

Knee Posterolateral Corner Reconstruction with a Single Tendon



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Abstract: Knee posterolateral corner (PLC) injuries are troublesome conditions and are always involved in complicated knee-ligament injuries. Various surgical techniques have been reported to address these conditions, in either an open or an arthroscopic manner. However, a simple and effective method is still being pursued. We introduce a mini-invasive PLC reconstruction technique in which a single tendon is used to reconstruct the lateral collateral ligament, the popliteofibular ligament and the popliteal tendon simultaneously. The critical points of this technique are proper location and creation of the tibial, fibular and femoral tunnels, proper passing and setting of the tendon graft, as well as protection of the peroneal nerve. Our clinical experience indicates that this technique is easy to perform and effective. We consider that the introduction of this technique will provide more reasonable options when PLC reconstruction is indicated.

Introduction

Knee posterolateral corner (PLC) injury always involves the 3 main structures: the lateral collateral ligament (LCL), the popliteofibular ligament (PFL) and the popliteal tendon (PT), which correspond to type B and type C injuries, according to the Fanelli classification. PLC injury results in posterolateral knee instability, and reconstruction may be indicated in both the acute and the chronic stages. Various methods of PLC reconstruction have been reported regarding the structures, the type of grafts and the fixations.¹ However, an easily performed procedure is still needed,² and there is still much room for improvement

regarding the clinical results.³⁻⁵ Thus, we would like to introduce a PLC reconstruction technique in which a single tendon is used to reconstruct or augment the LCL, the PFL and the PT, and 1 femoral tunnel is created for the reconstruction of all 3 structures. Our clinical experience indicates that this technique is simple and effective. The indication for the current PLC reconstruction technique is acute type B and type C PLC injuries with intratendon/ligament rupture and chronic type B and type C PLC injuries with normal lower limb alignment.

Surgical Technique

Graft Preparation

PLC injury is always combined with other ligament injuries, especially the posterior cruciate ligament. Thus, multiligament reconstruction may be needed. The donor sources are of concern because many grafts are required. We prefer to use an autogenous or allogeneous tendon that is approximately 5 mm wide with a length of more than 24 cm. The semitendinosus tendon or the anterior half of the peroneus longus tendon⁶ is the best choice. The gracilis tendon can also be used if it is thick enough. When an allogeneous tibialis anterior or peroneus longus tendon is used, two-thirds of the thickness of the tendon is recommended so that a 5 mm-wide tendon string is achieved.

Each end of the tendon is braided with 2 #2 ultrahigh molecular-weight polyethylene (UHMWPE) sutures as are used for the cruciate ligament reconstruction. After the tendon is braided, the diameters of the single-tendon

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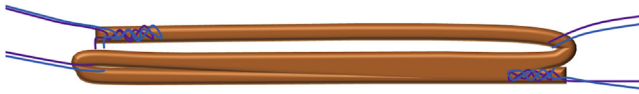


Fig 1. Illustration of a 3-stranded structure made from a single tendon string.

string, which is used as a reference to create the fibular and the tibial tunnels, and the diameters of a 3-stranded structure made from it (Fig 1), which is used as a reference to create the femoral tunnel, are measured (Table 1).

Surgical Approaches

The knee is flexed at 90°, and a longitudinal incision is made on the posterolateral side of the knee from a site over the posterior side of the lateral femoral epicondyle (LFE) to a site over the posterior side of the fibula head, with a length of approximately 4 cm (Fig 2) (Video 1). The skin and superficial and deep fascia layers are incised. Separation is performed medially through the triangle formed by the biceps femoris tendon, the iliotibial band, and the connecting line between the LFE and the posterior edge of the fibula head. The posterior side of the proximal tibiofibular joint is reached. The posteromedial side of the fibular head is checked through this approach to separate any tissue or structure that has adhered to the fibular head. The posterolateral corner of the tibial plateau and the popliteal muscle are defined by palpation. In this incision, the iliotibial band is incised longitudinally from a site 5 mm posterior to the tip of the LFE distally to expose the midpoint between the insertion of the lateral collateral ligament and the popliteal tendon.

Creating Bone Tunnels

A 5 mm-long longitudinal incision is made over the anterolateral styloid of the fibula. From this incision, a fibular tunnel with a size the same as that of the single tendon string is drilled from the anterolateral fibular styloid to the posteromedial side of the fibular head at an angle of 45° to 60° to the sagittal plane (Fig 3) (Fig 4) sequentially, using a Kirschner wire and a cannulated drill.

A 5 mm incision is made over the anteromedial side of the Gerdy tubercle. A tibial tunnel with a size the same as that of the single tendon string is drilled from the distal medial edge of the Gerdy tubercle, parallel to the sagittal plane and perpendicular to the longitudinal axis of the tibia, to the posterolateral corner of the proximal tibia (Fig 5) sequentially, using a Kirschner wire and a cannulated drill. The posterior orifice of the tibial tunnel is in the popliteal notch of the proximal tibia, 1 to 2 cm below the tibial plateau.

The femoral tunnel is located 5 mm posterior and 5 mm distal to the LFE, with tunnel directions pointing proximally and anteriorly. The femoral tunnel is created sequentially with a Kirschner wire, a cannulated drill of the same size as the 3 tendon structures to a depth of 2 cm, and a 4.5 mm cannulated drill through the whole femur (Fig 6).

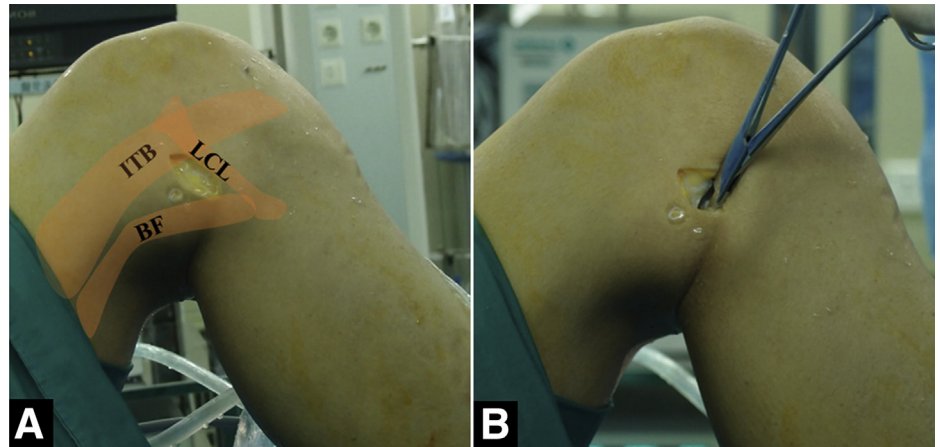
Tendon Implantation and Fixation

A folded steel wire is passed through the fibular tunnel. With the steel wire, the tendon is first passed through the fibular tunnel in a single-string style (Fig 7A,B). Both ends of the tendons are passed proximally through the underside of iliotibial band out of the iliotibial band incision (Fig 7C).

Table 1. Step-by-Step Procedure of Knee Posterolateral Corner Reconstruction With a Single Tendon

1. One autogenous or allogeneous tendon string is used. The tendon is braided in routine fashion with 2 #2 ultrahigh molecular-weight polyethylene sutures.
2. A longitudinal incision is made on the posterolateral side of the knee.
3. Separation is performed medially through the triangle formed by the iliotibial band, the lateral collateral ligament and the biceps femoris tendon to reach the posterior side of the proximal tibiofibular joint.
4. The iliotibial band is incised longitudinally for a length of approximately 2 cm from a site 5 mm posterior to the tip of the lateral femoral epicondyle distally to reach the midpoint of the native insertion of the lateral collateral ligament and the popliteal tendon.
5. A 5 mm-long incision is made over the anterolateral styloid of the fibula. A fibular tunnel is created from the anterolateral styloid to the posteromedial side of the fibular head.
6. An incision is made at the anterior medial side of the Gerdy tubercle. A tibial tunnel is drilled from the distal medial edge of the Gerdy tubercle posteriorly through the lateral tibial condyle to the posterolateral side of the proximal tibia.
7. The femoral tunnel is created at the distal posterior site of the tip of the lateral femoral epicondyle.
8. The tendon string is passed through the fibular tunnel.
9. Both ends of the tendons are passed through the underside of the iliotibial band proximally and out of the iliotibial band incision.
10. The proximal fixation tape or sutures are folded, and their free ends are passed through the femoral tunnel.
11. One end of the tendon is tied to the loop of the proximal fixation tape or sutures.
12. The other end of the tendon is passed through the loop and folded.
13. The 3-stranded tendon structure is pulled into the femoral tunnel. The free graft end is tightened.
14. The proximal fixing tape or sutures are fixed onto a cortical suspensory fixation button.
15. The free returning end of the tendon is passed through the underside of the iliotibial band to the posterior side of the proximal tibiofibular joint.
16. The free returning end is pulled into the tibial tunnel and fixed by suspension fixation anteriorly.

Fig 2. Illustration of the skin incision (A) and dissection through this incision to the posteromedial side of the proximal tibiofibular joint (B) (lateral view of right knee). BF, biceps femoris tendon; ITB, iliotibial band; LCL, lateral collateral ligament.



A single UHMWPE tape or 2 #2 UHMWPE sutures are used for fixation on the femoral side. The tape or the sutures are folded, the free ends are passed through the iliotibial band incision and the femoral tunnel from lateral to medial side out of the medial incision used for posterior cruciate ligament reconstruction or a newly created medial incision. The loop end is left out of the lateral incision.

The thin end of the tendon is tied to the loop of the proximal fixation tape or sutures (Fig 8A). The other end of the tendon is passed through the loop and folded (Fig 8B) to form a 3-strand graft on the femoral side (Fig 8C).

Then the 3-stranded tendon structure is pulled into the femoral tunnel, and the graft is placed to a depth of more than 1 cm (Fig 9). The proximal fixing tape or sutures are fixed onto a cortical suspensory fixation button (Smith-Nephew, Andover, MA) over the medial orifice of the femoral tunnel. The free end of the graft complex is tensioned to tighten the 2 strands from the fibular head.

The free end of the tendon is passed through the underside of the iliotibial band to the posterior side of the proximal tibiofibular joint. The folded steel wire is passed through the tibial tunnel from the anterior to the posterior side and is drawn out of the posterolateral incision. Using the steel wire, the free end of the tendon is passed through the tibial tunnel from the posterior to the anterior side and fixed with suspension fixation at or distal to the anterior orifice of the tibial tunnel in the neutral position of internal-external rotation of the knee near extension (Fig 10).

Discussion

The current technique is not an anatomic PLC reconstruction because on the femoral side, the 2 isolated insertions of the LCL and the PT are not reproduced. We use 1 femoral tunnel, which lies between the native insertions of the LCL and the PT, to accommodate the 3 reconstructed structures. It is due mainly to the fact that in multiligament knee reconstruction that involves anterior cruciate ligament (ACL)

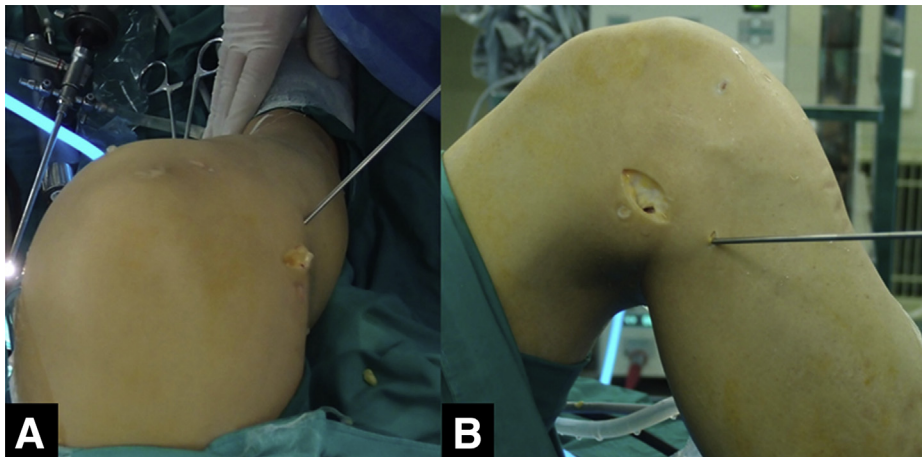


Fig 3. Proximal view (A) and lateral view (B) photographs illustrating the direction of the fibular tunnel (right knee).

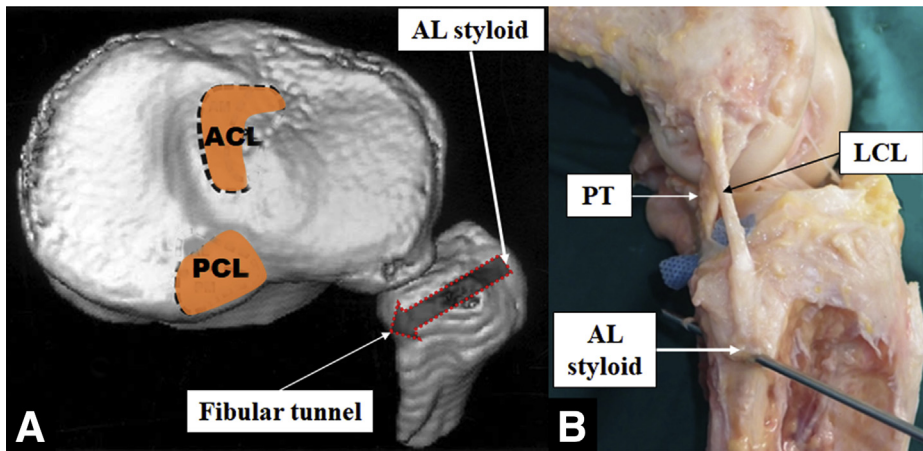


Fig 4. Illustration of the route of the fibular tunnel on computerized tomography (A) and specimen (B) (right knee). AL styloid, the anterolateral fibular styloid; ACL, the footprint of the anterior cruciate ligament; LCL, the lateral collateral ligament; PCL, the footprint of the posterior cruciate ligament; PT, the popliteal tendon.

Fig 5. Illustration of creation of the tibial tunnel. (A) lateral view photography indicating the direction of the drilled-in Kirschner wire to create the tibial tunnel. (B) computerized tomography indicating the route of the tibial tunnel.

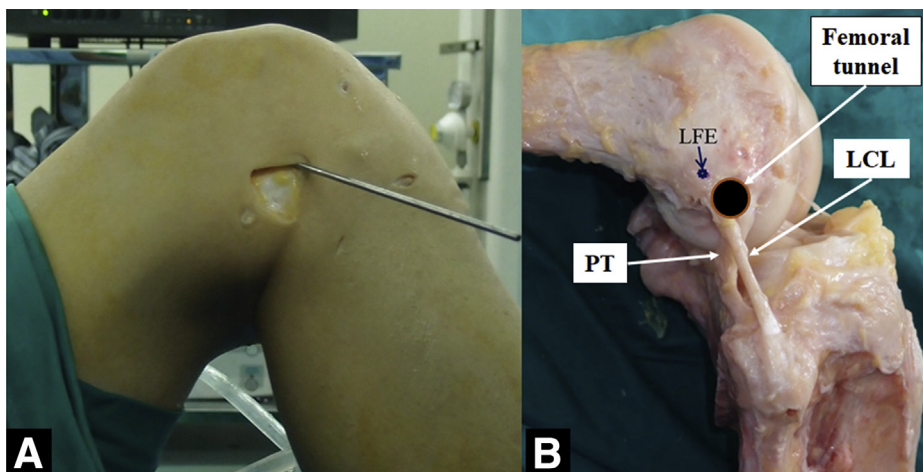
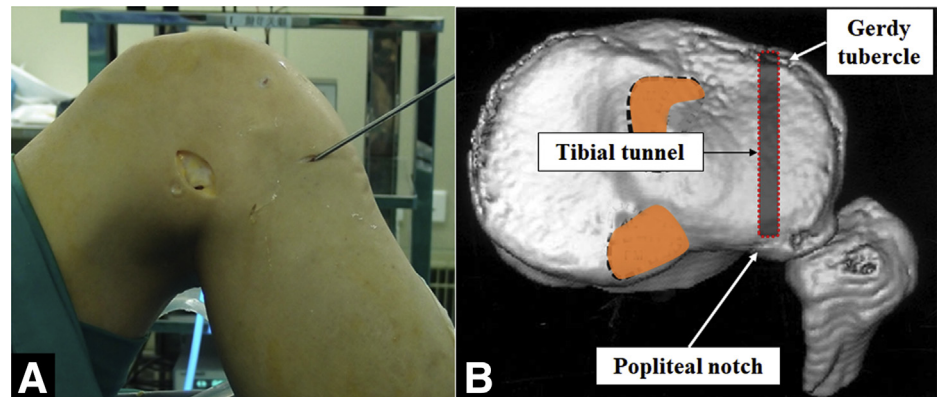


Fig 6. Illustration of the creation and the location (B) of the femoral tunnel. (A) lateral view of the right knee, indicating the direction of the drilled-in Kirschner wire to create the femoral tunnel. (B) lateral view of a specimen of the right knee indicating the location of the femoral tunnel. LCL, lateral collateral ligament; LFE, lateral femoral epicondyle; PT, popliteal tendon.

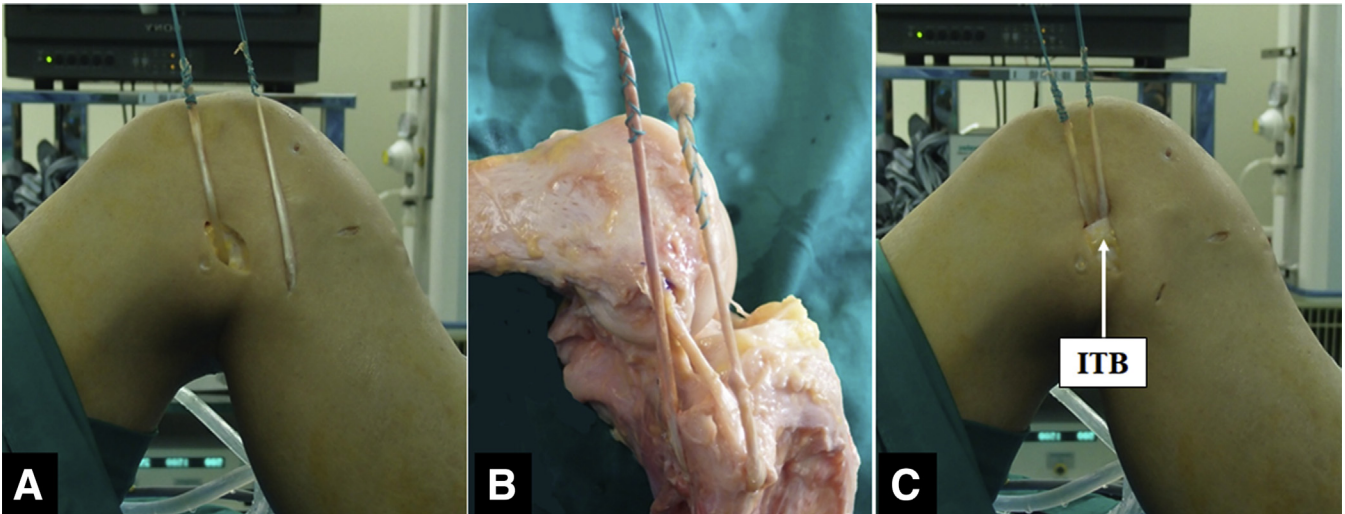


Fig 7. Illustration of the passage of the tendon through the fibular tunnel (A and B) and the underside of the iliotibial band (C). (A and C) lateral view of right knee. (B) lateral view of right knee specimen without removal of the PLC structure. ITB, iliotibial band.

reconstruction, at least 1 femoral tunnel through the lateral femoral condyle is needed for the reconstructed ACL; 2 additional femoral tunnels for the PLC reconstruction will increase the risk of tunnel interference. Also, we found no difference between single and double femoral tunnel PLC reconstruction. We perform 2-femoral tunnel PLC reconstruction only in cases in which no simultaneous ACL reconstruction is performed.

In recent years, various arthroscopic PLC reconstruction techniques have been developed; they address differing structural injuries of the PLC, especially the treatment of type B and type C injuries.⁷ There are many advantages of arthroscopic surgery over open surgery,

including better visualization of some anatomical landmarks that are hidden in open procedures and better protection of the peroneal nerve. However, arthroscopic PLC reconstruction is time consuming, which prevents its wide application in simultaneous multiligament reconstruction. In our clinical practice, we prefer the current mini-invasive PLC reconstruction technique because it is effective and time saving. It usually takes 15 to 20 minutes to complete the current procedure.

The pearls and pitfalls of the current technique are listed in Table 2. The main potential risk of the current technique is peroneal nerve injury. Defining the location of the peroneal nerve during creation of the fibular tunnel is critical. It is usually easily detected by

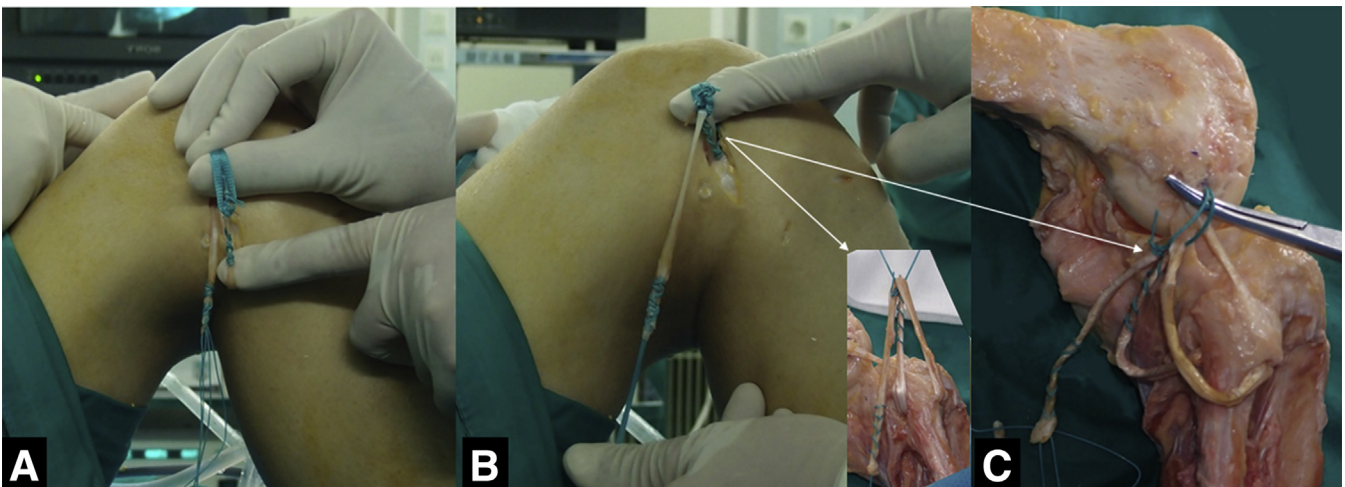


Fig 8. Illustration of the method of connecting the tendon to the proximal fixation tape or suture. A, 1 end of the tendon is tied to the loop of the proximal fixation tape (A, intraoperative photography of right knee). B, the free end is passed through the loop and returns (intraoperative photography of right knee). C, photograph of right knee specimen without PLC removal, indicating the connecting the tendon to the proximal fixation suture.

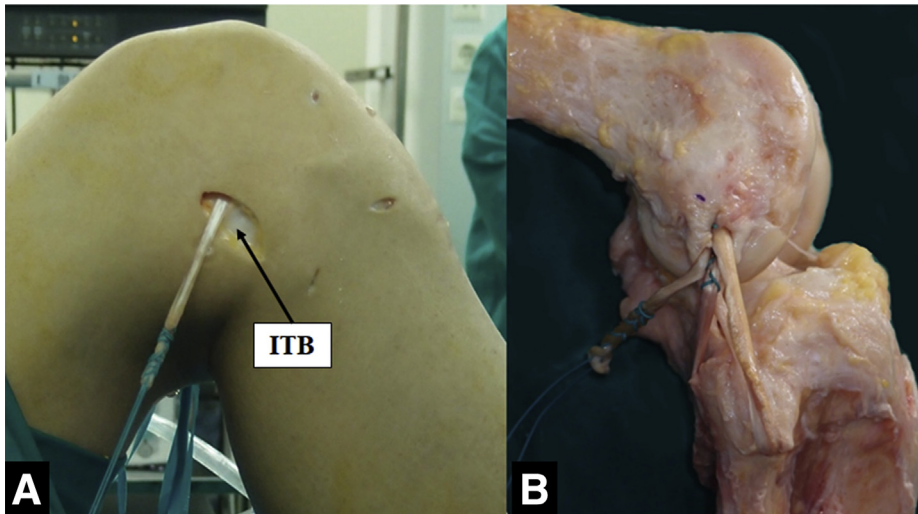


Fig 9. Intraoperative lateral view of right knee (A) and photography of right knee specimen (B) indicating the tendon status following tendon emplacement into the femoral tunnel. ITB, iliotibial band.

Fig 10. Illustration indicating the 3 reconstructed tendon structures. A, lateral view of right knee specimen. B, posterolateral view of right knee specimen.

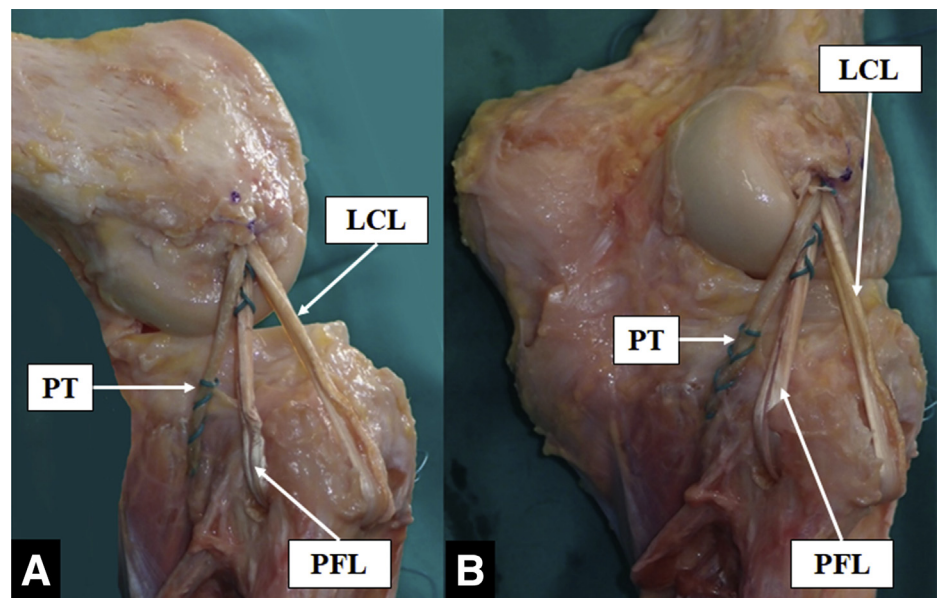


Table 2. Pearls and Pitfalls of Knee Posterolateral Corner Reconstruction With a Single Tendon

1. If allogeneic tibialis anterior or peroneus longus tendon is used, 2/3 of the thickness of the tendon is recommended. Because a tunnel is drilled through the fibular head for ligament reconstruction, a too-thick graft may cause a fracture of the fibular head.
2. The anatomical insertion of the lateral collateral ligament is on the anterolateral styloid of the fibular head instead of on its anterior styloid. Creating the fibular tunnel from the anterolateral styloid is critical to reproducing the lateral collateral ligament.
3. Precise location of the femoral tunnel depends on accurate location of the lateral femoral epicondyle.
4. The common peroneal nerve should be protected. The fibular tunnel should be created through the fibular head instead of the fibular neck and should be in anterolateral to posteromedial direction instead of anterior to posterior direction. Otherwise, the common peroneal nerve is endangered. Extending the posterolateral incision distally and exposing the common peroneal nerve around the fibular neck is a matter of choice to protect the common peroneal nerve when it is not palpable.
5. The free tendon end through the tibial tunnel is fixed in neutral external-internal rotation. Fixation in medial rotation may over constrain the knee and result in discomfort.

palpation through the small posterolateral incision. However, when it is not definitively palpated, the incision can be extended distally to expose the peroneal nerve around the fibular neck through meticulous dissection.

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