

Simultaneous Anterior Cruciate Ligament, Posterior Cruciate Ligament, Posteromedial Corner, and Posterolateral Corner Reconstruction of the Knee



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Abstract: Concomitant injuries of the 4 groups of ligaments of the knee are a serious condition and challenge the orthopaedic surgeon when reconstruction of all ligaments is needed. Staged reconstruction can be chosen owing to the complexity of the combined procedures; however, simultaneous reconstruction is favored to facilitate recovery. We describe a simultaneous anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), posteromedial corner (PMC), and posterolateral corner (PLC) reconstruction technique, in which autografts are used and both cruciate ligaments are reconstructed in a single-bundle manner. We believe the introduction of this technique will familiarize surgeons with the principle of simultaneous 4-ligament reconstruction of the knee and the method of cruciate ligament balancing during bicruciate ligament reconstruction.

Concomitant injury of the 4 groups of ligaments of the knee is relatively rare but poses challenges to orthopaedic surgeons when all 4 groups of ligaments require reconstruction. Under this condition, staged reconstruction is a reasonable choice. However, simultaneous reconstruction may be better for ligament balancing, as well as for earlier rehabilitation and recovery.¹ We introduce a simultaneous anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), posteromedial corner (PMC), and posterolateral corner (PLC) reconstruction technique, presenting the basic principle and sequences of bone tunnel creation, graft emplacement, and final distal fixation (Table 1). Theoretically, simultaneous 4-ligament

reconstruction of the knee can be performed in the most complicated combination involving double-bundle ACL and PCL reconstruction.^{2,3} However, in our current clinical practice, the most frequently performed simultaneous 4-ligament reconstruction procedure involves single-bundle ACL and PCL reconstruction, as well as single-bundle PMC and

Table 1. Overall sequence of simultaneous anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), posteromedial corner (PMC), and posterolateral corner (PLC) reconstruction of the knee

Establishment of bone tunnels
1. Creating femoral and tibial tunnels for PCL reconstruction (arthroscopy)
2. Creating tibial and femoral tunnels for ACL reconstruction (arthroscopy)
3. Creating femoral and tibial tunnels for PMC augmentation (mini-open operation)
4. Creating fibular, tibial, and femoral tunnels for PLC reconstruction (mini-open operation)
Graft placement and proximal fixation
1. PCL graft implantation (arthroscopy)
2. ACL graft implantation (arthroscopy)
3. PMC graft implantation (mini-open operation)
4. PLC graft implantation (min-open operation)
Distal fixation
1. Fixing PMC at 30° knee flexion and neutral internal-external rotation position
2. Fixing PLC at 10° knee flexion and neutral internal-external rotation position
3. Fixing PCL at full extension of the knee
4. Fixing ACL at full extension of the knee

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Table 2. Step-by-step procedure of simultaneous anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), posteromedial corner (PMC), and posterolateral corner (PLC) reconstruction of the knee

1. The anterior half of the peroneus longus tendons (AHPLT) and the hamstring tendons are harvested from the contralateral leg.
2. The AHPLT and the hamstring tendons are harvested from the injured leg.
3. The tendons are braided, and 4 corresponding grafts are fabricated.
4. Anteromedial, anterolateral, posteromedial, and posterolateral portals are created.
5. The PCL tibial insertion is exposed. A Kirschner wire for PCL tibial tunnel creation is first placed.
6. PCL femoral tunnel is created through the anterolateral portal in an inside-out manner.
7. PCL tibial tunnel is created.
8. Location of the ACL femoral tunnel is marked.
9. ACL tibial tunnel is created.
10. ACL femoral tunnel is created.
11. PMC femoral is located and created.
12. Soft tissue passage for the PMC is created through the medial scar tissue.
13. PMC tibial tunnel is created.
14. An incision is made at the posterolateral side of the knee. The posterior side of the proximal tibiofibular joint is reached.
15. PLC fibular tunnel is created.
16. PLC tibial tunnel is created.
17. PLC femoral tunnel is created.
18. A guide suture is placed into the joint through the tibial tunnel, pulled to the anterior compartment of the knee, and passed through the femoral tunnel.
19. A switching stick is placed at the anterior inferior side of the guide suture at the inner orifice of the tibial tunnel.
20. PCL graft is placed into the joint through the tibial tunnel and then pulled into the femoral tunnel.
21. Proximal fixing sutures from the PCL graft are tied to a cortical fixation button.
22. ACL graft is placed into the femoral tunnel through the tibial tunnel.
23. Proximal fixing sutures from the PCL graft are tied to a cortical fixation button.
24. Proximal end of the PMC graft is placed into the PMC femoral tunnel through the medial incision.
25. Proximal fixing sutures from the PMC graft are tied to a cortical fixation button.
26. Distal end of the PMC graft is passed through the created soft tissue passage to the posteromedial tibial ridge and pulled into the PMC tibial tunnel.
27. Distal fixing sutures from the PMC graft are pulled out through an incision over the lateral orifice of the PMC tibial tunnel.
28. PLC graft is passed through the fibular tunnel.
29. Both ends of the graft are passed through the underside of the iliotibial band out of the iliotibial band incision.
30. Proximal fixing sutures for the PLC reconstruction are folded and passed through the PLC femoral tunnel.
31. One end of the graft is tied to the fixing suture loops, and the free limb of the graft is passed through fixing suture loops to hang on them.
32. The 3-stranded graft complex is pulled into the PLC femoral tunnel.
33. The free graft limb is passed through the underside of the iliotibial band to the posterior side of the proximal tibiofibular joint, and then pulled into the PLC tibial tunnel.
34. A trans-tibial ridge tunnel is created at a site distal to all the orifices of the created tibial tunnels. A set of cortical suspensory fixation devices with an adjustable loop is passed through this tunnel.
35. Distal fixing sutures from the PMC and PLC graft are passed subcutaneously to the medial side of the tibial.
36. Half of the sutures from the distal end of each graft are passed through the adjustable loop.
37. Cortical fixation button is passed through the trans-tibial ridge tunnel and flipped over the lateral orifice.
38. Distal fixing sutures from the PMC graft are tied at the adjustable loop at 30° knee flexion.
39. Distal fixing sutures from the PLC graft are tied at the adjustable loop at 10° knee flexion.
40. The knee is fully extended. An interference screw is placed first into the PCL tibial tunnel.
41. Distal fixing sutures from the PCL graft are tied at the adjustable loop.
42. Another interference screw is placed into the ACL tibial tunnel.
43. Distal fixing sutures from the ACL graft are tied at the adjustable loop.

single-femoral tunnel PLC reconstruction. The indication for this technique is the combination of the indications of each isolated ligament reconstruction in multiligament injuries.

Surgical Technique

The patient is placed in a supine position. Tourniquets are placed at the proximal thighs. One lateral post is placed at each thigh for the leg to lean on in knee flexion.

Graft Harvesting and Preparation

The anterior half of the peroneus longus tendons (AHPLT)⁴ and the hamstring tendons are first harvested from both legs (Table 2; Video 1). The tendons are braided, and 4 corresponding grafts are fabricated, with the 2 AHPLTs to make a 6-stranded graft to reconstruct the PCL, 1 semitendinosus tendon to make a 4-stranded graft to reconstruct the ACL, another semitendinosus tendon to reconstruct the lateral collateral ligament (LCL), and 2 gracilis tendons to make a 4-stranded graft to reconstruct the PMC.

Table 3. Tunnel location in simultaneous anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), posteromedial corner (PMC), and posterolateral corner (PLC) reconstruction of the knee

Tunnel	Location
PCL tibial tunnel	Lateral to the midline of the PCL tibial footprint, 7 mm anterior to the posterior capsule insertion
PCL femoral tunnel	12 mm to the most anterior edge of the PCL femoral footprint, 8 mm from the distal cartilage edge along the femoral axis
ACL tibial tunnel	At the intersection of the anterior-posterior midline of the lateral slope of the medial tibial eminence and a midline, and a horizontal midline between the lateral tibial eminence and the anterior edge of the lateral meniscus
ACL femoral tunnel	In the middle of the over-the-top point and the posterior ligament bundle point (5 mm anterior to the lowest point of the lateral wall of the femoral notch)
PMC femoral tunnel	In the middle of the area formed by the adductor tubercle, the tip of the medial femoral epicondyle, and the gastrocnemius tubercle
PMC tibial tunnel	At the narrow point along the posteromedial tibial ridge
PLC fibular tunnel	Anterolateral fibular styloid
PLC tibial tunnel	Popliteal notch at the posterolateral proximal tibia
PLC femoral tunnel	5 mm posterior and 5 mm distal to the tip of the lateral femoral epicondyle

Creating Bone Tunnels

The location of each set of tunnels is the same as that in isolated ligament reconstruction (Table 3). Anteromedial (AM) and anterolateral (AL) portals are created. Combined meniscus lesions are treated. Femoral notch plasty is performed as indicated. Posteromedial (PM) and posterolateral (PL) portals are created as in isolated PCL reconstruction.⁵

With the arthroscope and instruments placed through the PM and PL portals, respectively, part of the posterior septum is removed to expose the PCL tibial insertion. Part of the PCL remnant is removed. A Kirschner wire (K-wire) for PCL tibial tunnel creation is first placed (Fig 1A). With the arthroscope placed in through the AM portal, the PCL femoral tunnel is created through the AL portal in an inside-out manner (Fig 2). With the arthroscope placed in through the PM portal again, the PCL tibial tunnel is created (Fig 1B).

The arthroscope is placed and through the AM portal, the location of the ACL femoral tunnel is marked with a radiofrequency probe (Fig 3). With the arthroscope placed through the AL portal, the ACL tibial tunnel is first created (Fig 4). Then the ACL femoral tunnel is created in a trans-tibial manner (Fig 5).⁶

An incision is made over the medial femoral epicondyle. The PMC femoral is located and created in a

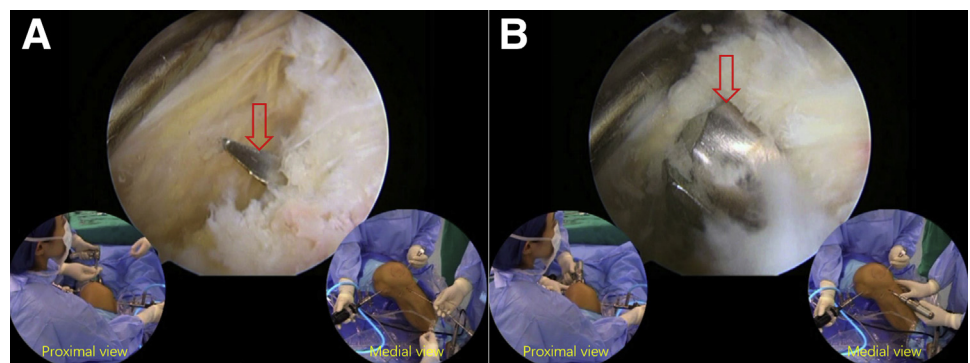
lateral direction with slight proximal deviation to avoid the lateral femoral condyle (Fig 6A, B). A soft tissue passage is created through the medial scar tissue as close to the bone as possible to the narrow point of the PM tibial ridge. The PMC tibial tunnel is created in an AL direction with slight distal deviation (Fig 6B, C).

A longitudinal incision is made at the PL side of the knee. The posterior side of the proximal tibiofibular joint is reached through the moving skin window and cleared of tissue adhesion. The PLC fibular tunnel is first created from the AL fibular styloid angulating the sagittal plane at 45° to 60° (Fig 7). The PLC tibial tunnel is created from the distal medial edge of the Gerdy tubercle along the sagittal plane, perpendicular to the tibial axis (Fig 8). An iliotibial band (ITB) incision is made over the site 5 mm posterior to the tip of the lateral femoral epicondyle. The PLC femoral tunnel is located 5 mm posterior and distal to the tip of the lateral femoral epicondyle, created in a medial direction with slight proximal deviation to avoid the medial femoral condyle (Fig 9).

Graft Placement and Proximal Fixation

A guide suture is placed into the joint through the tibial tunnel and passed through the femoral tunnel (Fig 10). With the arthroscope placed through the PM

Fig 1. Creation of the tibial tunnel for reconstruction of the posterior cruciate ligament (arthroscopic view of the posterior compartments of the left knee through the posteromedial portal). (A) Kirschner wire is first placed (arrow). (B) Tibial tunnel is created with corresponding drill (arrow).



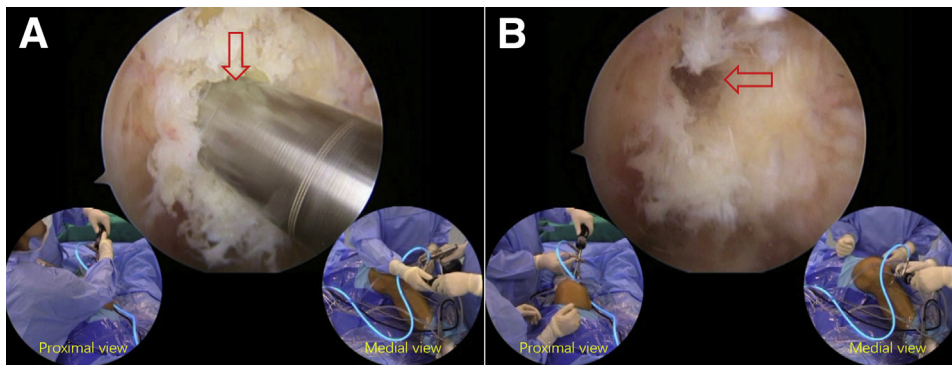


Fig 2. Creation of the femoral tunnel for reconstruction of the posterior cruciate ligament (arthroscopic view of the left knee through the anteromedial portal). (A) Femoral tunnel is created with inside-out technique (arrow). (B) Location of the created femoral tunnel (arrow).

portal, a switching stick or hemostat is placed at the anterior inferior side of the guide suture at the inner orifice of the tibial tunnel. The PCL graft is placed into the joint through the tibial tunnel with the switching stick used as a pulley or lever (Fig 11), and then pulled into the femoral tunnel (Fig 12A). The proximal fixing sutures from the PCL graft are tied to a cortical fixation button over the outer orifice of the PCL femoral tunnel (Smith & Nephew, Andover, MA).

The ACL graft is placed into the femoral tunnel through the tibial tunnel (Fig 12B). The proximal fixing sutures from the PCL graft are tied to a cortical fixation button over the outer orifice of the ACL femoral tunnel.

The proximal end of the PMC graft is placed into the PMC femoral tunnel. The proximal fixing sutures from the PMC graft are tied to a cortical fixation button over the lateral orifice of the PMC femoral tunnel. The distal end of the PMC graft is passed subcutaneously to the PM tibial ridge and pulled into the PMC tibial tunnel. The distal fixing sutures from the PMC graft are pulled

out through an incision over the lateral orifice of the PMC tibial tunnel.

The PLC graft is passed through the fibular tunnel. Both ends of the graft are passed through the underside of the ITB out of the ITB incision. The proximal fixing sutures for the PLC reconstruction are folded and passed through the PLC femoral tunnel from lateral to medial side through the ITB incision (Fig 13A). One end of the graft is tied to the fixing suture loops (Fig 13B), and the free limb of the graft is passed through fixing suture loops to hang on them (Fig 13C, D). The 3-stranded graft complex is pulled into the PLC femoral tunnel and fixed on a cortical fixation button over the medial orifice. The free graft limb is passed through the underside of the ITB to the posterior side of the proximal tibiofibular joint and then pulled into the PLC tibial tunnel anteriorly.⁷

Distal Fixation of the Grafts

A trans-tibial ridge tunnel is created at a site distal to all the orifices of the created tibial tunnels. A set of cortical suspensory fixation devices with an adjustable loop (Mitek, Raynham, MA) is passed through this tunnel. The distal fixing sutures from the PMC and PLC grafts are passed subcutaneously to the medial side of the tibia. Half of the sutures from the distal end of each graft are passed through the adjustable loop. The cortical fixation button is passed through the trans-tibial ridge tunnel and flipped over the lateral orifice.

At 30° knee flexion with the leg in neutral internal-external rotation, the distal fixing sutures from the PMC graft are tied at the adjustable loop (Fig 14A). Then at near extension, with the leg in neutral internal-external rotation, the distal fixing sutures from the PLC graft are tied at the adjustable loop (Fig 14B).

The knee is fully extended to lock the knee with the reconstructed PMC and PLC in neutral anterior-posterior position. The ACL and PCL graft are tightened. An interference screw is placed first into the PCL tibial tunnel. The distal fixing sutures from the PCL

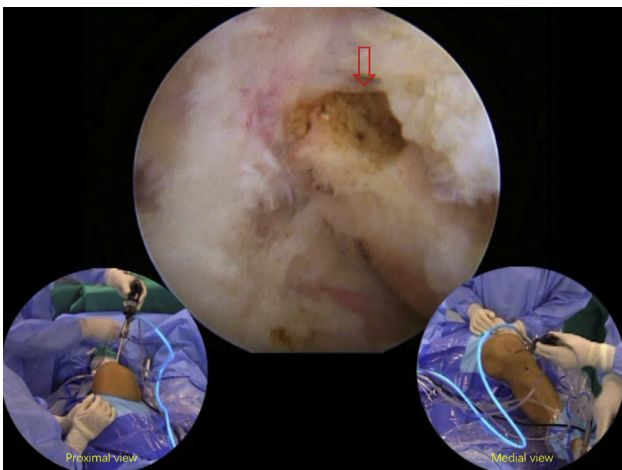


Fig 3. Location of the femoral tunnel (arrow) for reconstruction of the anterior cruciate ligament (arthroscopic view of the left knee through the anteromedial portal).

Fig 4. Creation of the tibial tunnel for reconstruction of the anterior cruciate ligament (arthroscopic view of the left knee through the anterolateral portal). (A) Kirschner wire is first placed (arrow). (B) Tibial tunnel is created with corresponding drill (arrow).

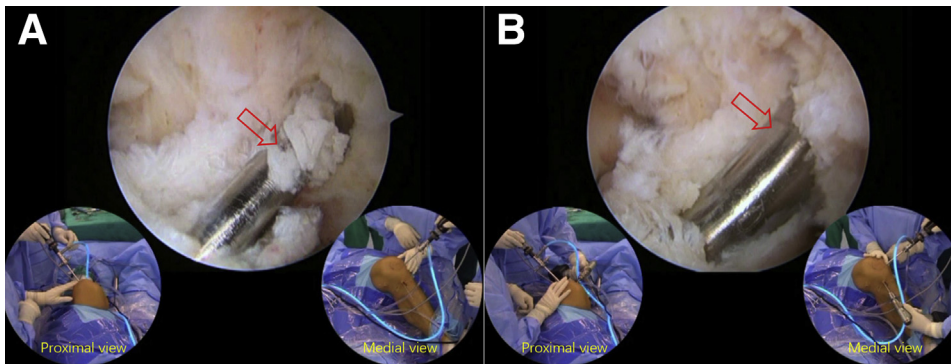
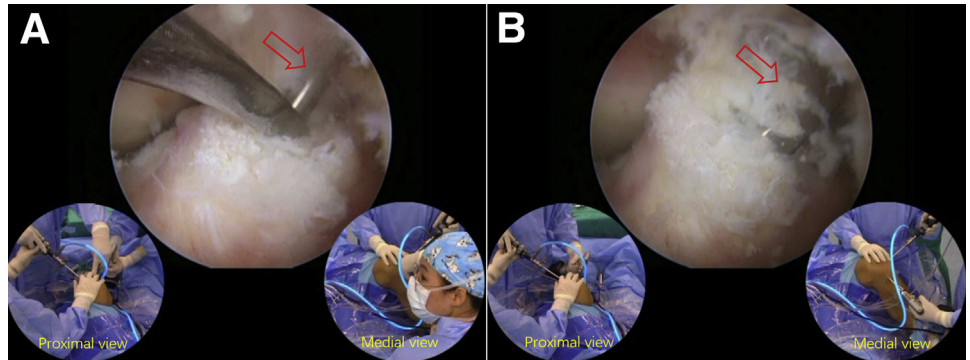


Fig 5. Creation of the femoral tunnel for reconstruction of the anterior cruciate ligament with trans-tibial technique (arthroscopic view of the left knee through the anterolateral portal). (A) Kirschner wire is first drilled to the marked point of the femoral tunnel (arrow). (B) Tibial tunnel is created with corresponding drill (arrow).

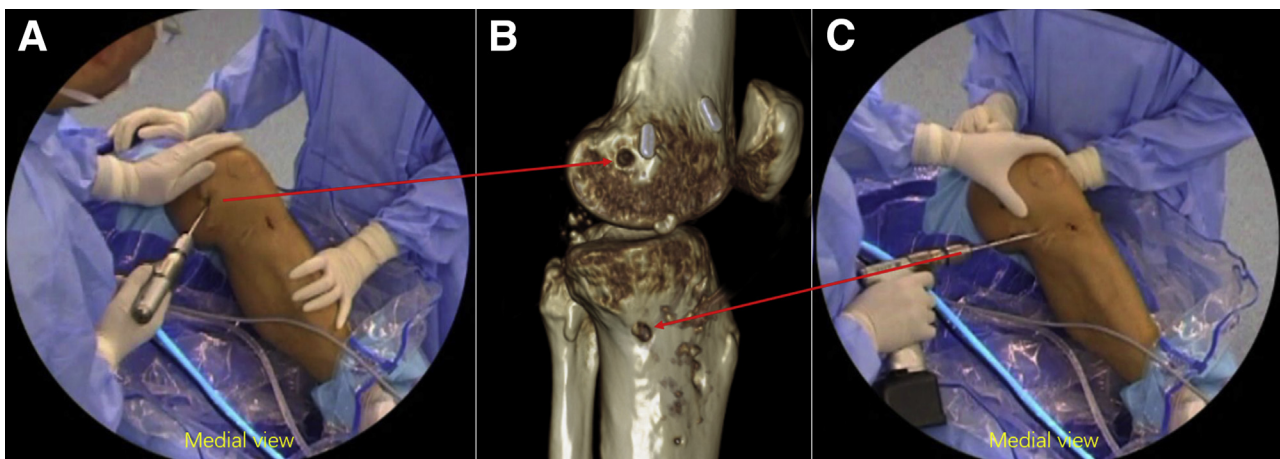


Fig 6. Creation of the femoral (A) and tibial (C) tunnels for reconstruction of the posteromedial corner (left knee). (B) Illustration of the locations of the femoral and tibial tunnels for reconstruction of the posteromedial corner.

graft are tied at the adjustable loop. Then another interference screw is placed into the ACL tibial tunnel. The distal fixing sutures from the ACL graft are tied at the adjustable loop (Fig 14C).

Postoperative Management

A hinged brace is used postoperatively. Range-of-motion exercise and muscle strengthening begin

immediately after surgery. Partial weightbearing is allowed in the first 6 weeks postoperatively, and then full weightbearing is allowed. Agility training begins 3 months after the operation.

Discussion

In the current technique, one of the critical points is to avoid tunnel interference during tunnel creation.

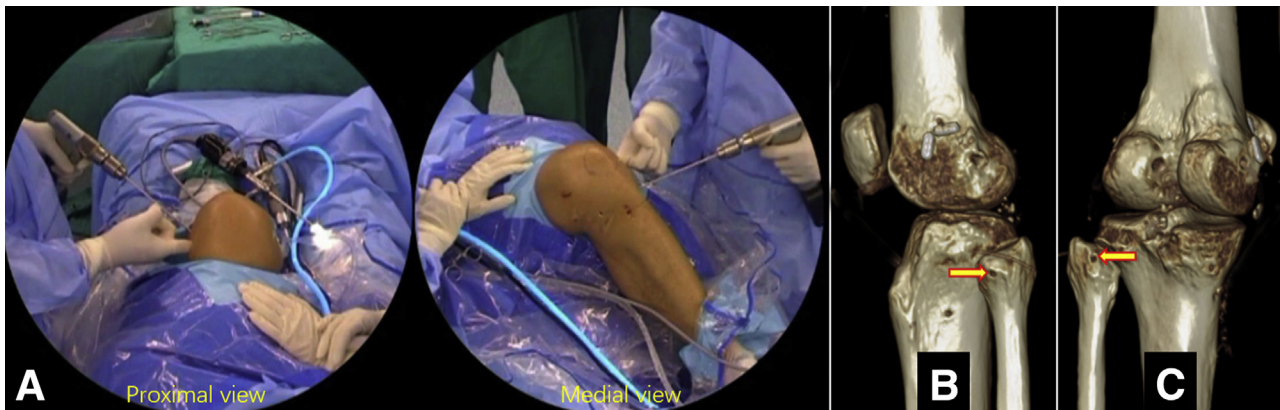


Fig 7. Creation of the fibular tunnel for reconstruction of the posterolateral corner (left knee). (A) Intraoperative view. (B) Illustration of the anterolateral orifice of the fibular tunnel (arrow). (C) Illustration of the posteromedial orifice of the fibular tunnel (arrow).

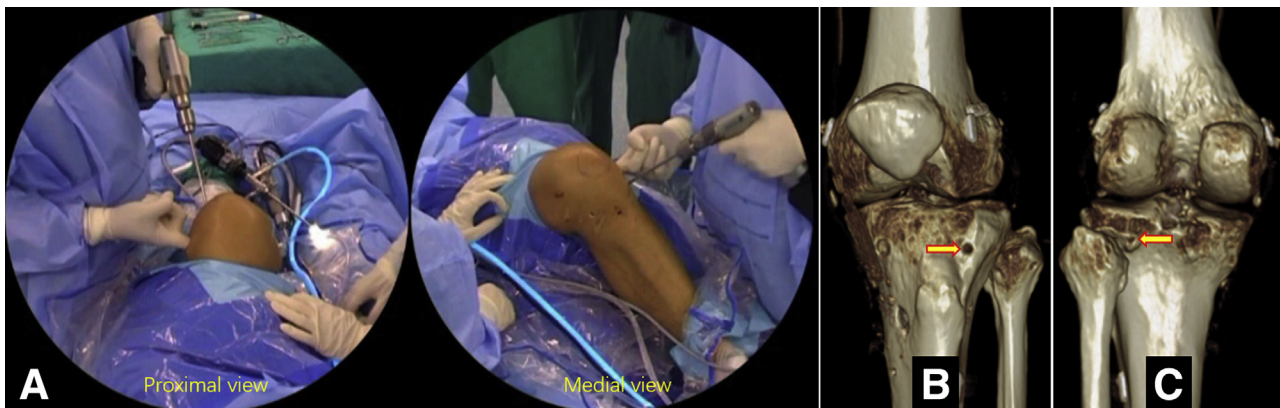


Fig 8. Creation of the tibial tunnel for reconstruction of the posterolateral corner (left knee). (A) Intraoperative view. (B) Illustration of the anterior orifice of the tibial tunnel (arrow). (C) Illustration of the posterior orifice of the tibial tunnel (arrow).

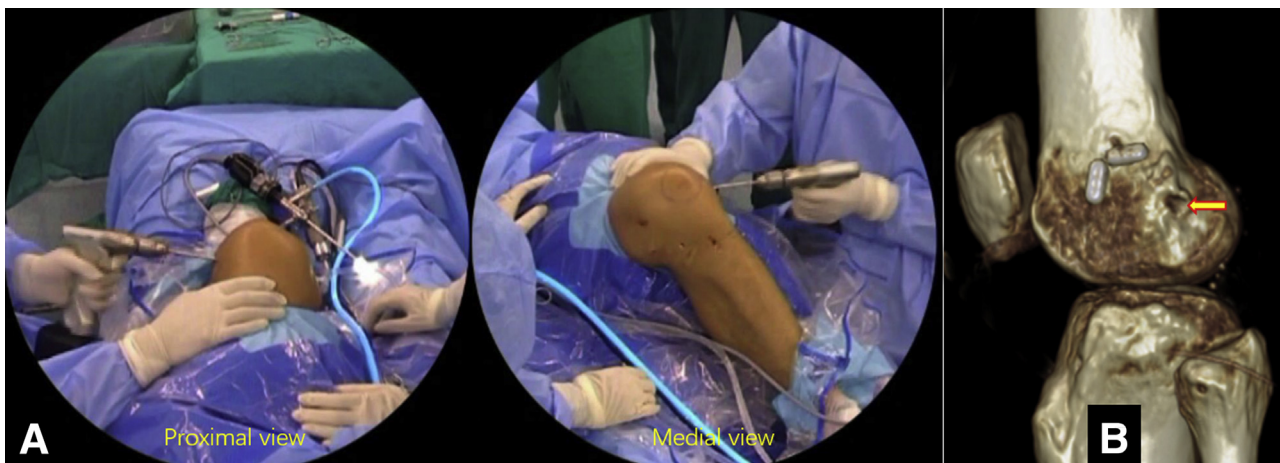


Fig 9. Creation of the femoral tunnel for reconstruction of the posterolateral corner (left knee). (A) Intraoperative view. (B) Illustration of the lateral orifice of the femoral tunnel (arrow).

During creation of the femoral tunnels for the PMC and the PLC, deviating the tunnels proximally to avoid the corresponding femoral condyles is suggested. The location of the PMC femoral tunnel can be moved

proximally when the ideal position is occupied by the outer orifice of the PCL femoral tunnel. Another critical point is to create all the tunnels, except for the trans-tibial ridge tunnel, first and then place the grafts to

Fig 10. Placement of guide suture (arrows) for implantation of the graft of the posterior cruciate ligament. (A) Arthroscopic view of the posterior compartments of the left knee through the posteromedial portal. (B) Arthroscopic view of the left knee through the anteromedial portal.

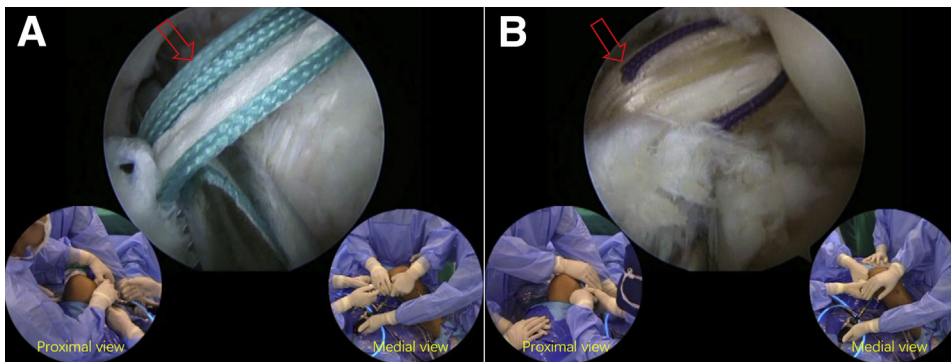
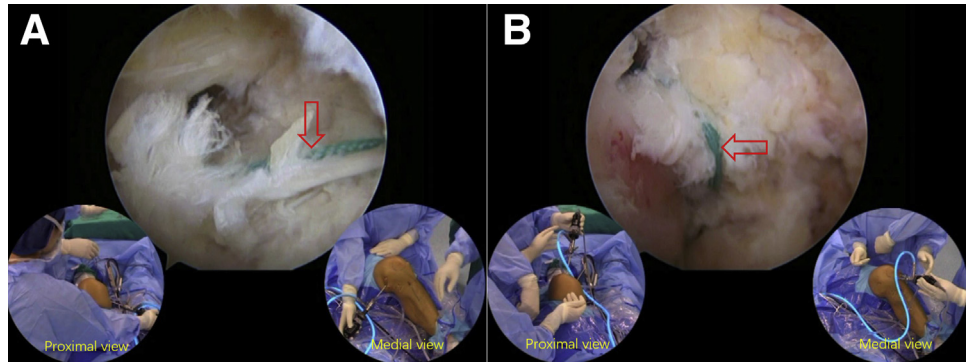
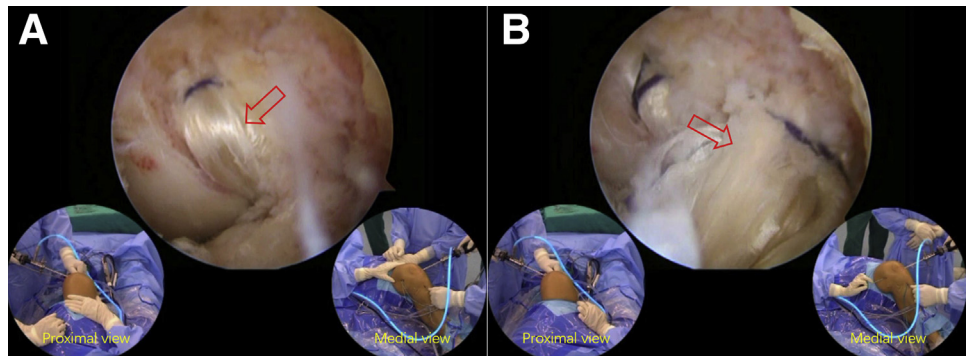


Fig 11. Placement of the graft of the posterior cruciate ligament into the joint through the tibial tunnel (arthroscopic view of the posterior compartments of the left knee through the posteromedial portal). (A) Proximal fixing sutures are first pulled in (arrow). (B) Graft is pulled in (arrow).

Fig 12. Emplacement of the grafts of the cruciate ligaments into the femoral tunnels. (A) Arthroscopic view of the left knee through the anterolateral portal, indicating placement of the graft of the posterior cruciate ligament into the femoral tunnel (arrow). (B) Arthroscopic view of the left knee through the anterolateral portal, indicating placement of the grafts of the anterior cruciate ligament into the femoral tunnel (arrow).



avoid graft injury by later tunnel creation. The third critical point is to avoid graft interference once there is tunnel interference, which may occur between the ACL and the PLC femoral tunnels, the PCL and the PMC femoral tunnels, and the PCL and the PMC tibial tunnels. The cruciate ligaments are placed first (Figs 15 and 16). Then the collateral ligament is placed. Even though in some cases tunnel interference occurs, fixation of the

collateral ligament can be realized by passing the fixing sutures through the cruciate ligament grafts crossing the tunnels. The fourth critical point is to obtain anterior-posterior neutral position of the knee during distal graft fixation of the ACL and the PCL.⁸⁻¹⁰ Through previous tensioning and distal fixation of the PMC and PLC to restore PM and PL stability and full extension of the knee, the knee is locked in neutral

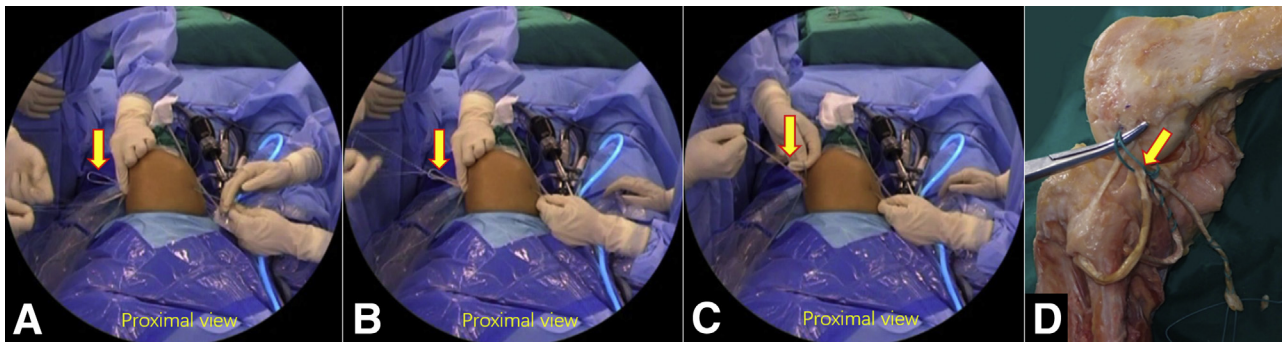


Fig 13. Configuration of the graft structure of the posterolateral corner (left knee). (A–C) Intraoperative view. (A) Looped proximal fixing sutures are pulled through the femoral tunnel. (B) One end of the graft tendon is tied at the loop of the proximal fixing sutures. (C) Free limb of the graft tendon is passed through the loop. (D) Specimen illustration.

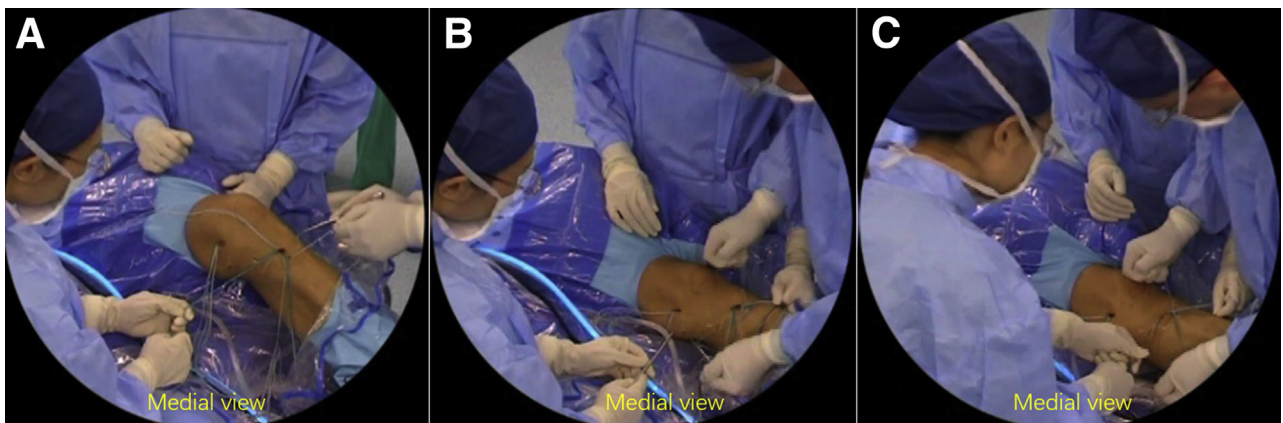


Fig 14. Distal fixation of the grafts (left knee) at an adjustable loop in a cortical suspension fixation device. (A) Graft for the reconstruction of the posteromedial corner is fixed at 30° knee flexion. (B) Graft for the reconstruction of the posterolateral corner is fixed at 10° knee flexion. (C) Graft for the reconstruction of the anterior and posterior cruciate ligament is fixed at full extension of the knee.

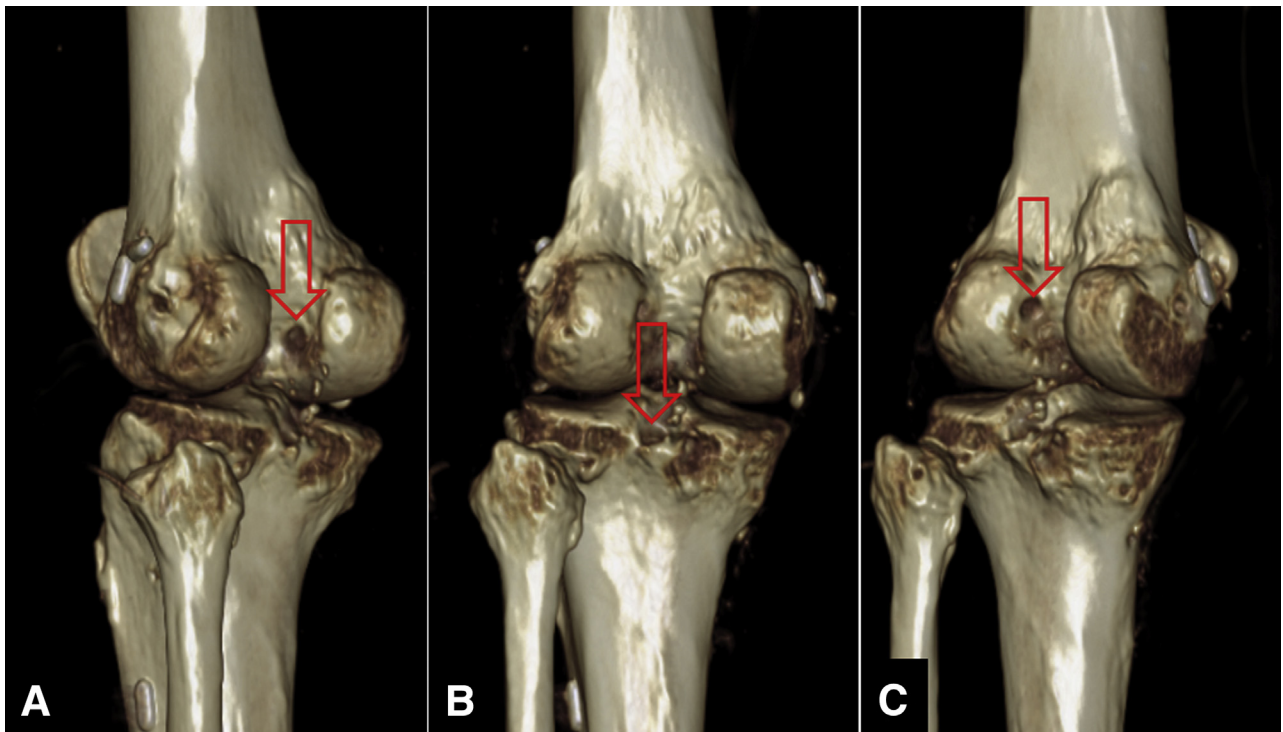


Fig 15. Illustration of the location of the femoral tunnel of the posterior cruciate ligament (A) (arrow), the tibial tunnel of the posterior cruciate ligament (B) (arrow), and the femoral tunnel of the anterior cruciate ligament (C) (arrow).

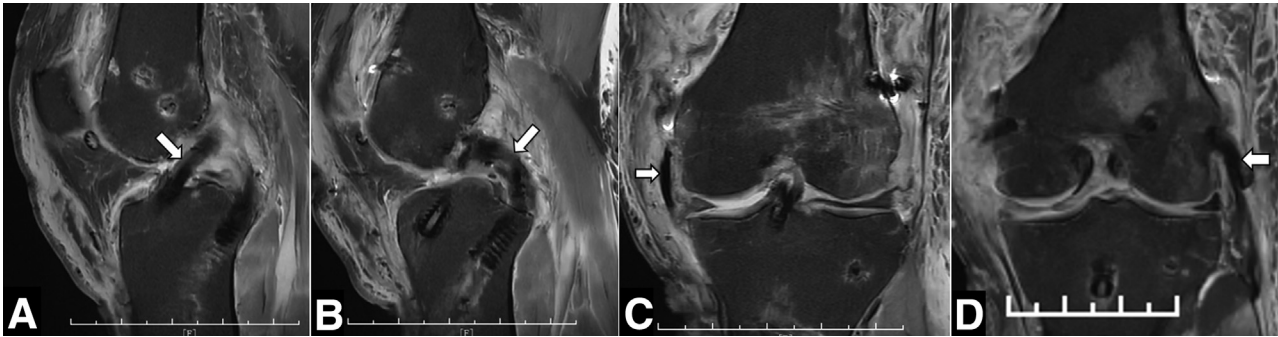


Fig 16. Postoperative magnetic resonance images of left knee indicating the reconstructed anterior cruciate ligament (A) (arrow), posterior cruciate ligament (B) (arrow), posteromedial corner (C) (arrow), and posterolateral corner (D) (arrow).

Table 4. Pearls and pitfalls

1. A skilled autograft harvesting technique is required to reduce overall surgical time.
2. The posterior cruciate ligament (PCL) tibial stump is partially preserved and used as a cushion to prevent the cutting effect of the tunnel edge to the graft.
3. During creation of the anterior cruciate ligament (ACL) femoral tunnel, the tibia can be pushed posteriorly to get access to the femoral tunnel location through the tibial tunnel when the ACL tibial tunnel is not shallow enough.
4. Preoperative 3-dimensional computerized tomography is needed to evaluate the medial and lateral side of the distal femur to facilitate tunnel location by palpation of the medial and lateral femoral epicondyles.
5. When heterotopic ossification exists close to the medial and lateral femoral epicondyles, they should be removed for accurate tunnel location.
6. The thick scar tissue along the route of the posteromedial corner (PMC) should be removed to facilitate the anteroposterior swing of the reconstructed PMC postoperatively.
7. The posterolateral corner (PLC) fibular tunnel is located at the anterolateral fibular styloid instead of the anterior styloid.
8. The PLC fibular tunnel is created with an angle of 45° to 60° to the sagittal plane instead of along the sagittal plane.
9. A switching stick is placed at the anterior inferior side of the guide suture at the inner orifice of the tibial tunnel and used as a pulley or lever to facilitate placement of the PCL graft.
10. All the PLC graft structures are passed through the underside of the iliotibial band.

anterior-posterior position.^{1,2} Pearls and pitfalls are listed in [Table 4](#).

References

1. Zhao J, He Y, Wang J. Simultaneous arthroscopic reconstruction of the anterior and posterior cruciate ligaments with autogenous hamstring tendons. *Arthroscopy* 2006;22(5):497-504.
2. Zhao J, Huangfu X, He Y, Yang X, Zhu Y. Simultaneous double-bundle anterior cruciate ligament and posterior cruciate ligament reconstruction with autogenous hamstring tendons. *Arthroscopy* 2008;24:1205-1213.
3. Yasuda K, Kitamura N, Kondo E, Hayashi R, Inoue M. One-stage anatomic double-bundle anterior and posterior cruciate ligament reconstruction using the autogenous hamstring tendons. *Knee Surg Sports Traumatol Arthrosc* 2009;17:800-805.
4. Zhao J, Huangfu X. The biomechanical and clinical application of using the anterior half of the peroneus longus tendon as an autograft source. *Am J Sports Med* 2012;40:662-671.
5. Zhao J. Single-bundle anatomical posterior cruciate ligament reconstruction with remnant preservation. *Arthrosc Tech*. In press.
6. Zhao J. Anatomical single-bundle transtibial anterior cruciate ligament reconstruction. *Arthrosc Tech* 2020;9:e1275-e1282.
7. Tang J, Zhao J. Knee posterolateral corner reconstruction with one tendon string. *Arthrosc Tech*. In press.
8. Kim SJ, Kim SH, Jung M, Kim JM, Lee SW. Does sequence of graft tensioning affect outcomes in combined anterior and posterior cruciate ligament reconstructions? *Clin Orthop Relat Res* 2015;473:235-243.
9. Mardani-Kivi M, Karimi-Mobarakeh M, Hashemi-Motlagh K. Simultaneous arthroscopic ACL and PCL reconstruction using allograft Achilles tendon. *J Clin Orthop Trauma* 2019;10:S218-S221 (suppl 1).
10. Franciozi CE, de Carvalho RT, Itami Y, McGarry MH, Ingham SJM, Abdalla RJ, Tibone JE, Lee TQ. Bicurciate lesion biomechanics, Part 2—treatment using a simultaneous tensioning protocol: ACL fixation first is better than PCL fixation first to restore tibiofemoral orientation. *Knee Surg Sports Traumatol Arthrosc* 2019;27:2936-2944.