

# Arthroscopic Visualization of the Popliteus Tendon

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**Purpose:** This study was conducted to define what portion of the normal popliteus musculotendinous unit can be visualized during standard diagnostic arthroscopy. **Methods:** Knee arthroscopy was performed on 5 fresh-frozen cadaveric human knees by use of standard anterolateral and anteromedial portals. The most proximal and distal portions of the popliteus that could be visualized were tagged with arthroscopic sutures. The knees were subsequently dissected, and 4 measurements were made per specimen: the total length of the popliteus tendon; the length of the popliteus tendon that was able to be visualized; the extrasynovial segment at the femoral attachment, which was unable to be visualized; and the distance from the distal-most visible point of the tendon to the musculotendinous junction of the popliteus. **Results:** The mean total length of the popliteus tendon was 42.0 mm. The arthroscopically tagged portion of the popliteus tendon that was able to be visualized averaged 18.2 mm, or 43.8% of the tendon length. The mean distance from the musculotendinous junction to the visualized portion was 15.1 mm, or 35.8% of the total tendon length. The mean distance from the most proximal visualized portion of the tendon to the femoral attachment was 8.7 mm, or 20.4% of the total tendon length. The musculotendinous junction was not arthroscopically visible in any specimen. **Conclusions:** On standard knee arthroscopy, less than half of the normal popliteus tendon is visible, and the femoral insertion and musculotendinous junction are not visualized. Because most reported popliteus injuries have occurred here, reliance on arthroscopic visualization alone is inadequate. **Clinical Relevance:** The limitations of arthroscopic visualization of the normal popliteus tendon have implications for the diagnosis and treatment of posterolateral corner injuries. **Key Words:** Knee—Popliteus tendon—Arthroscopy—Anatomy.

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Injuries to the popliteus musculotendinous unit are frequently associated with injuries to the posterolateral ligamentous complex of the knee.<sup>1</sup> There have been less frequent reports of isolated injuries to the popliteus.<sup>2-6</sup> Case reports of isolated ruptures indicate that clinical examination reveals only subtle instability, if any, and standard diagnostic studies can be inconclusive.

Arthroscopic examination can aid in the detection of popliteus injuries.<sup>3-9</sup> This is possible because the

popliteus tendon takes an intra-articular course as it passes from the muscular origin on the posterior aspect of the proximal tibia through a hiatus in the lateral meniscus toward an extrasynovial insertion at the popliteus sulcus on the lateral femoral condyle.<sup>9,10</sup> The popliteus tendon attaches to the lateral meniscus through a series of fascicles at the popliteus hiatus.<sup>11</sup> The popliteofibular ligament originates just distal to the popliteomeniscal fascicles and just proximal to the popliteus musculotendinous junction.<sup>7</sup>

While one is visualizing the lateral compartment, the popliteus tendon can be seen as it courses posterior to the posterior horn of the lateral meniscus. When viewing from the lateral gutter, the tendon can be seen as it enters the joint from the depth of the popliteus hiatus. It then courses tightly around the posterolateral femoral condyle toward its extrasynovial femoral insertion. To our knowledge, there has been no published report of the extent to which the popliteus tendon can be visualized on routine arthroscopy. The

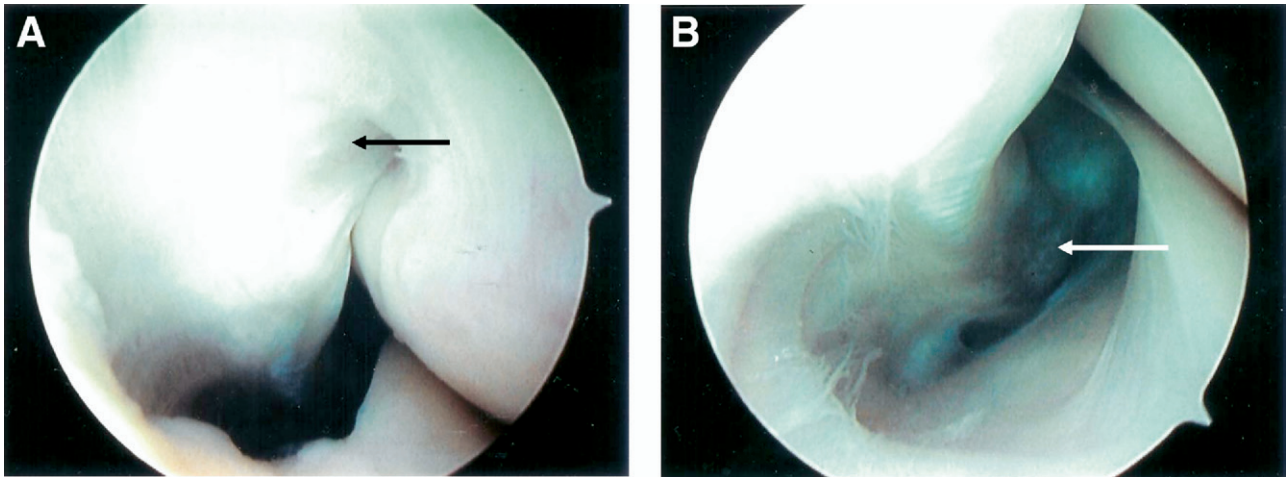
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**FIGURE 1.** (A) Arthroscopic picture with black arrow marking proximal-most portion of popliteus tendon. (B) Arthroscopic picture with white arrow marking distal-most portion of popliteus tendon.

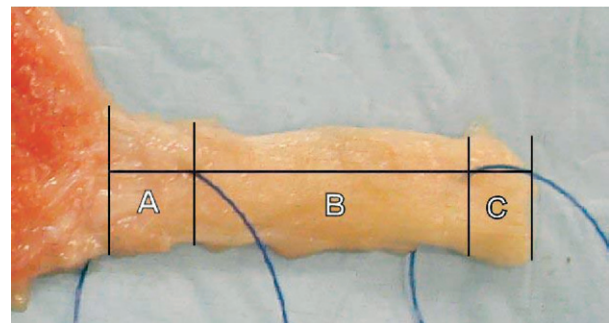
purpose of this study was to define what percentage and which portion of the normal popliteus tendon can be visualized by means of standard knee arthroscopy.

### METHODS

Five fresh-frozen cadaveric human knees with intact ligaments were obtained after institutional review board approval of this project. The number of specimens was chosen based on the availability of cadavers at our institution and was believed to be adequate for this anatomic study. Each cadaveric knee was thawed to room temperature and secured to a laboratory table with a vice attached to the femoral shaft. Standard infrapatellar anterolateral viewing and anteromedial working arthroscopic portals were established, and a 4-mm, 30° arthroscope was inserted into the knee. After a thorough diagnostic examination of the knee, the popliteus was visualized through the lateral compartment and lateral gutter. The popliteus was best seen proximally while the surgeon was viewing the anterior aspect of the lateral gutter and rotating the arthroscope to view proximal and medial. The popliteus was best seen distally while viewing the posterior aspect of the lateral gutter and rotating the arthroscope to view distal and medial (Fig 1). The most proximal and distal portions of the popliteus tendon that were visible were tagged by passing a suture through a spinal needle with an outside-in technique. Care was taken to insert the needle perpendicular to the tendon. The intra-articular end of each suture was passed

through an accessory lateral portal and clamped to its opposite end outside of the specimen (Fig 2).

Each cadaveric knee was then dissected, and the popliteus musculotendinous unit was removed in its entirety from its origin to its insertion. Care was taken to ensure that the 2 tagging sutures were not disturbed during the layered dissection. The following measurements were made: (1) the total length of the popliteus tendon; (2) the length of the popliteus tendon that was able to be visualized (i.e., distance between tagging sutures); (3) the proximal segment that could not be visualized (i.e., distance from proximal suture to femoral attachment); and (4) the distal tendon segment that could not be visualized (i.e., distance from distal suture to musculotendinous junction). The mean of the measurements was used to calculate the length per-



**FIGURE 2.** Removed popliteus tendon with proximal and distal extent of visualized tendon marked with suture: (A) unvisualized distal segment of tendon, (B) visualized segment of tendon, and (C) unvisualized proximal segment of tendon.

**TABLE 1.** *Popliteus Tendon Length Visible With Knee Arthroscopy*

	Tendon Length (mm)		
	Distal Segment	Visualized Segment	Proximal Segment
Specimen No.			
1	14.16	15.0	15.2
2	11.3	28.4	8.9
3	23.3	13.9	6.9
4	19.7	13.2	6.8
5	7.2	20.7	5.5
Mean	15.1 ± 6.4	18.24 ± 6.4	8.7 ± 3.9

centage of the various segments of the popliteus tendon.

Arthroscopy and tagging of the popliteus were performed by the same surgeon to ensure that a consistent technique was used. The measured distances were made with a digital caliper with an accuracy to 0.1 mm, and reliability was confirmed by 2 individuals.

## RESULTS

A segment of the popliteus tendon could be arthroscopically visualized in each specimen. However, the musculotendinous junction and femoral insertion were not visualized in any of the specimens. The mean length for each measured segment was as follows: (1) total length,  $42.0 \pm 5.8$  mm; (2) length of popliteus tendon able to be visualized,  $18.2 \pm 6.4$  mm (or 43.8% of total tendon length); (3) length of proximal segment that could not be visualized,  $15.1 \pm 6.4$  mm (or 35.8% of total tendon length); and (4) length of distal tendon segment that could not be visualized,  $8.7 \pm 3.9$  mm (or 20.4% of total tendon length) (Table 1).

## DISCUSSION

The principal finding of this cadaveric study is that less than half of the popliteus tendon can be visualized by standard knee arthroscopy. The muscle, musculotendinous junction, and femoral insertion are not able to be visualized. Similar to muscular and tendinous injuries elsewhere in the body, injury of the popliteus complex frequently occurs as an avulsion of the tendon from its femoral insertion or a rupture at the musculotendinous junction.<sup>3,12</sup> The midportion of the tendon, which can be arthroscopically visualized, is the least likely to show signs of injury.

This study was performed on cadaveric knees with intact ligaments including the complex anatomy of the posterolateral corner. Thus it is reasonable to conclude that arthroscopic examination alone may not be expected to identify all isolated popliteus injuries or those associated with low-grade posterolateral corner injuries. However, arthroscopic evaluation of the popliteus is often performed in the process of evaluating the extent of injury when addressing more severe injuries to the posterolateral structures. LaPrade<sup>7</sup> found arthroscopic examination of the lateral compartment to be very useful in the assessment of grade 3 posterolateral knee injuries. Avulsion of the popliteus tendon from the femur was identified arthroscopically in 33% of grade 3 injuries.

With grade 3 injuries to the posterolateral corner, there is marked varus laxity and often a resultant widening of the lateral joint space. At arthroscopy, the lateral compartment is best visualized with the knee in a figure-4 position. Increased laxity within the lateral compartment creates a "drive-through sign," which provides a more expansive view. The popliteus is also viewed from the lateral gutter at 20° to 30° of flexion and neutral rotation. If the tendon remains intact at its femoral insertion, the distal portion may become more visible and can uncover ruptures at the musculotendinous junction. This injury may be directly visualized or inferred based on hemorrhage extending into the tendon segment.

Popliteus disruption may also occur at the femoral insertion with or without a bony avulsion. Capsular attenuation is a more subtle sign of popliteus injury at the femoral insertion. Other secondary signs of injury may include popliteus tendon laxity or bulging of the tendon away from its normal tight course along the posterolateral femoral condyle. Nakhostine et al.<sup>5</sup> reported laxity with arthroscopic probing of the popliteus tendon in 4 cases of isolated femoral avulsion. One should also evaluate for injury to the more obscure popliteomeniscal fascicles and popliteofibular ligament. A high incidence of arthroscopically identifiable injuries to the popliteomeniscal fascicles has been described in conjunction with anterior cruciate ligament and posterolateral injuries.<sup>7,11</sup>

Posterolateral corner injuries including isolated injuries to the popliteus are often elusive, requiring a high degree of suspicion. Given the complex nature of the posterolateral anatomy, a clear picture of the injury can only be gained from a comprehensive approach. A detailed history will focus on the mechanism of injury and symptomatology. It has been suggested that popliteus injuries occur with blows to the proximal tibia with

the knee hyperextended or by a noncontact, external rotation mechanism.<sup>1</sup> No one specific test can reliably elucidate the extent of injury. A comprehensive knee examination should include gait analysis and an advanced assessment of knee laxity. An effusion and posterolateral tenderness are typically present. Posterolateral injuries may involve the peroneal nerve, necessitating a detailed distal neuromuscular examination.

Radiographs should be closely reviewed for bony avulsions and malalignments. Bony avulsions at the popliteus sulcus, fibular head, and lateral capsule can be useful signs. Magnetic resonance imaging (MRI) is helpful and required. Standard MRI protocols should be expanded to include the proximal tibia. It has been suggested that specialized coronal oblique views can be aligned with the popliteus.<sup>13</sup> MRI analysis has shown that up to 95% of popliteus injuries involve the muscular portion and that popliteus injuries occur in isolation less than 10% of the time.<sup>12</sup>

Arthroscopy should be considered an additional step in the process of information gathering when dealing with these complex injuries. Whereas arthroscopy can be useful in the diagnosis, it does pose a risk of fluid extravasation in acutely injured knees with major capsular damage. It is often performed concurrently with open repair. Knees that require posterolateral surgery must have all injured structures explored, repaired, and augmented as needed. Chronic injuries with extensive scarring and secondary changes often require a reconstructive procedure. Management of isolated popliteus injuries is not well defined, with authors favoring both surgical and conservative approaches.<sup>2-5</sup>

The results of this cadaveric study indicate that reliance on arthroscopy may result in under-diagnosis of popliteus injuries. Limitations of the study include the small sample size and the substantial variability, as evidenced by the large SD. The large variation may be the result of anatomic differences in the cadaveric knees including alignment, ligamentous laxity, and degree of intra-articular pathology. However, there was no analysis of the specimens with regard to their alignment or ligamentous laxity. Anatomic variation of the popliteus tendon has been described and may have contributed to the variability in the results.<sup>14</sup> Another limitation of the study is that the design does not account for the diagnosis of extra-articular popliteus injuries based on changes in appearance or probing of the intra-articular segment of the tendon. Furthermore, the study does not account for the added arthroscopic exposure gained with more severe injuries involving the posterolateral structures.

Arthroscopic visualization of the popliteus tendon is incomplete, and most injuries occur at the unvisualized femoral insertion and musculotendinous junction. Reliance on direct arthroscopic visualization of the tendon injury for diagnosis may result in a missed diagnosis. Careful evaluation and probing of the popliteus tendon should be performed when a posterolateral corner injury is suspected.

## CONCLUSIONS

On standard knee arthroscopy, less than half of the normal popliteus tendon is visible, and the femoral insertion and musculotendinous junction are not visualized. Because most reported popliteus injuries have occurred here, reliance on arthroscopic visualization alone is inadequate.

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