Remnant-Preserving Posterior Cruciate Ligament Reconstruction: Arthroscopic Transseptal, Rod and Pulley Technique

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Abstract: The preservation of posterior cruciate ligament (PCL) remnant augmentation was recently proposed as a technique for PCL reconstruction. The technique achieved isometry and anatomic position of the PCL graft, but it was technically difficult. The present technique is a modified transseptal technique with visualization from both posteromedial and posterolateral portals. Moreover, this rod-pulley technique could prevent the killer turn effectively. The result was anatomic remnant augmented PCL graft.

Posterior cruciate ligament (PCL) injury usually preserves both femoral and tibial insertion. In the past, the remnant and footprints of PCL were always removed for good visualization of tunnel placement. Recently, many authors proposed the concept of preservation of PCL remnant, which can increase the length of the PCL graft and allow more anatomic positions.1-6 However, their technique still has some drawbacks: the difficulty in passing graft, poor visualization of tibial tunnel guide placement, and the "killer turn" are major problems.3 We proposed our technique of PCL reconstruction, inspired by Ahn’s transeptal remnant preservation technique,3 with good visualization, easy graft passing, and elimination of the killer turn.

Surgical Technique

Patient Setting

Once the anesthesia was satisfactory, the patient was moved down to the caudal part of the surgical table. The caudal part was removed or flexed and something was put under both patient’s thighs; then the patient’s knee and leg can be moved freely. The posterior space of the knee should be enough for arthroscopic working. The other leg should be placed on a leg holder in hip abduction position. The patient should be in supine position, the affected knee in 90° flexion, and the other on the leg holder.

Transeptal Posterior Portals

Standard anteromedial and anterolateral portals were created and then arthroscopic examination was

Fig 1. From the anteromedial viewing portal; remnant of posterior cruciate ligament (*) was left intact.
performed. The 2 cruciate ligaments and both menisci were identified and then the torn meniscus was repaired as indicated. Chronic PCL insufficiency should be found with ligament laxity and positive posterior drawer test. From the anteromedial viewing portal, the PCL remnant could be identified, and then using cautery carefully separated the PCL remnant from the anterior cruciate ligament (Fig 1). After all pathologies in the knee joint were managed, the arthroscope was redirected to the space between the medial condyle and the PCL remnant and passed through to access the posteromedial compartment. With a 30° arthroscopic camera (Smith & Nephew), the viewing camera was turned to the medial wall of the capsule. On turning off the operating theater lights, we could see the transillumination at the posteromedial aspect of the knee (Fig 2). A No. 18 needle (Nipro) was pierced through the knee joint capsule at that point and evaluated for proper positioning with the arthroscope. The posteromedial portal was created at the same point of the needle. The motor shaver and radiofrequency (Smith & Nephew) were used for soft tissue debridement, avoiding injuring the posterior neurovascular structure by working as close to the bone as possible. When the posteromedial compartment was clearly spaced, a Wissinger rod (Arthrex) or switching stick was inserted from the posteromedial portal. The rod was pushed slowly and broken through the posterior septum to the posterolateral compartment. The arthroscopic camera was redirected anteriorly and the rod’s position was confirmed by viewing from the space between the lateral condyle and the anterior cruciate ligament. The rod was pushed again through the lateral joint capsule.
and then we could see the tip of the rod underneath the skin at the posterolateral aspect of the knee. The posterolateral portal was created at the tip of the rod, and then the rod was passed through the portal. After clearing the soft tissue in the posterolateral space, both the posteromedial and posterolateral portals were ready for PCL reconstruction (Fig 3).

Tibial Tunnel Preparation
The PCL graft was harvested and prepared in quadruple and whipstitch fashion. With the arthroscopic camera viewing from the posterolateral portal, the tibial insertion of the original PCL was easily identified. The outside-in PCL drill guide (Smith & Nephew) was placed at the insertion from the posteromedial portal. The guide angle was $55^\circ$ (Smith & Nephew) and aimed at the anteromedial tibia as midline as possible. The tibial tunnel was created with a guide pin and cannulated reamers (Smith & Nephew) until it was equal to the graft size (Fig 4). Finally, the motor shaver was used for removing bone dust and blocked soft tissue.

Femoral Tunnel Preparation
The arthroscopic camera was moved to the anteromedial portal and then the original PCL femoral insertion was easily identified at the wall of the medial femoral condyle. With the knee in deep flexion, the femoral tunnel was created with a guide pin and cannulated reamer (Smith & Nephew) (Fig 5). The bony tunnel depth was measured, and then the proper EndoButton loop (Smith & Nephew) was fixed to the PCL graft. The femoral tunnel was reamed until the diameter was equal to the graft size and the depth was appropriate for the EndoButton loop. The reamer was removed and the guide pin, which was attached to a No. 1 Vicryl (Ethicon) suture loop, was left just at the entrance of the tunnel. All bone dust and soft tissue were removed with the motor shaver.

Graft Passage and Fixation
The PCL graft, which was already prepared with EndoButton loop, was slowly passed through the tibial...
Fig 8. Posterior cruciate ligament reconstruction with remnant augmentation was anatomic and there was no impingement (white arrows). The left picture was from the anterolateral viewing portal. Right picture was from the posterolateral viewing portal.

Fig 9. Radiographs before and after posterior cruciate ligament reconstruction show anatomic tunnels (white arrows).
tunnel until the suture’s end could be seen at the posteromedial compartment. The arthroscopic camera was directed from the posterolateral portal, and the Wissinger rod, from the posteromedial portal and placed anterior to the suture. The suture’s end was retrieved posteromedially to the anterior compartment via the space between the medial femoral condyle and the original PCL remnant. The arthroscopic camera was redirected to the superior space between the anterior cruciate ligament and the original PCL, then looking down for a clear posteromedial view. The PCL graft was slowly passed to the anterior compartment while using the rod as a pulley for graft injury prevention (Fig 6). The arthroscopic camera was moved to the anteromedial portal, and the Vicryl loop was used for retrieving the PCL graft’s suture through the femoral tunnel. The PCL graft was then placed over the remnant of the previous PCL (Fig 7). The arthroscopic camera was moved back to the posterolateral portal. After the PCL graft was pretensioned, the PCL graft was fixed at the tibial site with an interference screw while the knee was in 90° flexion and anterior drawing position. The position of the screw had to be at just the bony cortex of the tibial tunnel, which could be easily seen from the posterolateral view. Impingement and position of the PCL graft could be confirmed again from both the anterolateral and posterolateral viewing portals (Fig 8). Radiographs from before and after PCL reconstruction show the result of anatomic tunnels (Fig 9). Video 1 shows the complete procedure of the right knee PCL reconstruction.

### Discussion

PCL reconstruction with remnant augmentation has a very strong potential for revascularization and healing.1,7 With the original PCL preserved, the patient gained the previous proprioception,5 and postoperative stability was good. The position of the PCL graft was anatomic because the original PCL insertion was intact. Several authors advocated for PCL remnant augmentation reconstruction but with a technically demanding technique. The visualization of the tunnel placements was very difficult. In our technique, however, transseptal portals were created, and the tunnel placements could be clearly seen. The neurovascular structures were left uninjured with our technique, as described in other posterior transseptal techniques.1,3,4

Another drawback of the transtibial technique for PCL reconstruction was the killer turn. Our technique used the Wissinger rod as a pulley for graft passing. The rod prevented the graft from injury due to the tibial killer turn. Moreover, passing the PCL graft over the remnant of a previous PCL would increase the intra-articular length. In this position, the PCL graft would have least excursion and good isometric function throughout the range of motion.6

The advantages of our technique are the creation of transseptal portals with visualization of the posterior compartment and killer turn prevention. A disadvantage is that the critical angle still exists, but we can lessen it with the deep flexion knee. Another drawback is that while creating the tunnels, we injured the original PCL insertion, which is necessary for anatomic tunnel placement. See Table 1. Pearls and Pitfalls of this technique are in Table 2. Hence, PCL reconstruction with remnant augmentation should be the future of transtibial PCL reconstruction. Further research of the results of this technique is needed.

### Table 1. Advantages and Disadvantages

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<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tr>
<td>Clear visualization of posterior compartment and posterior cruciate ligament tibial insertion</td>
<td>More portals created, posteromedial and posterolateral</td>
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<td>Low risk of neurovascular injury</td>
<td>More operative time</td>
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<td>No killer turn effect</td>
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### Table 2. Pearls and Pitfalls

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<th>Pearls</th>
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<tr>
<td>Remove soft tissue for visualization of both the anterior and posterior compartments</td>
<td>Directing the rod posteriorly while breaking the septum can lead to neurovascular injury</td>
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<td>When breaking the posterior septum, keep the rod anterior and close to the bone as much as possible</td>
<td>Mismatch of draft size and tunnel will make graft passing difficult</td>
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<td>Two-step graft passing: posterior tibial tunnel to anterior compartment and anterior compartment to femoral tunnel</td>
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<td>Turn the rod while passing the graft as a pulley</td>
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<td>Anterior draw while performing tibial graft fixation</td>
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References


