Technical Note

Nanoscopic-Assisted Anterior Cruciate Ligament–Posterior Cruciate Ligament Reconstruction

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Abstract: Knee arthroscopy has allowed us to continue performing surgeries that are minimally invasive and allow patients to have a quick recovery. Multiligamentous knee reconstruction with regards to the anterior cruciate ligament and posterior cruciate ligament can be done in a minimally invasive matter. Visualization is an issue during this surgery, especially looking in the posterior compartment of the knee. The NanoScope (Arthrex, Naples, FL) continues to provide increased possibilities for orthopaedic surgeons. Our technique provides a less-invasive way to observe the posterior compartment to assist the drilling of the tibial tunnel during the posterior cruciate ligament reconstruction. This technique provides distinct advantages over other treatments.

Introduction (With Video Illustration)

Multiligamentous knee reconstruction is a complicated surgery for any orthopaedic surgeon. Generally, only highly specialized orthopaedists should attempt to correct this issue. Careful assessment of vasculature, physical examination findings, and magnetic resonance imaging help discern further treatment.[1] The timing of when to fix these is controversial, with some literature stating it is better to fix acutely versus a delayed fashion.[2,3] Issues with multiligamentous reconstruction include posterior cruciate ligament (PCL) fixation. In an isolated PCL injury, the mainstay of treatment is nonoperative.[4] If both your anterior cruciate ligament (ACL) and PCL are ruptured, then it is advantageous to reconstruct both of them.[5] The difficulty with PCL surgery is the visualization of the back of the knee when you are preparing and drilling your tibial tunnel. A posteromedial (PM) portal can be made; however, there are dangerous structures that can be lacerated when you make this portal with an incision.[6] These structures include the popliteal artery, which is less than 1 cm from the PCL insertion, as well as the tibial nerve. The NanoScope (Arthrex, Naples, FL) is an advanced miniaturized arthroscope with a single-use camera that can be inserted into a joint without the need for a traditional incision. In addition to less blood loss and the potential for a quicker recovery, the NanoScope uses only a 1.9-mm puncture of the for visualization, without making an incision in the capsule. We demonstrate below a technique using a NanoScope (Arthrex) to assist with ACL-PCL reconstruction. This allows for visualization of the posterior aspect of the tibia during preparation, drilling, and graft passage. Video 1 and Figs 1-8 show the nanoscopic-assisted ACL-PCL reconstruction

Graft Preparation

Allograft GraftLink (Arthrex) constructs are made with an Adjustable Button System (ABS) (Arthrex) and bone–patella tendon–bone TightRope (Arthrex) loaded to the tibial and femoral side of the 2 grafts, respectively. The ACL graft should be around 68 mm in length and the PCL around 90 mm.

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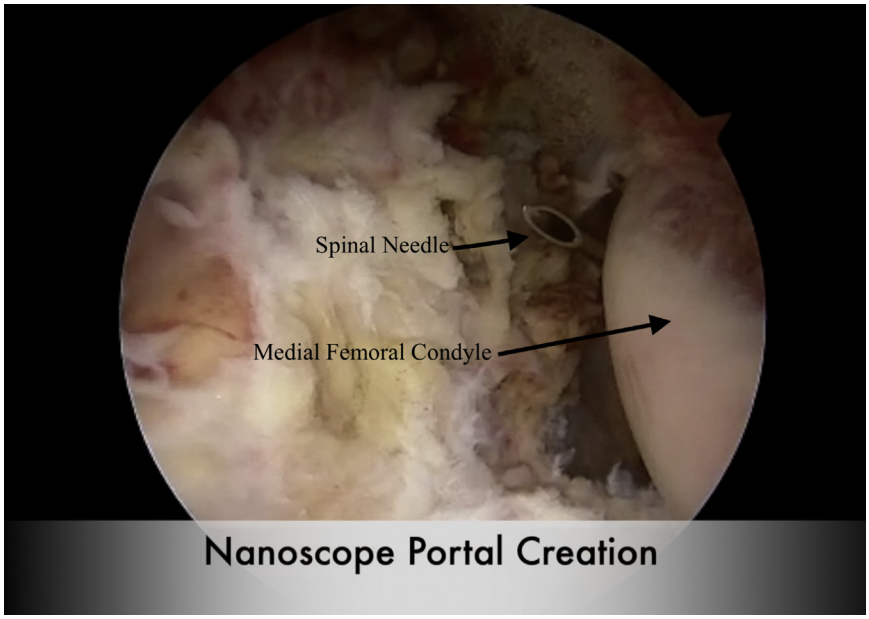

Fig 1. Viewing the right knee in flexion with the 30° arthroscope placed in the anterolateral portal, the spinal needle can be seen placed from the posteromedial aspect of the knee.

PCL Technique

Diagnostic Arthroscopy

The knee is placed in 90° of flexion and an anterolateral portal is made in a transverse fashion. The 30° arthroscope is placed into the patellofemoral joint with the knee in extension and brought to the medial compartment where a spinal needle is used to make a medial portal in outside in fashion. This portal needs to be large enough to fit a 9-mm graft through and a standard diagnostic arthroscopy is performed and reveals an ACL and PCL rupture.

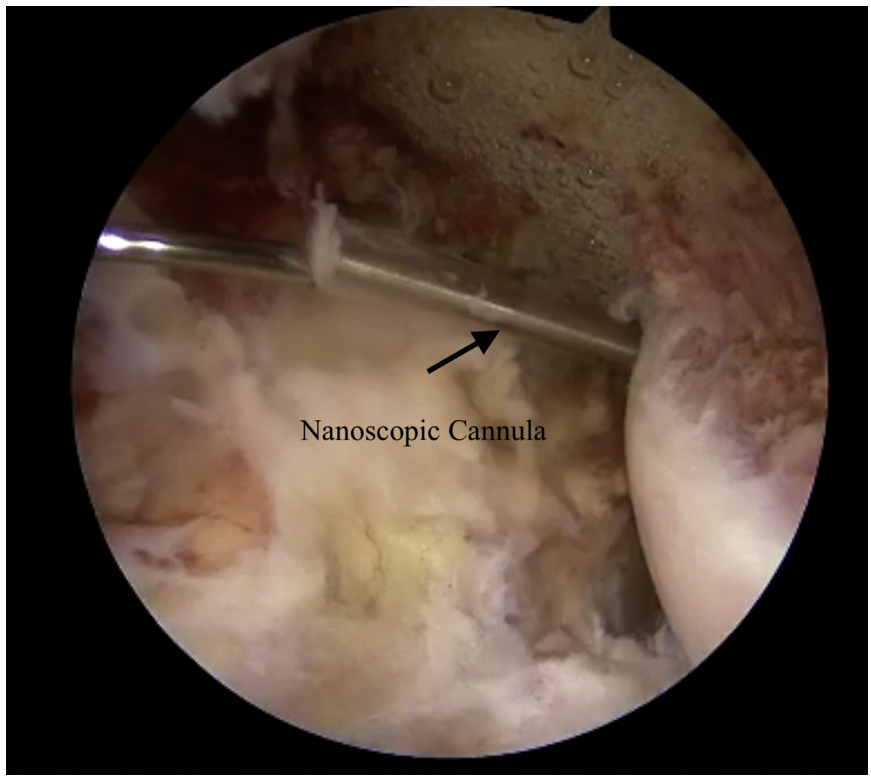

Fig 2. Viewing the right knee in flexion with the 30° arthroscope placed in the anterolateral portal, the NanoScope cannula and nitinol wire can be seen coming from the posteromedial area of the knee.

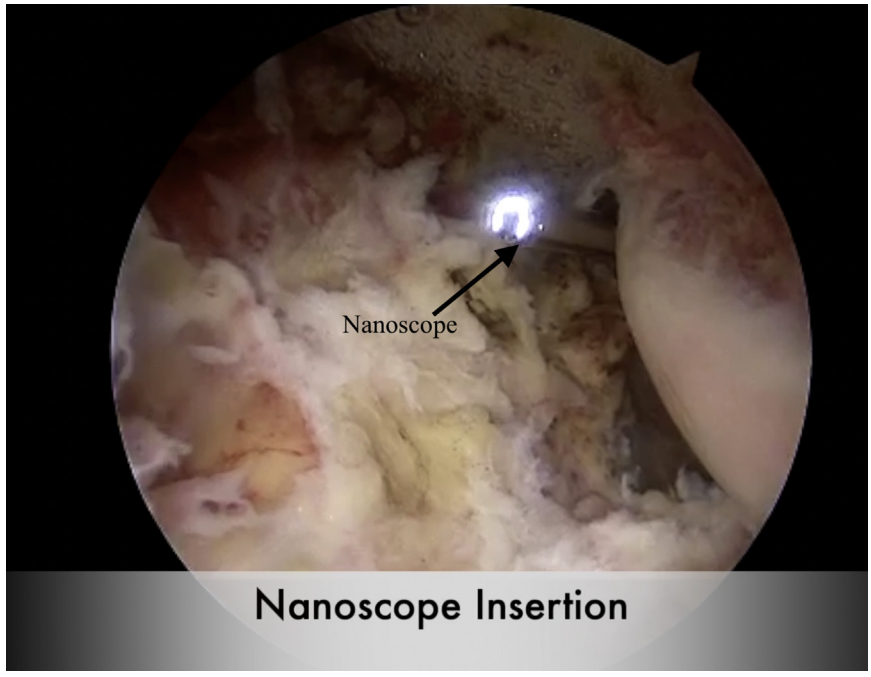

Fig 3. Viewing the right knee in flexion with the 30° arthroscope placed in the anterolateral portal, the Nanoscope is seen inserted from the posteromedial portal of the knee.

Initial Debridement

From the anterolateral and anteromedial portals, the intercondylar notch is debrided to remove remnants of the ACL and PCL ligaments. At this time, a notchplasty is performed for the ACL reconstruction of the lateral intercondylar notch from the medial portal with a burr. The 30° arthroscope is placed into the lateral portal to begin the PCL reconstruction portion of the case.

NanoScope Placement

With the knee in 90° of flexion, the intercondylar notch is thoroughly debrided. The PCL is reconstructed first in an all-inside fashion. The standard 30° arthroscope is placed into the lateral portal and a spinal needle is inserted from a standard posteromedial portal location (Fig 1). A nitinol wire is inserted through the spinal needle and a curved high flow sheath for the NanoScope (Arthrex) is then inserted (Fig 2). The NanoScope is then placed through the cannula and you can view the posterior tibia with both scopes (Fig 3).

PCL Tibia Technique

A curved electrocautery device and curved curette are then used to find the appropriate landmarks on the posterior tibia for locations of the tibial tunnel

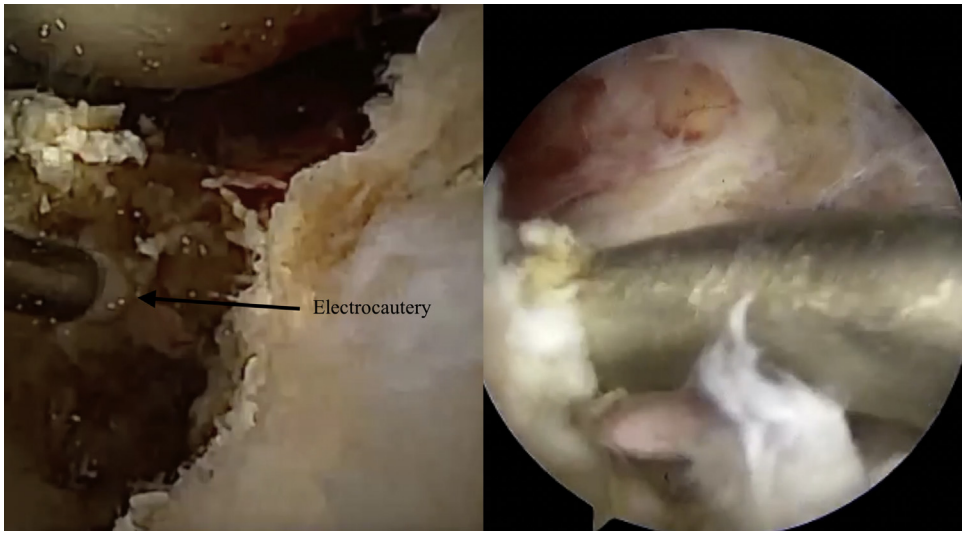

Fig 4. The right knee is being viewed in flexion. The left side of the screen is viewing from the posteromedial knee with the 0° NanoScope and you can see the electrocautery being used on the tibia. The right side of the screen is viewing with the standard 30° arthroscope from the anterolateral portal.

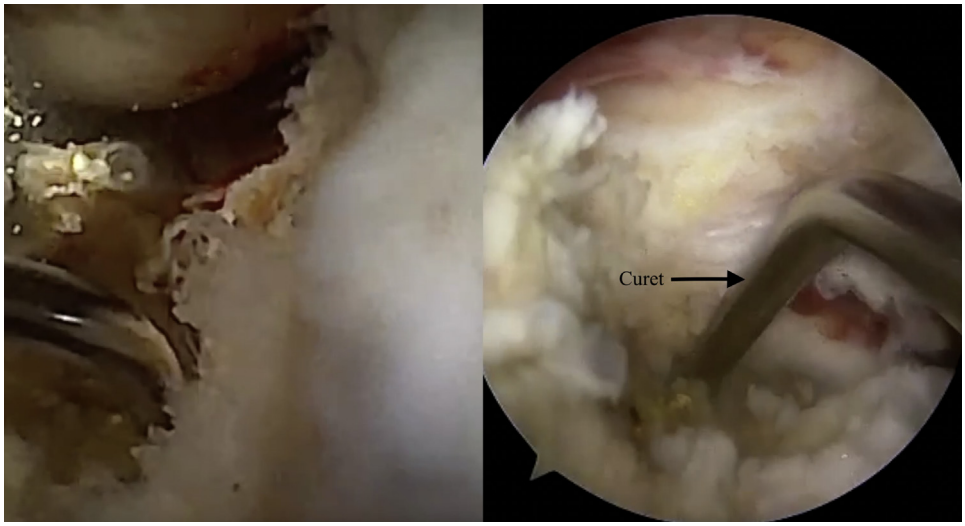

Fig 5. The right knee is being viewed in flexion. The left side of the screen is viewing from the posteromedial knee with the 0° Nanoscope and you can see the curette being used on the tibia. The right side of the screen is viewing with the standard 30° arthroscope from the anterolateral portal.

(Figs 4 and 5). The PCL tibial guide is then placed at 65° with the guide set along the medial tibia. We then check with a lateral view of the tibia the location of the guide and begin drilling the FlipCutter (Arthrex) into the tibia (Fig 6). While viewing with the Nanoscope posteriorly, we can safely see the tibial FlipCutter come into view. The FlipCutter guide is tapped into the bone to prevent breaching the tibial cortex. The curette is used or a Freer is used as retraction and the FlipCutter is then deployed to begin retrograde drilling the socket. A FiberStick is placed through the guide and brought out medially.

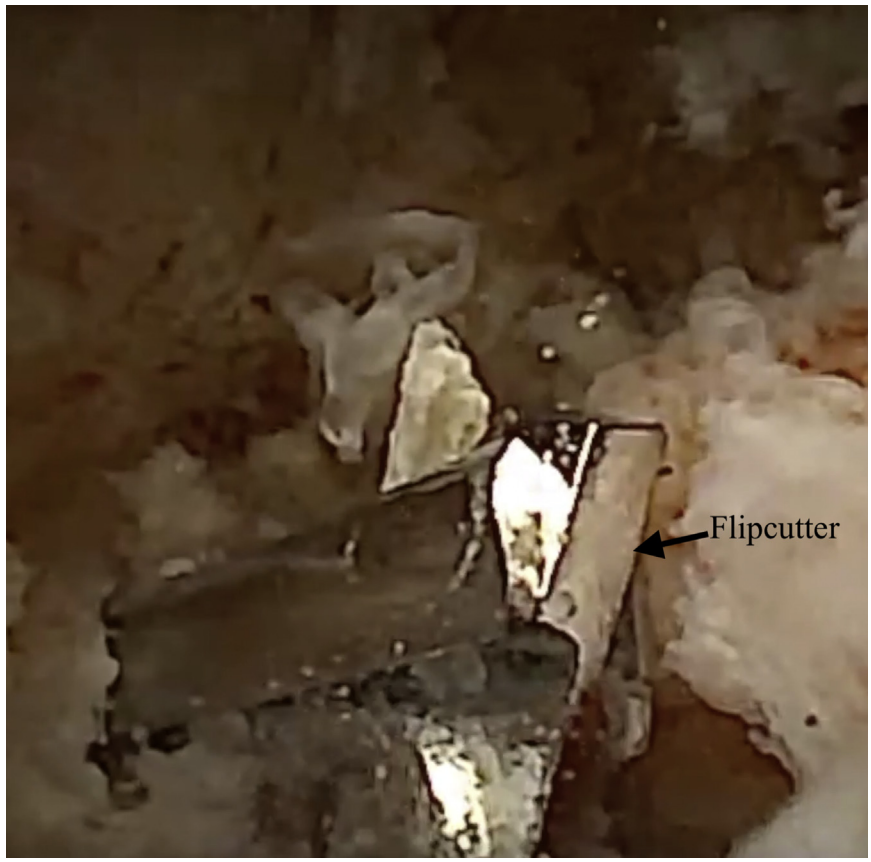

Fig 6. The right knee is being viewed in flexion. We are viewing from the posteromedial knee with the 0° NanoScope and you can see the FlipCutter brought through the tibia.

Fig 7. The right knee is being viewed in flexion. We are viewing with the standard 30° arthroscope from the anterolateral portal. The FiberStick has been placed up through the tibial tunnel.

PCL Femoral Technique

A PCL femoral guide is place high and anterior on the medial intercondylar notch at around 90° . This tunnel is then drilled in standard fashion. A FiberStick is placed through that tunnel and also brought out medially (Fig 7).

PCL Fixation

The tibial side of the graft is loaded into the tibial tails first and brought down into the tibia socket. This step can also be viewed with the NanoScope. It may be useful to use a freer to make sure the graft goes into the tibial tunnel in line with the socket posteriorly. The femoral side of the graft is pulled into the femur and the femoral button is flipped. Next with the knee in 90° of flexion and an anterior drawer applied the tibia, the ABS sutures are placed through a 14-mm button and the white pulling sutures are sequentially pulled to provide tibial fixation.

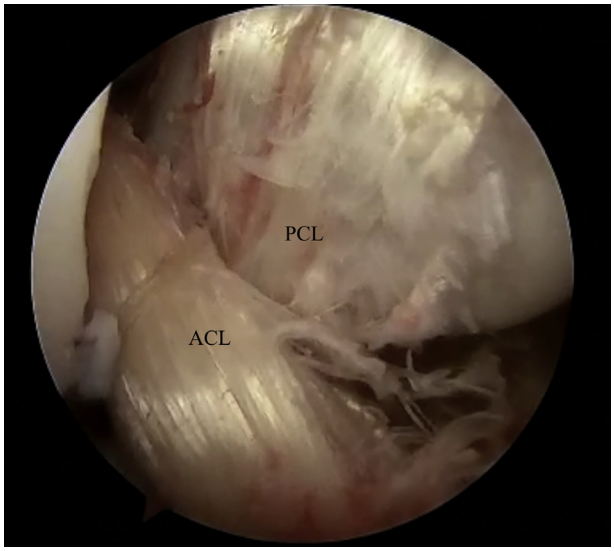

Fig 8. The right knee is being viewed in flexion. We are viewing with the standard 30° arthroscope from the anterolateral portal. The ACL-PCL reconstruction grafts can be seen with appropriate tension. (ACL, anterior cruciate ligament; PCL, posterior cruciate ligament.).

Table 1. Pearls and Pitfalls of Nanoscopic-Assisted ACL-PCL Reconstruction

Pearls
• A nanoscopic high-flow cannula should be used to improve visualization
• Initial spinal needle placement for NanoScope needs to be placed with precision to allow for appropriate visualization
• Use a Freer or shaver to remove tissue posteriorly that would block the NanoScope view
Pitfalls
• Soft tissue posteriorly can get in the way of visualizing with NanoScope
• The angle of NanoScope entry may take a few attempts before it is appropriate

ACL Technique

A standard all-inside ACL technique is performed. A femoral guide is placed on the femur around 60% anterior from the posterior edge of the femur. The FlipCutter is drilled into the joint and the guide is malleted into the bone 7 to 8 mm to prevent breaching the cortex and the socket is drilled in a retrograde fashion. A FiberStick is placed down through that guide. That stitch is docked laterally. A tibial guide is then placed into the center of the ACL remnant on the tibia in a slight medial direction. The FlipCutter is then drilled into the joint and the guide is malleted into the bone to prevent breaching the far cortex and a socket is drilled in a retrograde fashion after which a FiberStick is placed up through the tibia and both FiberStick stitches are brought out medially. The femoral button is brought into the femoral tunnel and flipped on the lateral cortex. We confirm with fluoroscopy the flipped buttons and then the tibial side is dunked after 10 mm of femoral graft is brought into the femur. The remaining portion of the femoral side is brought into

Table 2. Advantages and Disadvantages of Nanoscopic-Assisted ACL-PCL Reconstruction

Advantages
• Allows posterior knee visualization with minimal approach
• Decrease the risk of saphenous nerve injury
• Can show whether anything is blocking graft passage
Disadvantages
• Technically difficult for surgeons not comfortable with standard arthroscopy
• Need multiple assistants in the operating room to help with holding scopes while tibia is being drilled
• The NanoScope is a 0° scope, which could affect how well you can see

the femur and the tibia abs sutures are fixed over a button at 30° of flexion with a posterior drawer applied (Fig 8).

Discussion

With the advent of the NanoScope, more procedures can be minimally invasive as well as using the NanoScope to enhance your surgery. In a multiligamentous knee reconstruction surgery, visualization of the posterior portion of the tibia is critical to the case for PCL reconstruction. Risks associated with multiligamentous knee reconstruction include iatrogenic vascular injury, iatrogenic nerve injury (saphenous nerve), compartment syndrome, tourniquet complications, wound problems, complex regional pain syndrome, deep vein thrombosis, loss of motion, and persistent laxity[7]. For visualization, a PM portal can be made; however, there is a danger if making an incision in the medial capsule, which could lead to damage of surrounding neurovascular structures. The obturator used with a standard scope to enter into the joint could also lead to iatrogenic cartilage injury off of the medial femoral condyle posteriorly if you are not perfect with your technique. The NanoScope uses a spinal needle for localization of your portal, followed by a nitinol wire, a small cannula, and then the NanoScope is entered into the joint. This allows for controlled entrance into the joint without causing an iatrogenic injury to the femoral condyle. Once you place this scope, you then have 2 views of the knee, one being with your standard scope anteriorly and then your NanoScope looking from posteromedial. If you do not want to make a posteromedial portal to visualize the poster aspect of the knee, some people use a 70° scope. Even with this extra angle, there are limitations when looking from the anterior knee portals, and you will actually have blind spots to some portions of the posterior compartment of the knee.[8] The visualization of the tibia is important for tunnel placement as poor tunnel placement is one of the most common causes of PCL reconstruction failure. A tibial tunnel that is too proximal will lead to a vertical graft and decreasing the ability for the PCL to resist posteriorly translated forces.

There are several pearls to our technique that make it more streamlined for the surgeon. Removing tissue posteriorly that would block the nanoscopic view is very important as this will enhance your visualization (Table 1). This technique also allows simultaneous viewing. A disadvantage to this technique is that it is technically challenging given that you have to have multiple assistants in the operating room helping you since you are using 2 cameras at once (Table 2). One should not hesitate to make the standard portal if necessary.

Limitations to the technique include being technically demanding and there is a learning curve. Working with a 0° NanoScope has its challenges in the back of the knee which is why your needle placement initially is so important. Another limitation is the added cost versus an open PM portal. However, if you are able to gain that access, it yields for a more comprehensive surgery.

The use of a minimally invasive NanoScope during an ACL-PCL reconstruction has significant advantages with regards to visualization of the posterior tibia when preparing and drilling your PCL tunnel. We believe that this is an attractive technique that may be used as the years progress.

References

1. Fanelli GC, Orcutt DR, Edson CJ. The multiple-ligament injured knee: Evaluation, treatment, and results. *Arthroscopy* 2005;21:471-486.
2. Mook WR, Miller MD, Diduch DR, Hertel J, Boachie-Adjei Y, Hart JM. Multiple-ligament knee injuries: A systematic review of the timing of operative intervention and postoperative rehabilitation. *J Bone Joint Surg Am* 2009;91:2946-2957.
3. Hohmann E, Glatt V, Tetsworth K. Early or delayed reconstruction in multi-ligament knee injuries: A systematic review and meta-analysis. *Knee* 2017;24:909-916.
4. Vaquero-Picado A, Rodríguez-Merchán EC. Isolated posterior cruciate ligament tears: An update of management. *EFORT Open Rev* 2017;2:89-96.
5. Buyukdogan K, Laidlaw MS, Miller MD. Surgical management of the multiple-ligament knee injury. *Arthrosc Tech* 2018;7:e147-e164.
6. Ogilvie-Harris DJ, Biggs DJ, Mackay M, Weisleder L. Posterior portals for arthroscopic surgery of the knee. *Arthroscopy* 1994;10:608-613.
7. Manske RC, Hosseinzadeh P, Giangarra CE. Multiple ligament knee injury: Complications. *North Am J Sports Phys Ther* 2008;3:226-233.
8. Morin WD, Steadman JR. Arthroscopic assessment of the posterior compartments of the knee via the intercondylar notch: The arthroscopist's field of view. *Arthroscopy* 1993;9:284-290.