# Reproducibility Of Arthroscopic Posterior Cruciate Ligament Femoral Tunnel Placement

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**Citation**

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**Abstract**

Purpose: To determine the reproducibility and reliability of arthroscopic PCL femoral tunnel placement and anatomic landmarks.

Materials and Methods: 10 frozen cadaveric knees underwent arthroscopy. Through anterior inferolateral portals with the knee in 90-100 degrees in flexion, a drill guide bit was inserted into the center of the anterolateral bundle of the PCL femoral origin. The guide wire was driven through the femoral condyle to create a PCL femoral tunnel from an inside to outside technique. An anatomic dissection was performed and measurements from exit point of the guide pin to the anterior, distal, and posterior articular margins of the femoral condyle were recorded. The average angle of the arthroscopic pin was calculated. The mean and 95% confidence intervals were calculated for all measurements. Reliability was measured with the coefficient of variance.

Results: The femoral tunnel was readily created with arthroscopic visualization from either the standard anterolateral or anteromedial portal. The average distance from the distal articular margin of the medial femoral condyle was 2.6 cm with a range of 1.8 to 3.8 cm. The average distance from the posterior articular margin of the medial femoral condyle was 3.9 cm with a range of 3.0 to 4.8 cm. The angle of the femoral tunnel was repeatable with an average of 45.1 degrees (95% CI 39.6 - 50.6 degrees) with a coefficient of variance of 6.2%.

Discussion: Using an arthroscopic technique through a low anterolateral portal, the femoral tunnel could be reliably created. The tunnel angle and exit point was reproducible. The tunnel exits within 1 cm of the medial epicondyle. This resulted in the average distance from the distal articular of 2.6 cm, which is similar to previously reported results. This technique decreases the theoretical possibility of AVN of the medial femoral condyle, with greater distance from the subchondral bone. Also, if a femoral arthroscopic tunnel is created, a paramedial capsular incision is avoided, as is the potential for violating the vastus medialis.

Conclusion: An arthroscopically placed femoral tunnel in the reconstruction of the posterior cruciate ligament using the inside-out technique can be reliably reproduced using the low anterolateral portal.

## INTRODUCTION

Knowledge concerning posterior cruciate ligament (PCL) reconstruction has dramatically increased within the past decade. Much advancement in PCL reconstruction involves the development of techniques that facilitate arthroscopic assistance. One of the many advancements in arthroscopic PCL reconstruction is the development of the far lateral portal that facilitates proper femoral tunnel placement.[10] Saddler believed that the successful reconstruction of the PCL required “a reproducible means for locating tunnel entrances during PCL reconstruction.”[20] This is further borne by the works of Oakes and colleagues who reported that a central tunnel in the PCL femoral footprint partially recreated the posterior portion of the anterolateral bundle and anterior portion of the posteromedial bundle whereas an eccentrically placed tunnel recreated only the anterolateral bundle.[17] Several studies have further documented the importance of the femoral tunnel placement in the restoration of the normal posterior knee motion limits.[1, 7, 10, 11, 21]

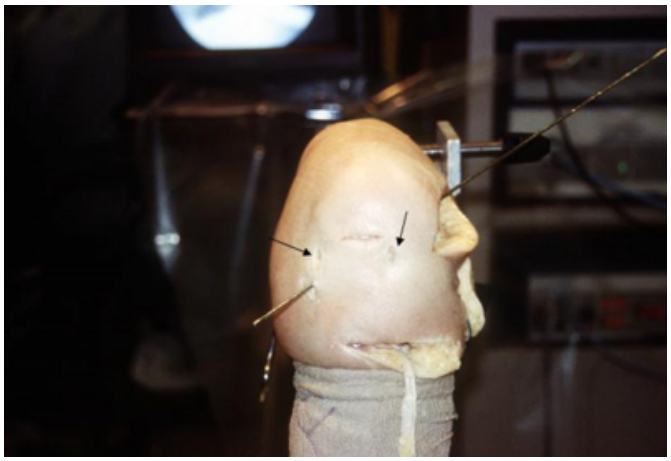
To the best of our knowledge, no study has evaluated the reproducibility of the femoral tunnel placement via arthroscopic techniques. The purpose of our study is to determine the reliability of reproducing the femoral tunnel using arthroscopic techniques.

## MATERIALS AND METHODS

Ten frozen cadaveric knees underwent diagnostic arthroscopy through standard inferolateral, inferomedial, and superolateral (outflow) portals. A second inferolateral (far lateral) portal was created 3-4mm inferior and 1.5cm lateral to the standard inferolateral portal.

### Figure 1

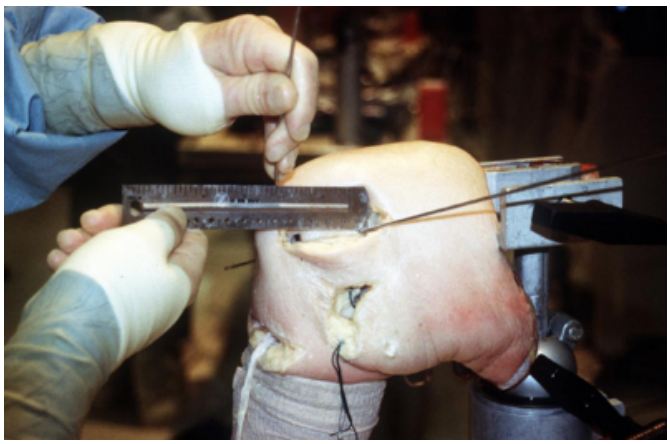
Figure 1: Photograph depicting the placement of the arthroscopic portals and the femoral guide pin.



This portal was readily created with arthroscopic visualization from either the standard anterolateral portal or the anteromedial portal. A drill guide was placed through this far lateral portal into the center of the anterolateral bundle of the PCL femoral origin with the knee in 90-100 degrees of flexion.[13, 22] This guide wire was driven through the femoral condyle to mark the location for a PCL femoral tunnel from an inside out technique. The pin was left in place and anatomic dissection from the anterior articular margin, posterior articular margin, and distal articular margin of the femoral condyle (MFC) were recorded.

### Figure 2

Figure 2: Photograph depicting the exit point of the femoral guide pin.



### Figure 3

Figure 3: Anatomic specimen depicting technique for measurement of the distance from the anterior articular surface to the exit point of the guide pin in the medial femoral guide pin.

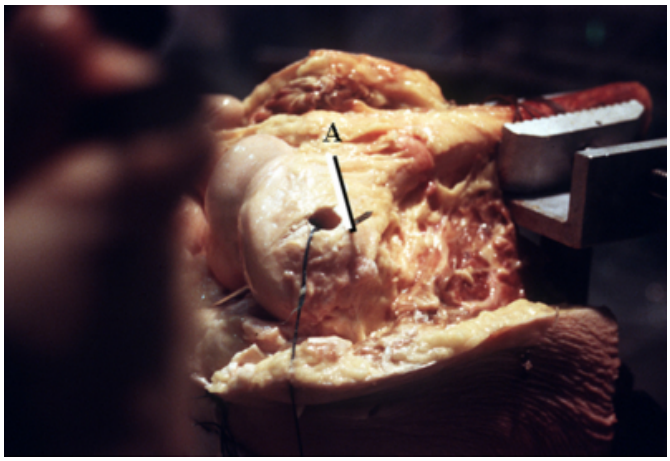
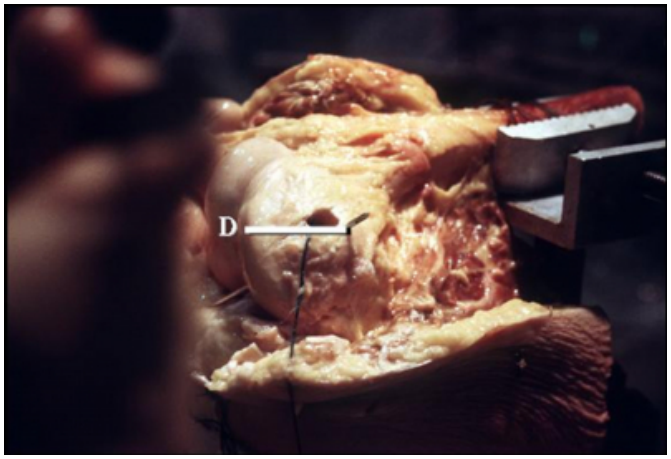


**Figure 4**

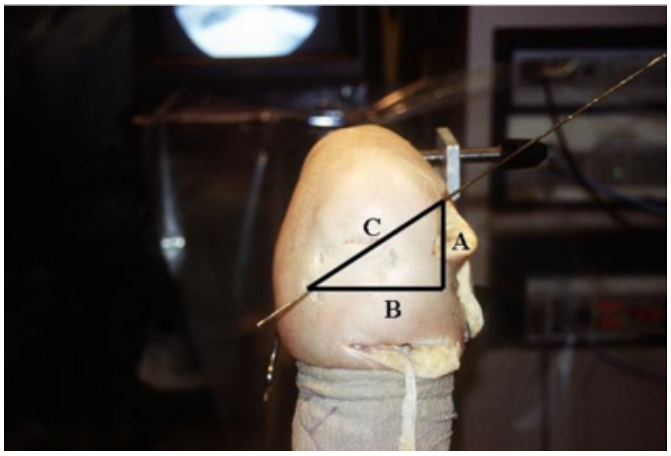
Figure 4: Anatomic specimen depicting technique for measurement of the distance from the distal articular surface to the exit point of the guide pin in the medial femoral guide pin.




The average angle of the arthroscopic guide pin within the medial femoral condyle was calculated by measuring the distance from the pin at the inferolateral portal to the medial aspect of the MFC and the distance from the joint surface to the exit point of the guide pin in the MFC.

**Figure 5**

Figure 5: Pictorial representation of the technique for calculating the angle of the femoral tunnel guide pin as well as portal placement.




The mean and the 95% confidence intervals of all measurements were calculated. The 95% confidence interval is the mean +/- 1.96 times the standard deviation. Reliability was calculated via the coefficient of variance.

## RESULTS

The average distance from the distal articular margin of the medial femoral condyle was 2.6 cm (95% CI = 1.5 to 3.8 cm). The average distance from the anterior articular margin of the medial femoral condyle was 2.5 cm (95% CI = 1.2 to 3.8 cm). The average distance from the posterior articular margin of the medial femoral condyle was 4.0 cm (95% CI = 2.7 to 5.2 cm). The coefficients of variance (standard deviation divided by mean) for the distal, anterior and posterior articular margins were 22.5%, 27.1% and 16.2% respectively. The angle of the femoral socket calculated was repeatable, 45.1 degrees (95% CI = 39.6 to 50.6 degrees), with a coefficient of variance of 6.2%.

## DISCUSSION

Using a low anterolateral portal, the femoral tunnel could be reliably created arthroscopically. The exit point was reproducible, exiting within one centimeter of the medial femoral epicondyle. The guide pin exited well away from the articular surface of the medial femoral condyle. The angle created in the MFC averaged 45-degrees.

The arthroscopic femoral tunnel potentially creates a greater bend in the femoral portions of the graft when compared to the outside-in technique using a standard PCL femoral guide. Graft placement using the arthroscopic inside-out technique may place greater stress on the graft leading to failure, although no long-term results using the inside-out techniques have been published. Further research on this question is warranted.

Known complications of PCL reconstruction are[6,15,24]:

1. Failure to recognize associated /combined ligament injuries,
2. Neurovascular complications,
3. Persistent posterior laxity,
4. Osteonecrosis, especially of the MFC,
5. Loss of knee motion,
6. Anterior knee pain,
7. Fractures.

The MFC, as opposed to the LFC, is especially prone to AVN given its intraosseous blood supply by a single nutrient vessel with a watershed area of limited blood supply to the subchondral bone.[19] The use of a guide pin for femoral tunnel placement may decrease the theoretical risk of development of AVN by maintaining a greater distance from the subchondral bone. Also, if a femoral arthroscopic tunnel is created, a paramedial capsular incision is avoided as well

as the potential for violating the vastus medialis.[2, 10]

Our study has several limitations. One major limitation of our study is the low sample size. However, we were able to demonstrate reproducibility of the femoral tunnel using the arthroscopic technique. Another limitation is that our study models the single femoral tunnel technique. In clinical practice, a myriad techniques exist.[2,3,4,12,14,18,23]Recently, the dual femoral tunnel technique has increased in popularity for it's theoretical advantage to better recreate the complex anatomy and biomechanical properties of the PCL.[21]However, no long term clinical studies have demonstrated a clear advantage to any technique.[8,9] Nyland reported at minimum 2-year follow up of double bundle PCL reconstructions, 47% of their patients had normal ligamentous exams with 63% excellent subjective results.[16]On the other hand, Deehan an colleagues in their 2-year follow up of single bundle PCL reconstructions demonstrated 56% normal exams with 63% of their patients returning to moderate or strenuous activity.[5] Finally, our model relied on measurements obtained by pins exiting the bone. Hence, our model used known entrance and exit points. In clinical practice, the tunnel is usually a blind pouch. As a result, the surgeon will know, with certainty, the start point of the tunnel. Even with the use of guide wires, unless the guide wire pierces the far cortex and tents or pierces the skin, the intended and final angles may be divergent.

## CONCLUSIONS

An arthroscopicaly placed femoral tunnel in the reconstruction of the posterior cruciate ligament using the inside-out technique can be reliably reproduced using the low anterolateral portal. Long term, randomized, prospective clinical trials are necessary to identify the clinical significance of our findings.

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