



Posterior Cruciate Ligament Reconstruction with Retrograde Femoral Technique, Posterior Trans-septal Portal and Full Tibial Tunnel

Man Soo Kim, M.D., In Jun Koh, M.D., Ph.D., Young Jun Choi, M.D., and Yong In, M.D., Ph.D.

Abstract: Suspensory femoral graft fixation has been a popular and reliable method in anterior cruciate ligament (ACL) reconstruction. Some authors have introduced suspensory femoral fixation in posterior cruciate ligament (PCL) reconstruction using inside-out (IO) technique. The use of IO technique for femoral tunnel preparation could significantly sharpen the critical corner, which might result in graft failure. A retrograde drilling pin that recently has been popular in ACL reconstruction allows “no incision” in the outside-in (OI) technique for the creation of a femoral socket. Here we describe the suspensory femoral fixation using a retro-socket technique in single-bundle PCL reconstruction. By using this technique, it is possible to create a retrograde femoral socket for suspensory femoral fixation in an OI manner in a desirable direction and reduce angulation of the graft in the entry area of the femoral tunnel.

Suspensory femoral graft fixation has been a popular and reliable method in anterior cruciate ligament (ACL) reconstruction.¹ Some authors have introduced suspensory femoral fixation in posterior cruciate ligament (PCL) reconstruction using an inside-out (IO) technique.^{2,3} Handy et al.⁴ have compared critical corner angles between outside-in (OI) and IO techniques for femoral tunnel placement in PCL reconstruction. Although their research was a 2-dimensional cadaveric study, they concluded that the use of an IO technique for femoral tunnel preparation could significantly sharpen the critical corner.⁴ A retrograde drilling pin, FlipCutter (Arthrex, Naples, FL), which has recently become popular in ACL reconstruction, allows “no incision” in outside-in (OI) technique for creation of a femoral socket.⁵

In this Technical Note, we describe a retro-socket technique for suspensory femoral fixation in single-bundle PCL reconstruction using FlipCutter and cortical suspension device TightRope RT (Arthrex) (Video 1, Tables 1-3).

PCL Reconstruction Technique

The patient was placed in a supine position on the operating table with appropriate tourniquet applied over the cast padding. The knee portion of the bed was flexed at more than 90° so the affected knee could freely dangle at the end of the operating table. The opposite limb was positioned in a supporting leg holder at a lithotomy position.

Standard arthroscopic examination was done using standard anteromedial (AM), anterolateral (AL), and superomedial (SM) portals to evaluate PCL lesion and treat the associated lesions, including meniscus, cartilage, etc. When the PCL was ruptured, the ACL appeared pseudo-lax and tightened during an anterior drawer test of the tibia (Fig 1). The arthroscope then passed easily from the AL portal to the posteromedial (PM) compartment through the intercondylar notch with knee flexion of 90°. The arthroscope was placed in the PM compartment and advanced medially as much as possible. From outside, the medial wall of the PM compartment was directly palpated and the soft spot was located between the medial collateral ligament, the medial head of the gastrocnemius muscle, and the

From the Department of Orthopaedic Surgery, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Republic of Korea.

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Address correspondence to Yong In, M.D., Ph.D., Department of Orthopaedic Surgery, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, 222 Banpo-Daero, Seocho-Gu, Seoul 06591, Republic of Korea. E-mail: iy1000@catholic.ac.kr

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Table 1. Step-by-Step Details of Technique

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| 1. Patient positioning and preparation of portals |
| a. Supine position with knee flexion more than 90° for free dangling of the affected knee |
| b. Anteromedial, anterolateral, posteromedial, posterolateral, and trans-septal portals |
| 2. Graft preparation |
| a. Tibialis anterior or posterior allograft tendon |
| b. Whip-stitched at both ends using no. 5 Ethibond suture |
| c. Two equal strands using the loop of the TightRope RT |
| 3. Tibial tunnel formation |
| a. Transtibial technique with 55° of tibial PCL guide |
| b. Targeting toward the PCL fossa and lateral portion of the PCL stump |
| 4. Femoral tunnel formation |
| a. Outside-in retro-socket technique using FlipCutter |
| b. 60° of femoral PCL guide |
| c. Debridement of PCL remnants for easy graft passage after creation of femoral tunnel |
| 5. Graft passage and fixation |
| a. Using the looped wire for graft passage |
| b. Graft passage with caudo-cranial direction from the tibial tunnel to the femoral tunnel |
| c. Advancement of graft by pulling the tensioning strands in the same direction of graft passage |
| d. Tibial fixation using bio-absorbable interference screw, metal screw, and spike washer with anterior drawer force |

PCL, posterior cruciate ligament.

semimembranosus tendon.⁶ An 18-gauge spinal needle was used to make the PM portal just above the joint line under arthroscopic view. A small longitudinal incision was made on the PM compartment using a no. 11 blade. It was important to observe the needle under direct visualization to prevent close placement of the needle to the medial femoral condyle. If the PM portal was created too close to the medial femoral condyle, it would be hard to handle the instruments. The posterolateral (PL) portal was also made using a switching stick inserted into the PM portal to PL compartment with penetration of the posterior septum. It was established on the palpable point of the switching

Table 2. Advantages and Disadvantages of Retro-Socket Technique for Suspensory Femoral Fixation in Posterior Cruciate Ligament Reconstruction

Advantages

1. It is possible to create a retrograde femoral socket in the outside-in manner in a desirable direction.
2. This technique creates less graft angulation on the entry area of the femoral tunnel.
3. This method helps avoid violation of the vastus medialis oblique muscle with the drill.
4. Suspensory fixation is possible using a button.

Disadvantages

1. It is difficult to use the autograft because of the need for a relatively long graft, as the usual disadvantage of transtibial techniques.
2. Posterior arthroscopy including making a trans-septal portal is a technically demanding procedure, which is the usual disadvantage of transtibial techniques.

Table 3. Tips, Pearls, and Pitfalls

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| Tips and Pearls |
| Trans-septal portal for direct visualization of the PCL stump |
| 55° of the tibial drill guide for producing oblique tibial tunnel |
| >70° of knee flexion for protecting the posterior neurovascular structures |
| The adequate exposure of the posterior tibia for optimal tibial tunnel |
| Penetration of the posterior tibial cortex in a controlled manner under direct visualization of the arthroscope |
| Using the looped wire for easy graft passage |
| Pitfalls |
| The possibility of the killer turn observed in transtibial techniques for the tibial tunnel |
| Suturing both ends of the tendon smoothly and nondistended for preventing the catching of the graft during the intra-articular passage |
| PCL, posterior cruciate ligament. |

stick. The trans-septal portal was made by connecting the PM and PL portal.^{7,8}

The tibialis anterior or posterior allograft tendon (Community Tissue Services, Kettering, OH) was used for graft preparation and a 2-strand graft with a minimum length of 10 cm was prepared. The allograft tendon was whip-stitched at both ends using a no. 5 Ethibond suture (Ethicon, Somerville, NJ). One free end of the graft was passed inside the loop of the TightRope RT and 2 equal strands were made by folding the graft.

A 2-cm longitudinal skin incision was made on the medial portion of the proximal tibia, just 3 to 4 cm distal to the joint line for contact of the tibial drill guide. Under direct visualization with the arthroscope from the PM portal, the PCL guide was inserted from the AM portal at an angle of 55° to decrease the acute angulation at the posterior tibia. A metal stick was inserted carefully from the PL portal to free up the posterior capsule behind the remaining PCL fibers. The neurovascular structures could be protected by this procedure as a result of the posterior displacement of the capsule. The guide pin was targeted toward the PCL fossa and the lateral portion of the PCL stump.^{9,10} A tibial tunnel guide pin was inserted carefully under direct visualization. When the tip reached the posterior cortex, the drilling speed was slowed down so as not to penetrate the cortex suddenly. The tibial tunnel was made using a reamer with the same size of the graft diameter after inserting the PCL guide pin. The migration of guide pin was prevented by positioning of a curved curette at the end of the guide pin. A twisted wire was prepared and passed from the proximal tibial opening. It brought out the AM portal using a grasper through the tibial tunnel.

The femoral tunnel was created using the OI retro-socket technique. The arthroscope was inserted via the AL portal and the femoral guide set was introduced via an AM portal at an angle of 60° using a FlipCutter



Fig 1. The right knee is shown. The arthroscope is inserted through the anterolateral portal for visualization. Arthroscope shows anterior cruciate ligament pseudo-laxity due to posterior subluxation of the tibia in posterior cruciate ligament rupture.

drill guide system. The tip of the guide hook was located 8 mm from the articular surface of the medial femoral condyle at an approximately 2 o'clock position on the right knee and a 10 o'clock position on the left knee (Fig 2). A stab incision was made anteromedially over the vastus medialis oblique (VMO) muscle at the level of the superior pole of the patella. The FlipCutter was

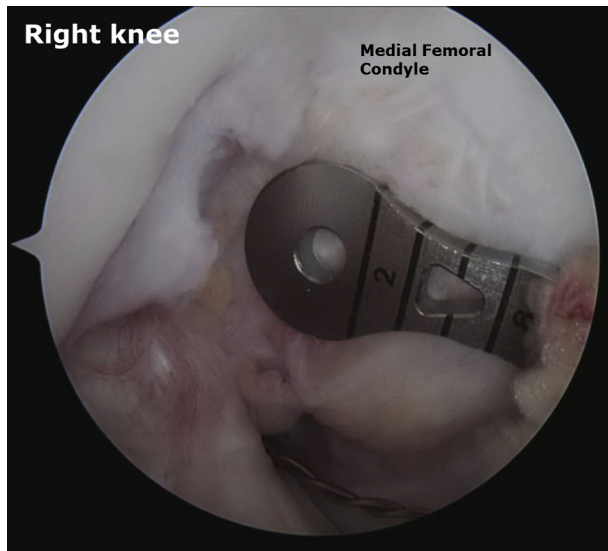


Fig 2. The arthroscope is inserted through the anterolateral portal for visualization, and a femoral guide set is introduced from the anteromedial portal. The tip of the femoral guide hook is positioned 8 mm from the articular surface of the medial femoral condyle at an approximately 2 o'clock position on the right knee and at the 10 o'clock position on the left knee for femoral tunnel.

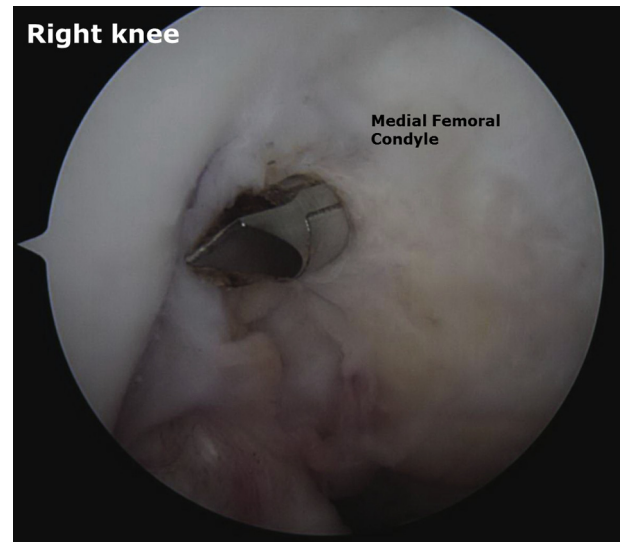


Fig 3. Viewing from the anterolateral portal, the FlipCutter tip is advanced with forward drilling into the knee joint. The right knee is shown in supine position with the knee flexed to 90°.

advanced with forward drilling into the knee joint (Fig 3). Once the FlipCutter entered from the outside, the 7-mm drill sleeve tip was tightly tapped into bone. The blue hub was unscrewed in a counterclockwise direction. The FlipCutter tip was slid forward to flip the tip into retrograde reaming position (Fig 4). The blue hub was retightened in a clockwise direction to lock the blade at 90°. The depth marker was set to the base of the drill sleeve. The FlipCutter was drilled on forward setting while pulling distally to create the socket. The socket length could be read off of the pin. Usually 20 mm of femoral socket was created (Fig 5). The blade was straightened again in the joint and the blue hub was slid back.

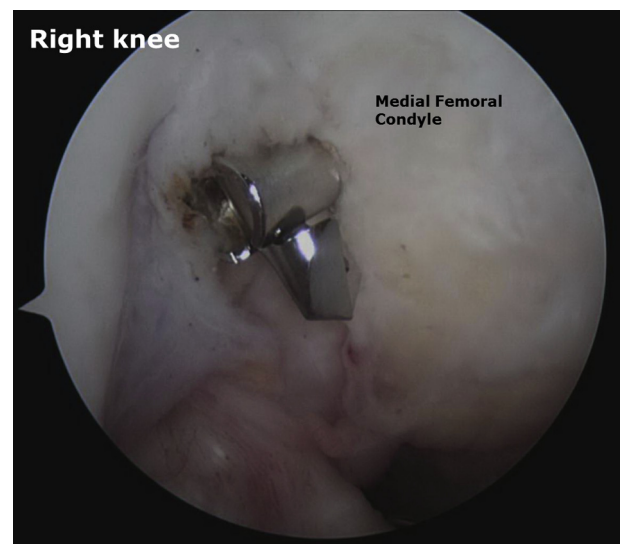


Fig 4. Viewing from the anterolateral portal, the FlipCutter tip is folded until it is perpendicular to the shaft. The right knee is shown in supine position with the knee flexed to 90°.



Fig 5. The right knee is shown. The patient is placed in a supine position on the operating table with appropriate tourniquet applied over the cast padding. The knee portion of the bed is flexed at more than 90° for free dangling of the affected knee at the end of the operating table. The femoral guide is inserted via an anteromedial portal at a 60° angle using a FlipCutter drill guide system. The arthroscope is inserted through the anterolateral portal. The socket length could be read off of the pin. Usually 20 mm of the femoral socket is created.

The looped wire for the graft passage was inserted through the drill sleeve to reach the AM portal. The graft passage was done stage by stage. The prepared graft was first passed into the knee joint through the tibial tunnel from the proximal tibia using a twisted wire under direct arthroscopic vision in the AL portal. Next, the tendon portion of the graft was passed into the femoral tunnel with the aid of a femoral wire shuttle. The TightRope RT button should be directly visualized to pass the femoral socket without difficulty (Fig 6). The graft was advanced by pulling the tensioning strands in the same direction as graft advancement.

After proper seating of the tendon graft in the femoral tunnel, retensioning of the graft was done by moving the knee 20 times through a full range of motion while pulling on the graft prior to tibial graft fixation. An anterior drawer force was applied to the proximal aspect of the tibia with the knee flexed at 70° to 90°. Tibial fixation was achieved with a long bio-absorbable interference screw (BioComposite screw; Arthrex) that was oversized by 0.5 to 1 mm with respect to the tibial tunnel diameter. The distal free end of the graft was secured with a metal screw (Post and Washer; Arthrex) and spike washer onto the anteromedial tibial cortex. Finally, tensioning of the grafted PCL was performed (Fig 7). Postoperative radiographs were also checked (Fig 8).

Discussion

Surgical treatment of PCL injuries remains challenging because of difficulty in technique and variability

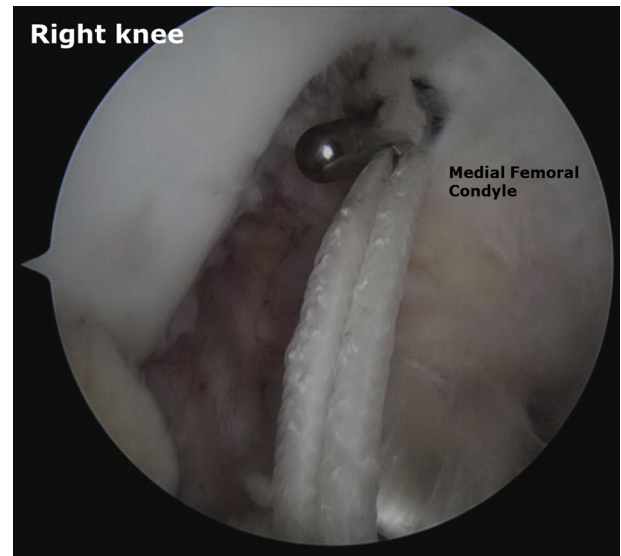


Fig 6. The arthroscope is inserted through the anterolateral portal for visualization. The TightRope RT button should be directly visualized to pass the femoral socket. The right knee is shown in supine position with the knee flexed to 90°.

in outcome.^{11,12} Several techniques and devices have been used for fixation of a PCL reconstruction.¹³ Nevertheless, several techniques have been used for femoral tunnel creation, and the OI and IO techniques have been the most popular choices. In the IO technique for femoral tunnel preparation, the guide pin was placed in the notch through the AL portal and advanced until it penetrated the medial femoral cortex.¹² Although this technique can minimize damage to the VMO muscle and avoid an additional incision with less

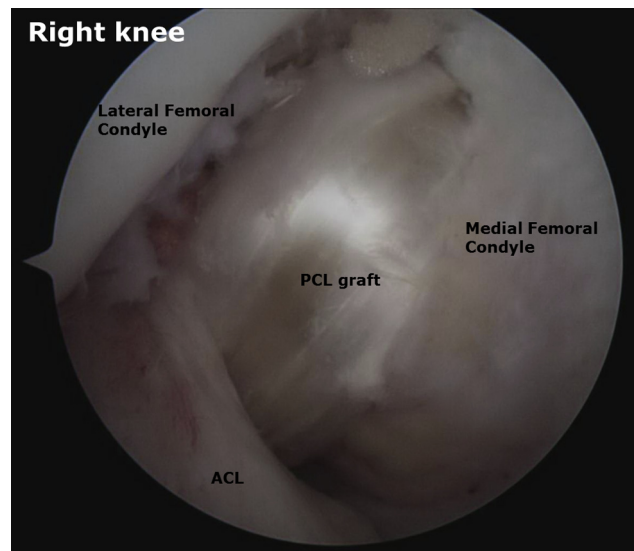


Fig 7. Viewing from the anterolateral portal, the reconstructed graft is well positioned, with adequate tension. The right knee is shown in supine position with the knee flexed to 90°. (ACL, anterior cruciate ligament; PCL, posterior cruciate ligament.)

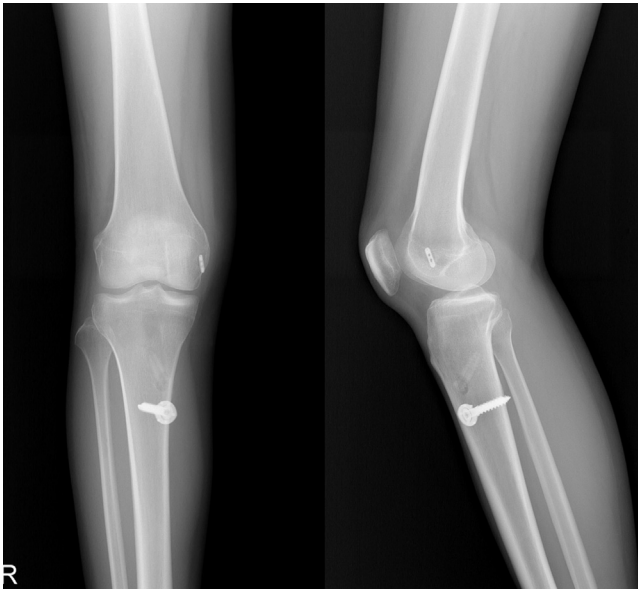


Fig 8. The right knee is shown. Postoperative anteroposterior and lateral radiographs showing well-seated TightRope RT button on the medial portion of the distal femur.

bone removal, with consequent reduction in the risk of medial femoral condyle osteonecrosis, this can result in restricted direction of the tunnel.¹¹ Poor femoral tunnel orientation may result in excessive femoral-sided graft angulation.² This could be potentially worse than the killer turn described for the tibial tunnel.² In contrast, the OI technique for femoral tunnel creation uses a guide to drill into the notch from outside the femoral cortex. During PCL reconstruction, the graft/femoral tunnel angle (critical corner angle) is critical and a contributing factor of early loosening and failure of the PCL.¹² The OI technique has a lower graft-femoral tunnel angle compared with the IO technique, which has high graft-femoral angles with increased shear stress and internal graft pressure.¹² Handy et al.⁴ have reported that the IO technique has a significantly sharp critical corner angle compared with the OI technique, which means that there is biomechanical disadvantage in the IO technique compared with the OI technique.

The conventional OI technique has shortcomings such as violation of VMO muscle and additional incision, which could be harmful to the extensor mechanism, with enhanced risk of osteonecrosis because of more bone removal.¹² Our technique minimized such disadvantages mentioned above by using TightRope RT and FlipCutter. FlipCutter was used for the bone-sparing procedure without violating VMO or soft tissue. Retrograde socket technique using FlipCutter has shown reduced fragmentation of tunnel rims and smooth, consistent walls of tunnel compared with an antegrade technique.¹⁴ The maintenance of tunnel rim integrity could provide better graft-tunnel interface and

superior graft incorporation and fixation with minimized tunnel widening.¹⁴

Some studies reported that cortical suspensory fixation device resulted in tunnel widening because of micromotion of the graft within the bone tunnel during loading.^{15,16} However, the stability and biomechanical properties of cortical button fixation was proved in many studies despite the concern of tunnel widening.¹⁷ There were no differences in anteroposterior stability and other clinical outcomes between cortical suspensory device and interference screw fixation.¹⁸ All fixation techniques had similar results for fixation, without the superiority.^{1,17,18}

We believe that our technique has some advantages. One of the main advantages of this technique is that making a femoral socket in the desired direction is possible with less graft angulation in the entry area. In addition, violation of the VMO muscle can be avoided with retro-drilling. The FlipCutter pin measures 3.5 mm in diameter, allowing femoral socket creation through portal-sized “stab incisions” (Table 2). Furthermore, we used a trans-septal portal for direct visualization of the PCL stump (Table 3).

However, our technique also has several disadvantages. First, it is difficult to use autograft because of the need for a relatively long graft. Second, posterior arthroscopy including a trans-septal portal is a technically demanding procedure. In addition, this technique is a single-bundle reconstruction technique that might not be appropriate for surgeons who favor a double-bundle reconstruction technique. However, a retro-socket technique can be used for double-bundle reconstruction with 2 retro-sockets.

Our retro-socket technique for suspensory femoral fixation can provide a precise PCL reconstruction with correct, anatomic femoral bone tunnels in the desirable direction.

References

1. Saccomanno MF, Shin JJ, Mascarenhas R, et al. Clinical and functional outcomes after anterior cruciate ligament reconstruction using cortical button fixation versus transfemoral suspensory fixation: A systematic review of randomized controlled trials. *Arthroscopy* 2014;30:1491-1498.
2. Ohkoshi Y, Nagasaki S, Yamamoto K, et al. A new endoscopic posterior cruciate ligament reconstruction: Minimization of graft angulation. *Arthroscopy* 2001;17:258-263.
3. Ohkoshi Y, Nagasaki S, Yamamoto K, et al. Description of a new endoscopic posterior cruciate ligament reconstruction and comparison with a 2-incision technique. *Arthroscopy* 2003;19:825-832.
4. Handy MH, Blessey PB, Kline AJ, Miller MD. The graft/tunnel angles in posterior cruciate ligament reconstruction: A cadaveric comparison of two techniques for femoral tunnel placement. *Arthroscopy* 2005;21:711-714.

5. Lubowitz JH, Ahmad CS, Anderson K. All-inside anterior cruciate ligament graft-link technique: Second-generation, no-incision anterior cruciate ligament reconstruction. *Arthroscopy* 2011;27:717-727.
6. Ogilvie-Harris DJ, Biggs DJ, Mackay M, Weisleder L. Posterior portals for arthroscopic surgery of the knee. *Arthroscopy* 1994;10:608-613.
7. Kim JM. Direct posterior-posterior triangulation of the knee joint. *Arthroscopy* 1997;13:262-264.
8. Ahn JH, Ha CW. Posterior trans-septal portal for arthroscopic surgery of the knee joint. *Arthroscopy* 2000;16:774-779.
9. Shin YS, Han SB, Hwang YK, Suh DW, Lee DH. Tibial tunnel aperture location during single-bundle posterior cruciate ligament reconstruction: Comparison of tibial guide positions. *Arthroscopy* 2015;31:874-881.
10. Lee YS, Ko TS, Ahn JH, et al. Comparison of tibial tunnel techniques in posterior cruciate ligament reconstruction: C-arm versus anatomic fovea landmark. *Arthroscopy* 2016;32:487-492.
11. Zawodny SR, Miller MD. Complications of posterior cruciate ligament surgery. *Sports Med Arthrosc* 2010;18:269-274.
12. Schoderbek RJ Jr, Golish SR, Rubino LJ, Oliviero JA, Hart JM, Miller MD. The graft/femoral tunnel angles in posterior cruciate ligament reconstruction: A comparison of 3 techniques for femoral tunnel placement. *J Knee Surg* 2009;22:106-110.
13. Hoher J, Scheffler S, Weiler A. Graft choice and graft fixation in PCL reconstruction. *Knee Surg Sports Traumatol Arthrosc* 2003;11:297-306.
14. Lopes R, Klouche S, Odri G, Grimaud O, Lanternier H, Hardy P. Does retrograde tibial tunnel drilling decrease subchondral bone lesions during ACL reconstruction? A prospective trial comparing retrograde to antegrade technique. *Knee* 2016;23:111-115.
15. Stener S, Ejerhed L, Sernert N, Laxdal G, Rostgard-Christensen L, Kartus J. A long-term, prospective, randomized study comparing biodegradable and metal interference screws in anterior cruciate ligament reconstruction surgery: Radiographic results and clinical outcome. *Am J Sports Med* 2010;38:1598-1605.
16. Baumfeld JA, Diduch DR, Rubino LJ, et al. Tunnel widening following anterior cruciate ligament reconstruction using hamstring autograft: a comparison between double cross-pin and suspensory graft fixation. *Knee Surg Sports Traumatol Arthrosc* 2008;16:1108-1113.
17. Kamelger FS, Onder U, Schmoelz W, Tecklenburg K, Arora R, Fink C. Suspensory fixation of grafts in anterior cruciate ligament reconstruction: A biomechanical comparison of 3 implants. *Arthroscopy* 2009;25:767-776.
18. Lubowitz JH, Schwartzberg R, Smith P. Cortical suspensory button versus aperture interference screw fixation for knee anterior cruciate ligament soft-tissue allograft: A prospective, randomized controlled trial. *Arthroscopy* 2015;31:1733-1739.