. Postoperative X-ray film (lateral view) of a left knee that displays a single-bundle anterior cruciate ligament reconstruction performed using the PL-portal outside-in method. The femoral fixation is accomplished by an adjustable titanium button, and the tibial fixation is done using a bioabsorbable interference screw. Left knee; Patient position: supine; Knee position: 0° extension.

AMP technique, the OI technique allows unconstrained preparation of the anatomical femoral tunnel. However, because the knee is put in 90° flexion during preparation of the tunnel in the OI technique, it does not suffer from the disadvantages associated with the AMP technique. Besides, the OI technique allows posterior placement of the graft with avoidance of posterior wall blowout.[4,10]

Despite this, correct assessment of femoral footprints can still be difficult in remnant-preserving ACLR with the outside-in technique.[3,5,6] Hence, some surgeons have proposed modifications to the viewing portal of the outside-in technique, from the anteromedial portal to the posterior portals, including viewing through a PL portal with a 70° arthroscope,[5] or viewing through a trans-septal portal with a 30° arthroscope.[6] However, most surgeons do not welcome these modifications. This is because many orthopaedic surgeons are not trained to observe the ACL footprint posteriorly through the PL portal with a 70° arthroscope or create a trans-septal portal, which is close to the neurovascular bundle. Besides, these posterior portal viewing modifications carry a theoretical risk of iatrogenic injury to the femoral condyle articular cartilage because the aiming guide is introduced into the joint through the anterior portal and advanced into the posterior compartment without monitoring by the arthroscope (because the scope is in the posterior compartment).

We propose a modification of outside-in technique by using the posterolateral portal as working portal for the

Table 2. Comparison of the Transtibial, Anteromedial Portal and Outside-in Techniques for Femoral Tunnel preparation in Anterior Cruciate Ligament Reconstruction

	Transtibial Technique	Anteromedial Portal Technique	Outside-In Technique
Relationship between femoral tunnel and tibial tunnel	Tibial tunnel Dependent	Tibial tunnel Independent	Tibial tunnel Independent
Viewing portal	Anterolateral portal	Anterolateral portal	Anteromedial portal
Working portal (for the ACLR aiming guide)	Through Tibial tunnel	Anteromedial portal	Anterolateral portal
Angle of knee flexion during femoral tunnel preparation	90°	Hyperflexion	90°
Characteristic of femoral tunnel			
Femoral tunnel length	+++	++	++
Obliquity of tunnel	+	++	+++
Complication rate			
Iatrogenic injury to cartilage of femoral condyle	-ve	+	+
"Blow-out" of posterior cortex of femoral tunnel	+	++	+
"Blow-out" of outer cortex of femoral tunnel	+	++	+

ACLR, Anterior cruciate ligament reconstruction; -ve, minimal; +, small or short; ++, medium; +++, large or long.

Table 3. Pitfalls and Risks

To avoid possible common peroneal nerve injury, standard precaution in opening posterolateral portal should be observed (e.g., the portal should be opened anterior to the tendon of biceps femoris).
To avoid iatrogenic injury to the lateral collateral ligament, the bullet of the anterior cruciate ligament (ACL) reconstruction aiming guide should be placed at the anterolateral cortex of distal femur, not the lateral cortex of lateral femoral condyle. This also helps reduce the obliquity of the femoral tunnel in the coronal plane.
To avoid possible damage to the ACL remnant during retrograde reaming, antegrade reaming can be adopted with protection of the ACL remnant by instrument (e.g., an arthroscopic curette).

aiming guide, while keeping the anteromedial portal as the viewing portal—the "PL-portal outside-in technique." It has all the advantages of the conventional outside-in technique. It also reduces the "crowdedness" and improves visibility of the femoral footprint when compared with the conventional technique that requires both the arthroscope and instruments to be introduced into the joint from the anterior portals. Because the aiming guide is now introduced into the joint through the PL portal under arthroscopic monitoring, it does not suffer from the problem of possible iatrogenic injury to the articular cartilage of the lateral femoral condyle. Because the viewing portal is the usual anterior portal, there is no learning curve in adopting this modification as in the case of using a PL portal or trans-septal portal as the viewing portal as described by Ahn et al.[5] and Lee et al.,[6] respectively.

However, the proposed "PL-portal outside-in technique" is not free of potential complications. There is a risk of injury to the common peroneal nerve during the opening of the posterolateral portal.[13] The bullet of the aiming guide needs to be placed at the anterolateral cortex of the distal femur, instead of the lateral cortex of the lateral femoral condyle, to avoid injury to the lateral collateral ligament. If retrograde reaming of femoral tunnel is adopted, there is a possibility of injury to the ACL remnant. Changing the reaming technique to antegrade reaming with the concomitant use of an instrument to protect the ACL remnant helps minimize this complication (Table 3). In conclusion, the proposed modification of the conventional outside-in technique by adopting the PL portal as the working portal for the aiming guide is an easy, safe, and reproducible technique in preparing femoral tunnel in ACLR.

References

1. Irarrazaval S, Kurosaka M, Cohen M, Fu FH. Anterior cruciate ligament reconstruction. *JISAKOS* 2016;1:38-52.
2. Cuzzolin M, Previtali D, Delcogliano M, Filardo G, Candrian C, Grassi A. Independent versus transtibial drilling in anterior cruciate ligament reconstruction. A meta-analysis with meta-regression. *Orthop J Sports Med* 2021;9:23259671211015616.
3. Joshi A, Basukala B, Singh N, Bista R, Pradhan I. Remnant tensioning through pullout sutures from the femoral tunnel during anatomic anterior cruciate ligament reconstruction. *Arthrosc Tech* 2021;10:e2515-e2522.
4. Robin BN, Jani SS, Marvil SC, Reid JB, Schillhammer CK, Lubowitz JH. Advantages and disadvantages of transtibial, anteromedial portal, and outside-in femoral tunnel drilling in single-bundle anterior cruciate ligament reconstruction: a systematic review. *Arthroscopy* 2015;31:1412-1417.
5. Ahn JH, Lee YS, Lee SH. Creation of an anatomic femoral tunnel with minimal damage to the remnant bundle in remnant-preserving anterior cruciate ligament reconstruction using an outside-in technique. *Arthrosc Tech* 2014;3:e175-e179.
6. Lee SH, Lee ES, Ko TW, Lee YS. Femoral tunnel placement in single-bundle, remnant-preserving anterior cruciate ligament reconstruction using a posterior transseptal portal. *Knee* 2019;26:628-635.
7. Lee DH, Kim HJ, Ahn HS, Bin SI. Comparison of femoral tunnel length and obliquity between transtibial, anteromedial portal, and outside-in surgical techniques in single-bundle anterior cruciate ligament reconstruction: a meta-analysis. *Arthroscopy* 2016;32:142-150.
8. Lee DH, Kim HJ, Ahn HS, Bin SI. Comparison of femoral tunnel aperture location in patients undergoing transtibial and anatomical single-bundle anterior cruciate ligament

reconstruction. *Knee Surg Sports Traumatol Arthrosc* 2016;24:3713-3721.
9. Loucas M, Loucas R, D'Ambrosi R, Hantes ME. Clinical and Radiological outcomes of anteromedial portal versus transtibial technique in ACL reconstruction. A systematic review. *Orthop J Sports Med* 2021;9: 23259671211024591.
10. Lee DK, Kim JH, Lee BH, et al. Influence of graft bending angle on femora tunnel widening after double-bundle ACL reconstruction. Comparison of transportal and outside-in techniques. *Orthop J Sports Med* 2021;9: 23259671211035780.
11. Feng H, Wang N, Xie D, et al. Anteromedial portal technique, but not outside-in technique, is superior to standard transtibial technique in knee stability and functional recovery after anterior cruciate ligament reconstruction: A network meta-analysis. *Arthroscopy* 2023;39: 1515-1525.
12. Haroun HK, Abouelsoud MM, Allam MR, Abdelwahab MM. Transtibial versus independent femoral tunnel drillings for anterior cruciate ligament reconstruction: Evaluation of femoral aperture positioning. *J Orthop Surg Res* 2022;17:166.
13. Greenwood K, Van Zyl R, Keough N, Hohmann E. The determination of safe zones for arthroscopic portal placement into the posterior knee by mapping the courses of neurovascular structures in relation to bony landmarks. *Eur J Orthop Surg Traumatol* 2021;31:1087-1085.