Technical Note

The Transportal Graft Passage in Transtibial Posterior Cruciate Ligament Reconstruction With a Bone—Patellar Tendon—Bone Graft

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Abstract: Posterior cruciate ligament injury is one of the most common problems in sports medicine. The treatment of choice for this injury is posterior cruciate ligament reconstruction, which improves the biomechanical and clinical stabilities of the knee. There are many graft choices, of which the bone—patellar tendon—bone (BPTB) graft is a popular option. In applying the BPTB graft, most surgeons use the transtibial technique by passing the graft from the tibial tunnel to the femoral tunnel, which is normally performed without problems, but there is a chance of patellar tendon fiber damage because of the sharp turn required from the tibial tunnel to the femoral tunnel. To minimize this risk, herein we propose a transportal graft passage technique with which it is easy to pass the BPTB graft and reduce the risk of graft damage.

Posterior cruciate ligament (PCL) injury is one of the most common problems in sports medicine. The treatment of choice for this injury is PCL reconstruction, which improves the biomechanical and clinical stabilities of the knee and reduces the risk of meniscal and/or chondral injuries.[1-3] The autologous graft choices consist of a hamstring tendon graft, bone—patellar tendon—bone (BPTB) graft, quadriceps tendon graft, and peroneus longus graft, of which the BPTB graft is a popular option. The BPTB graft offers many advantages, such as bone-to-bone healing, strong graft strength, and stiffness comparable with the native PCL, hence rapid graft healing, fast recovery, and return to their sports for athletes. In the graft passage, most surgeons use the transtibial technique by passing the graft from the tibial tunnel to the femoral tunnel. In this step, it is difficult to pass the graft though the tibial tunnel into the intercondylar notch and then into the femoral tunnel, creating a "double killer turn," for which the surgeon must use a probe to assist the graft passage. In addition, there is a chance of patellar tendon fiber damage because of the sharp turn from the tibial tunnel to the femoral tunnel.[4-6] As a workaround for both of these problems, we propose a transportal graft passage technique with which it is easy to pass the BPTB graft with a decreased risk of graft damage.

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Surgical Technique (With Video Illustration)

Anesthesia and Patient Position

After a combined adductor canal and spinal nerve block is given to the patient, the patient is turned to the supine position. Any hair between the mid-thigh and mid leg is removed by clippers. A tourniquet cuff is applied to the proximal thigh on the operative side.

Graft Harvest

After the affected leg is prepped and draped in a sterile fashion, with stockinet covering the leg and thigh, the tourniquet is inflated to 280 mm Hg. The knee is set at 90° flexion. A 4-cm longitudinal incision though the subcutaneous tissue and the paratenon is made approximately 2 cm below the inferior pole of the patella and medial to the medial edge of the patellar tendon. The medial and lateral edges of the patellar

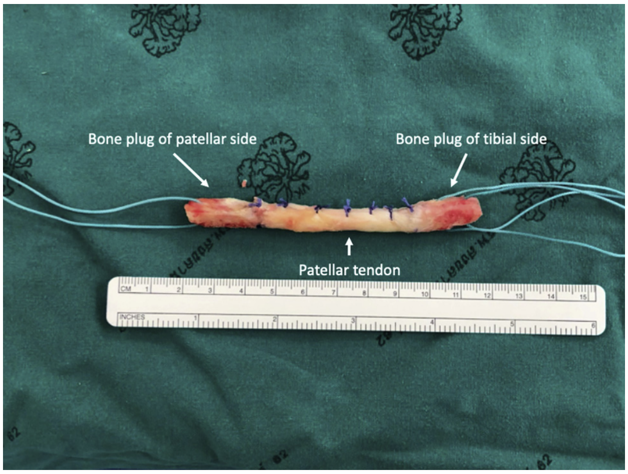

Fig 1. The bone–patellar tendon–bone graft is prepared for posterior cruciate ligament reconstruction.

tendon are identified and a center 10-mm patellar tendon strip is harvested. The tibial and femoral insertions of the patellar tendon are identified and a strip of bone approximately 20 mm in length and 10 mm in width is harvested from tibial and femoral sides using an oscillating saw. The paratenon is repaired with VICRYL no. 3-0 (Ethicon, Somerville, NJ). The bone plugs of both sides are smoothed into a cylindrical shape with a rongeur. A 2.4-mm drill is used to create one hole into the bone plug of the patellar side and 2 holes into the bone plug of the tibial side. An ETHIBOND no. 5 (Ethicon) is passed through each hole of the bone plug (Fig 1).

Portal Creation

Three portals are created for the arthroscopic surgery that is used for this procedure. A 1-cm standard low

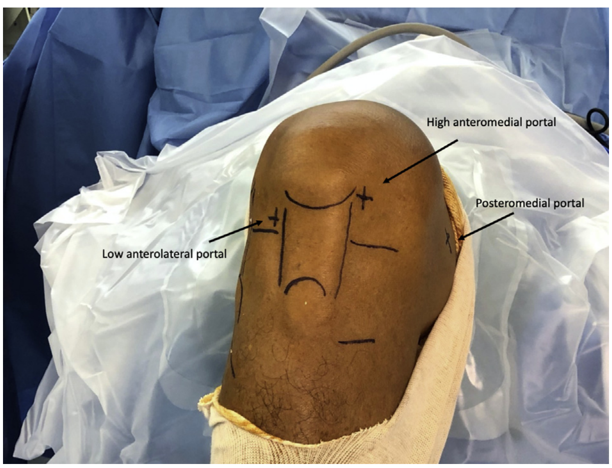

Fig 2. A 1-cm standard low anterolateral (AL) portal is created for a viewing portal and high anteromedial (AM) and posteromedial portals are created for working and instrumentation portals

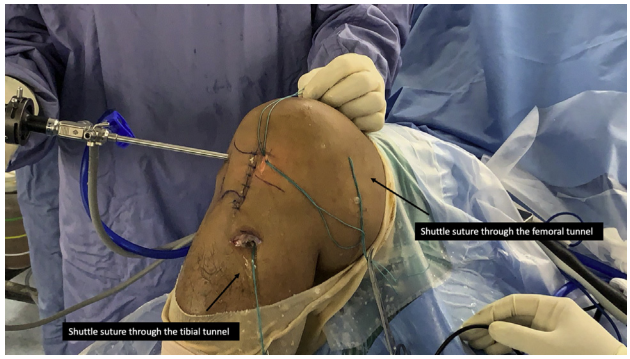

Fig 3. The patient is in the supine position with 90° of right knee flexion. Two shuttle sutures are passed through the anteromedial portal, one shuttle suture through the tibial tunnel and one through the femoral tunnel

anterolateral (AL) portal is created for a viewing portal and high anteromedial (AM) and posteromedial portals are created for working and instrumentation portals (Fig 2). An arthroscopic examination is done after the portals are created.

Tunnel Creation

The first step is to create the posteromedial portal. The posterior compartment of the knee joint is cleared using a shaver and radiofrequency probe, including the posterior septum if present, until the tibial footprint is fully visualized. The PCL aiming device is introduced into the knee joint through the AM portal and placed at the center of the tibial footprint just above the tibial overhang or about 20 mm below the joint line. A 10-mm tibial tunnel is created, approximately 0.5 mm bigger than the size of the tibial bone plug of the graft for easy graft passage. The center of the femoral footprint is identified. The camera is switched to the AM portal for confirmation of the landmark. A guidewire is then passed though the AL portal, flexed to 120°. The femoral tunnel is then drilled with a 10-mm drill bit to a

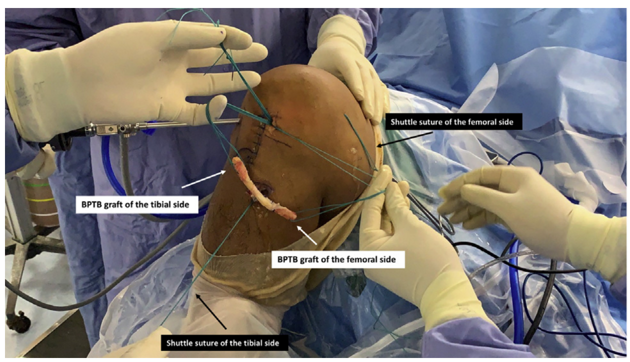

Fig 4. The patient is in the supine position with 90° of right knee flexion. The bone–patellar tendon–bone (BPTB) is prepared before shuttling.

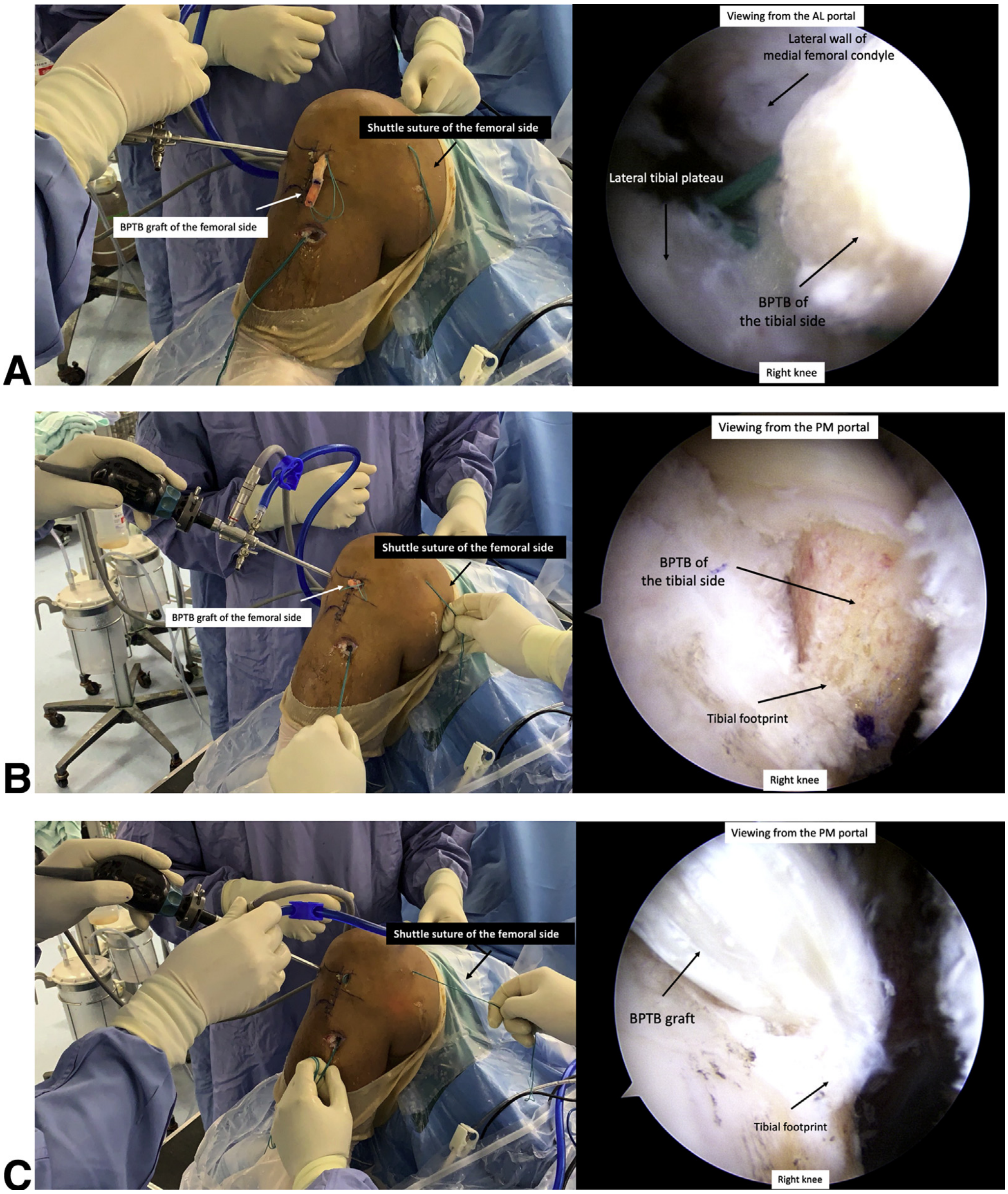

Fig 5. The AL portal and posteromedial portal are viewing portals, whereas the AM portal is the working portal. (A) The BPTB graft beginning on the tibial side is shuttled into the knee joint through the AM portal and (B) pulled down though the tibial tunnel until (C) the entire tibial bone plug has been inserted into the tibial tunnel using the shuttle suture on the tibial side. (AL, anterolateral; AM, anteromedial; BPTB, bone–patellar tendon–bone.)

depth of 25 mm. A shuttle suture is inserted through the femoral tunnel and pulled out of the medial thigh.

Graft Passage

A second shuttle suture is begun on the tibial side, passing into the joint through the tibial tunnel using either a suture retriever or the eyelet of the AL guidewire. With the arthroscope in the posteromedial portal, the suture is then pulled into the notch using the suture retriever from the AM portal. The shuttle sutures of the tibial and femoral side are then grasped together and brought out through the AM portal to avoid a soft tissue bridge. This step allows the surgeon to have 2 shuttle sutures through the AM portal, one through the tibial tunnel and the other through the femoral tunnel (Fig 3). The BPTB graft will then be passed through the AM portal first into the tibial tunnel and then on to the femoral tunnel (Fig 4). The graft passage involves 2 steps. First, the BPTB graft of the tibial side is shuttled into the knee joint (Fig 5A) and pulled down though the tibial tunnel until the entire tibial bone plug has entered into the tibial tunnel using the shuttle suture on the tibial side (Fig 5B). After this step, when the tibial bone plug has engaged the tibial tunnel (Fig 5C),

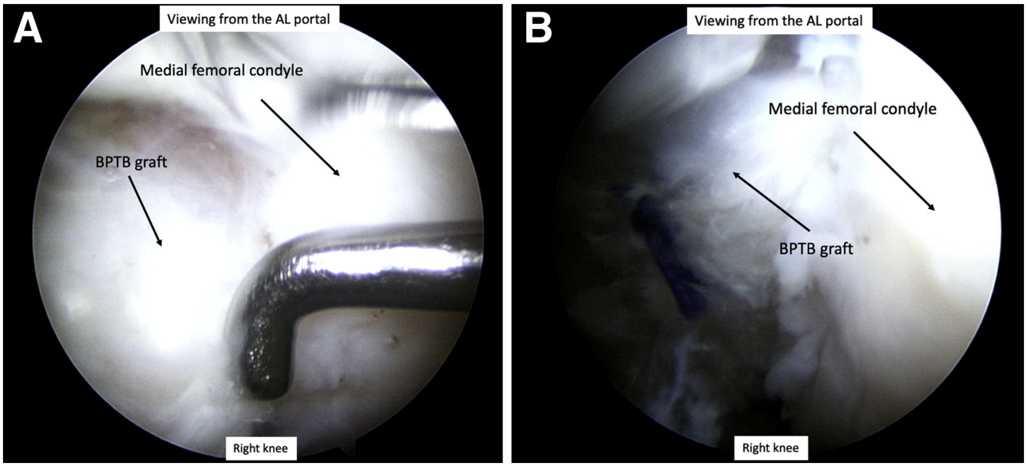

Fig 6. The AL portal and posteromedial portal are viewing portals, while the AM portal is the working portal. (A) The bone plug orientation is adjusted to align with the tunnel using a probe. (B) The femoral bone plug is then pulled until the entire femoral bone plug has entered into the femoral tunnel. (AL, anterolateral; AM, anteromedial.)

the whole femoral bone plug will already be in the intercondylar notch. For the second step, the BPTB graft of the femoral side is passed though the shuttle suture and pulled out of the medial thigh though the femoral tunnel until the femoral bone plug fills the entrance of the femoral tunnel. The bone plug

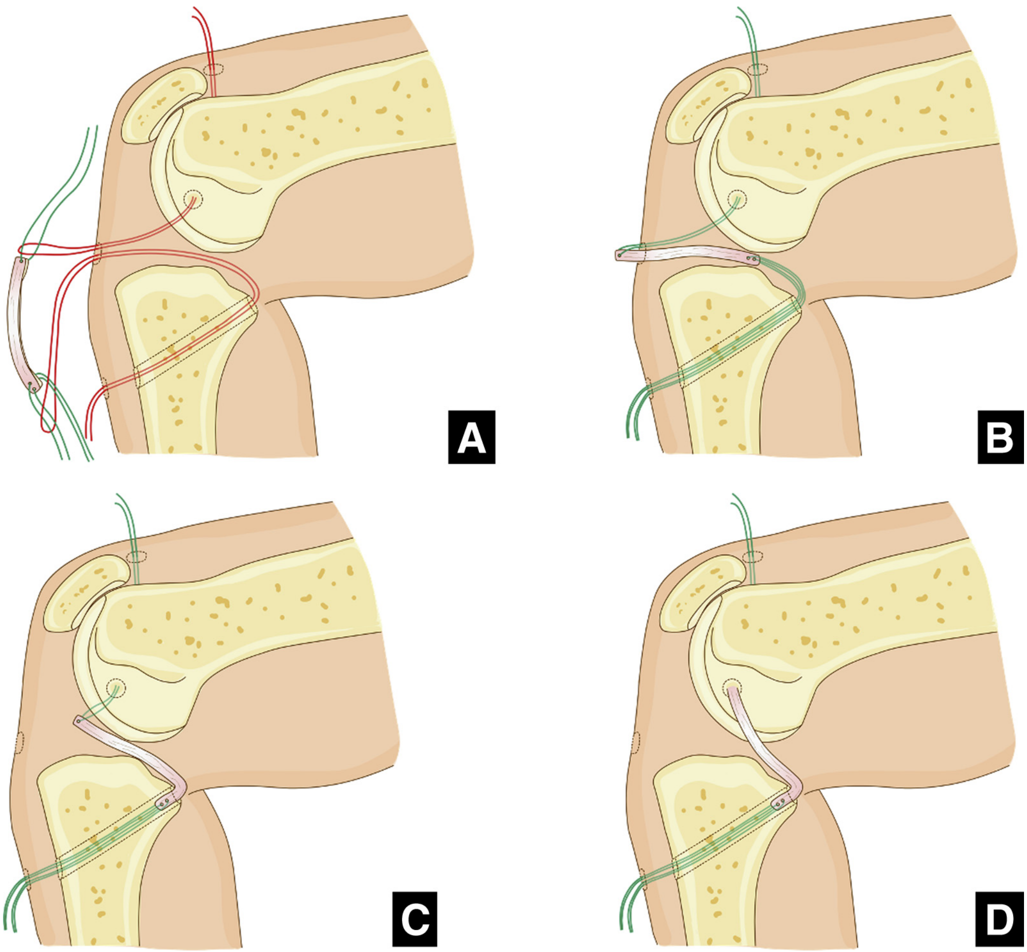

Fig 7. The steps of the graft passage. (A) The BPTB graft is prepared before shuttling. (B) The BPTB graft of the tibial side is shuttled into the knee joint through the AM portal and (C) pulled down though the tibial tunnel until the entire tibial bone plug has entered into the tibial tunnel using the shuttle suture on the tibial side. (D) The BPTB of the femoral side is then pulled until the entire femoral bone plug has passed into the femoral tunnel. (AM, anteromedial; BPTB, bone—patellar tendon—bone.)

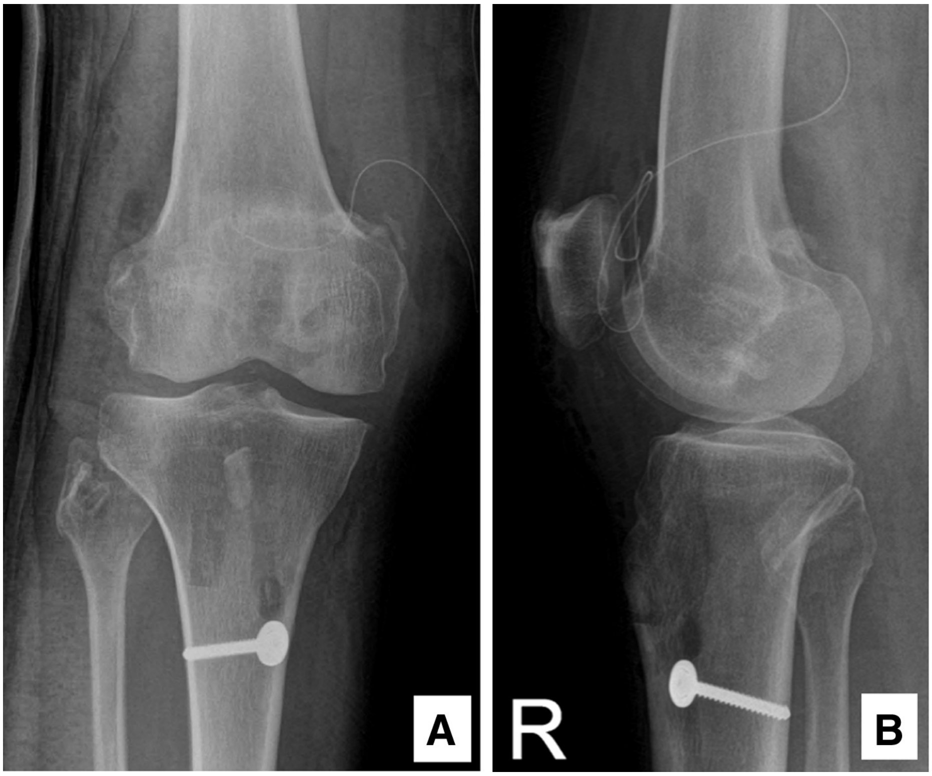

Fig 8. Postoperative radiographs of (A) anteroposterior and (B) lateral views of the right knee following a successful bone—patellar tendon—bone graft.

orientation is adjusted to align with the tunnel using a probe (Fig 6A). The BPTB graft of the femoral side is then pulled until the entire femoral bone plug is firmly sealing the femoral tunnel (Fig 6B). The steps of graft passage are concluded and shown in Fig 7 A-D.

Fixation of the BPTB Graft

The BPTB graft in the femoral side is fixed with BioSure HA (Smith & Nephew, Andover, MA). The range of knee motion is checked by flexing and extending the knee joint at least 10 times to remove any slack before securing the graft on the tibial side, then fixing it with BioSure HA (Smith & Nephew) with the knee in the 90° flexed position while applying anterior translation force. Suture-to-post fixation can be added for more secure fixation in cases of a soft cancellous tibial bone tunnel. After the fixation is secured, the stability of the knee is checked by the reverse Lachman test and posterior drawer test. Postoperative radiographs from an actual procedure are shown in Fig 8 A and B. The entire surgical technique is shown in Video 1, with audio narration. Tables 1 and 2 present pearls, pitfalls, advantages, and disadvantages of using this technique.

Discussion

PCL reconstruction is a common surgical procedure in sports medicine. The autologous graft choices are a hamstring tendon graft, BPTB graft, quadriceps tendon graft, and peroneus longus graft, of which the BPTB graft is most commonly used in PCL reconstruction. For graft passage, the BPTB graft is usually passed from the tibial tunnel to the femoral tunnel which is a difficult maneuver, and entails a high risk of damaging the graft fiber due to the sharp turn during graft passage.

Our proposed surgical technique can be used in a BPTB graft passage, for which the current common procedure is passing the graft from a tibial tunnel to a femoral tunnel. It is always difficult to pass the BPTB graft because of the sharp angulation between the tibial tunnel and the femoral tunnel (killer turns). There is also a risk of graft abrasion that will result in

Table 1. Pearls and Pitfalls

Pearls
Rounding the end of each bone block makes the graft passage into the tunnel easier.
The surgeon should extend the AM portal incision before shuttling the suture loop.
The suture loop in the tibial side is pulled down first, followed by the femoral side.
The stability of the knee should always be tested after the tibial fixation.
Pitfalls
The suture loops of the femoral and tibial sides should be passed through the portal at the same time.
Avoid graft kinking by cycling the graft before tibial fixation.

AM, anteromedial.

Table 2. Advantages and Disadvantages

Advantages	
	The risk of patellar tendon damage during passing the graft is reduced, since sharp killer turns are avoided.
	The operation time is less than the other graft-passage options.
Disadvantages	
	The length of the AM portal is longer than the usual portal.

AM, anteromedial.

graft failure. In such situations, the surgeon can use this proposed transportal graft passage technique to reduce the risk of graft abrasion and graft failure.

This technique also can be applied to pass a hamstring graft, which is commonly used in ACL reconstruction.[7] In graft preparation, the hamstring is divided into 4 to 6 bundles. The graft diameter of the tibial side is normally equal to or bigger than the graft diameter of the femoral side, which is related to the native diameter of the ACL.[8] For graft passage, the ACL graft is usually passed from the tibial tunnel to the femoral tunnel. If the graft cannot be passed due to the graft diameter of the femoral side being bigger than the diameter of the tibial tunnel, there are 2 options. First, the ACL graft can be re-prepared by changing between the tibial and femoral sides, which prolongs the surgical time by about 10 minutes. The second option is making the tibial tunnel wider to accommodate the diameter of the ACL graft in the femoral side, but this will create a size mismatch between the tibial tunnel and the ACL graft on the tibial side, decreasing the pull-out strength. It is easy to pass the BPTB graft and reduce the risk of graft damage when using our the transportal graft passage technique.

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