A Simple Method to Minimize Vascular Lesion of the Popliteal Artery by Guidewire During Transtibial Posterior Cruciate Ligament Reconstruction: A Cadaveric Study

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Purpose: To compare the outside-in transtibial lateral and medial approaches for posterior cruciate ligament (PCL) reconstruction regarding the guidewires and popliteal artery integrity. **Methods:** Twenty-two human cadaveric knees were used. A PCL tibial aimer was arthroscopically placed within the PCL footprint through the anteromedial portal for the medial approach and through the anterolateral portal for the lateral approach. For the medial approach, the drill guide was introduced through the anteromedial tibial cortex and the guidewire was advanced with the reamer beyond the posterior tibial cortex. For the lateral approach, the drill guide was introduced through the anterolateral tibial cortex and the guidewire was advanced with the reamer beyond the posterior tibial cortex. After this, the knee was dissected. The depth distance (DD) was defined as the distance between the popliteal artery and the tibial posterior cortex projected at the tibial level at which the guidewire intersected or passed by the artery. The guidewire travel distance was calculated as the distance the guidewire had to advance beyond the tibial cortex to intersect the popliteal artery or pass by it. **Results:** With the medial approach, the popliteal artery was intersected in all knees with a mean DD of 12.20 mm and a mean guidewire travel distance of 15.90 mm. With the lateral approach, the popliteal artery was not intersected in any knee; its mean medial distance from the artery was 4.8 mm at a DD of 10.05 mm. There was a significant difference in the popliteal artery intersection incidence and DD between both groups ($P < .0001$ and $P = .0003$, respectively). **Conclusions:** The transtibial lateral approach for PCL reconstruction was a safer method than the medial approach regarding popliteal artery injury by a guidewire. **Clinical Relevance:** This study presents a slight modification of the most frequently used PCL reconstruction technique, intending to minimize guidewire injury to the popliteal artery.

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One of the most feared complications of posterior cruciate ligament (PCL) reconstruction surgery is damage to the neurovascular structures in the popliteal fossa, particularly the popliteal artery. Although its occurrence is rare, it can be devastating.[1-6]

The transtibial technique is the most common method for PCL reconstruction when compared with the open-inlay procedure,[7] but the advantages of one technique over another remain uncertain in the setting of conflicting biomechanical studies and notable limitations in clinical studies.[7,8] The classic transtibial technique is an outside-in retrograde tibial tunnel technique with the drilling beginning over the anterior tibia and exiting at the tibial insertion site of the PCL. The medial approach is the standard method for the transtibial outside-in retrograde technique,[8] but a modification of this technique does exist with a lateral approach with an anterolateral tibial tunnel entry point, as described by Kim et al.[9] This technique was introduced to reduce the killer-turn effect[10] created by

the transtibial medial approach because, by the modified method, a less acute angle at the turning point of the tibial tunnel and a straighter alignment of the graft, in the coronal plane, could be obtained.[9] The transtibial lateral approach has been evaluated biomechanically and by clinical studies, but to our knowledge, it has never been evaluated regarding the safety of the popliteal artery.[11-14] The transtibial inside-out anterograde tibial tunnel technique, using the posteromedial accessory portal,[15] was not evaluated in this study.

The aim of this study was to compare the outside-in transtibial lateral and medial approaches for PCL reconstruction regarding the guidewires and popliteal artery integrity. Our hypothesis was that the transtibial lateral approach would be a safer method than the medial approach regarding the popliteal artery integrity.

Methods

Specimen Preparation

Twenty-two fresh unpaired human knees were used in this study. We have no information on the age and gender of the knees. The specimens were evaluated for congenital abnormalities, ligament lesions, and severe arthritis and were excluded if any abnormality was present. Each specimen consisted of approximately 60 cm of the distal femur and proximal tibia to prevent disruption of the soft-tissue planes in the popliteal region.[16] Each knee was mounted on a device that allowed flexion-extension while suspended in a supine position. During the procedures, the knees were positioned at 90° of flexion.

Surgical Technique

Standard anteromedial, anterolateral, and central transpatellar arthroscopic portals were used.[17] A 30° arthroscope was introduced through the anteromedial portal and placed up in the notch to better view the posterior region of the joint. Instruments were placed through a central or anterolateral portal, and the PCL was resected and debrided to re-create a PCL-deficient knee. The anterior cruciate ligament was resected to assist PCL reconstruction. A PCL Elevator/Wire Catcher (Smith & Nephew, Andover, MA, USA) was used, carefully, to free the posterior capsule and create a capsular recess posterior to the PCL, an important step during PCL reconstruction.[18]

The PCL Tibial Guide (Smith & Nephew, Andover, MA, USA) was placed toward the posterior cortex of the tibia through the anteromedial portal in the medial approach and through the anterolateral portal in the lateral approach. The tip of the guide rested on the PCL tibial insertion at the central portion of the PCL tibial footprint, 5 mm proximal to the posterior slope of the tibial metaphysis, approximately 1 cm below the joint line. With this, there was sufficient tibial bone proximal to the tunnel to prevent migration of the graft tunnel.[17] The guide angle was set at 55°.

The medial approach was performed through a 4-cm longitudinal skin incision just medial to the tibial tubercle and 5 cm distal to the tibial articular surface; the skin and subcutaneous tissue were protected by retractors. The drill guide was oriented 45° to the long axis of the tibia and introduced through the anteromedial tibial cortex.[17] The ratcheting bullet was advanced to keep the drill guide in place. We did not use the PCL Safety Stop (Smith & Nephew, Andover, MA, USA) or the PCL Safety Guidewire (Smith & Nephew, Andover, MA, USA) because it was intended that the guidewire could be advanced beyond the aiming device on the posterior tibial cortex.

The lateral approach was performed through a 4-cm longitudinal skin incision, 2 cm lateral to the tibial tubercle and 5 to 7 cm distal to the tibial articular surface.[9] The fascia was incised just lateral to the tibial crest; the tibialis anterior muscle was stripped off, with a periosteal elevator, and retracted laterally to expose the starting point of the tibial tunnel at the anterolateral tibial cortex. The PCL Tibial Guide was placed through the anterolateral portal onto the posterior cortex of the tibia. Similar to what was performed for the medial approach, the tip of the guide rested on the PCL tibial insertion at the central portion of the PCL tibial footprint, 5 mm proximal to the posterior slope of the tibial metaphysis, approximately 1 cm below the joint line.[17] The guide angle was set at 55°. The drill guide was oriented 30° to the long axis of the tibia and introduced through the anterolateral tibial cortex, just 2 cm lateral to the tibial crest and 5 to 7 cm distal to the tibial articular surface, with care taken to avoid drill slipping due to the greater obliquity of the lateral tibial cortex in comparison with the medial tibial cortex.[9] Similarly to the medial approach, we did not use the PCL Safety Stop or the PCL Safety Guidewire because it was intended that the guidewire could be advanced beyond the aiming device on the posterior tibial cortex.

The anteromedial entry tunnel—oriented guidewires with the medial approach were called group M, and the anterolateral entry tunnel—oriented guidewires with the lateral approach were called group L (Fig 1A).

Technique Analysis

After the previously described procedures were performed, 20 knees were dissected. The distance between the popliteal artery and each guidewire was measured with a 6-mm-wide metallic ruler with the knee flexed at 90°. The depth distance (DD) was defined as the distance between the popliteal artery and the pin exit at the tibial posterior cortex projected at the tibial level when the guidewire intersected or passed by the artery. The guidewire travel distance (TD) was defined as the distance the guidewire progressed beyond the tibial