

# A study on the morphology of the popliteus muscle and arcuate popliteal ligament

G. Paraskevas<sup>1</sup>, B. Papaziogas<sup>1</sup>, P. Kitsoulis<sup>2</sup>, S. Spanidou<sup>1</sup>

<sup>1</sup>Department of Anatomy, Medical School of Aristotle University of Thessaloniki, Greece

<sup>2</sup>Institute of Anatomy, University of Ioannina, Greece

[Received 28 December 2006; Revised 17 July 2006; Accepted 1 August 2006]

*The aim of this study was to investigate the origins and morphological features of the popliteus muscle in cadavers.*

*In a sample of 40 lower limbs taken from cadavers the exact morphological features of the popliteus muscle were examined.*

*In 100% of the cases studied we noticed, apart from the known femoral origin from the lateral femoral epicondyle, a fibular origin from the styloid process of the head of the fibula directed obliquely and blending with the main femoral origin, forming the arms of a Y-shaped structure. In all the cases a capsular origin was presented, while in 91.67% an origin lateral to it from the superior border of the posterior horn of the lateral meniscus was found. The capsular and meniscal origins formed the base of the Y-shaped structure that corresponded to the known arcuate ligament.*

*We consider that the additional origins of the popliteus muscle form the arcuate ligament, which is not a distinct anatomical structure as it is described in traditional anatomical textbooks. In addition, we have analysed the exact morphological features of the capsular, fibular and meniscal origins of the popliteal muscle.*

**Key words:** popliteus muscle, arcuate ligament, morphology

## INTRODUCTION

The popliteus muscle is a unique muscle because an inversion of its origin and insertion appears. Thus the tendinous attachment is the origin from the proximal bone, while the fleshy attachment represents the insertion of the muscle. There is confusion concerning the morphology of the popliteus muscle and especially its origins. McMinn [13] reported that only occasionally is the tendon partially attached to the lateral meniscus. Basmajian [4] stated that a variable bundle of fleshy fibres from its upper border gains a fibrous attachment to the hinder part of the lateral meniscus, thereby forming an articular muscle. Various authors, such as Anson [1], Moore [14] and Goss [7] have mentioned that the popliteus ten-

don takes its origin only from a pit on the lateral surface of the femoral condyle just below the attachment of the fibular collateral ligament of the knee.

The first description of the popliteus tendon as having additional origins from the lateral meniscus, the fibular head and the ligaments of Winslow and Wrisberg was by Higgins in 1894 [8]. Later, Fürst [6] in 1903 confirmed these observations, making analytical reports of popliteus muscle comparative anatomy. Paturet [16] described an origin from the posterior surface of the articular capsule of the knee through a fibrous band consisting of two portions: a lateral portion that gave an attachment to the lateral head of the gastrocnemius

and a medial portion that was united with the oblique popliteal ligament. Additionally, Paturet [16] mentioned a small fibrous expansion to the posterolateral surface of the lateral meniscus. Williams et al. [20] reported on three additional origins from the fibrous capsule, the arcuate popliteal ligament and the outer margin of the lateral meniscus, while Romanes [18] mentioned two additional origins, one from the lateral meniscus and one from the fibula.

In addition, Lindner [11] reported an origin from the oblique popliteal ligament and from the outer margin of the lateral meniscus. Rogers [17] mentioned two additional origins, one from the capsule and one from the lateral meniscus, while Pansky [15] reported an additional origin from the popliteal ligament without determining whether it was the oblique or the arcuate that was under consideration.

From the previous reports, it may be seen that there is some confusion about the exact morphology of such an important muscle. Our aim is to describe its origins and declare its morphological features in cadavers.

## MATERIAL AND METHODS

Our material was taken from human cadavers used for educational purposes with medical students in the Department of Anatomy of the Aristotle University of Thessaloniki. In particular, we prepared the knee region in 40 lower limbs of 20 cadavers, 12 of which were male and 8 female.

After a careful dissection of the popliteal fossa the popliteal vessels, the tibial and common peroneal nerves, the upper third of the gastrocnemius muscle and the long plantar muscle were dissected for the purpose of visualising the popliteus muscle, the fibrous capsule and the lateral meniscus. Our aim was to present the anatomical relationship between these structures. We also prepared drawings for representative photographs.

## RESULTS

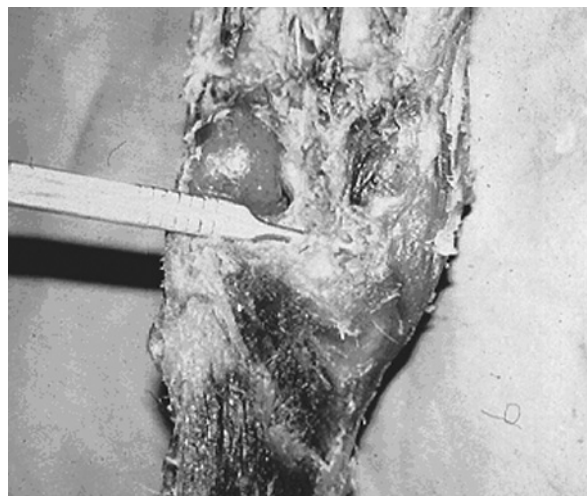
Our specimens were consistent in showing an origin in a small pit of the lateral surface of the lateral femoral condyle. This pit was located just anterior to the femoral attachment of the lateral collateral ligament. The tendon is then directed posteriorly and inferiorly underneath the lateral collateral ligament. The other aspect of the tendon blends with the fibrous capsule and finally emerges from the joint beneath the lateral head of the gastrocnemius muscle. During our dissections we noticed the presence



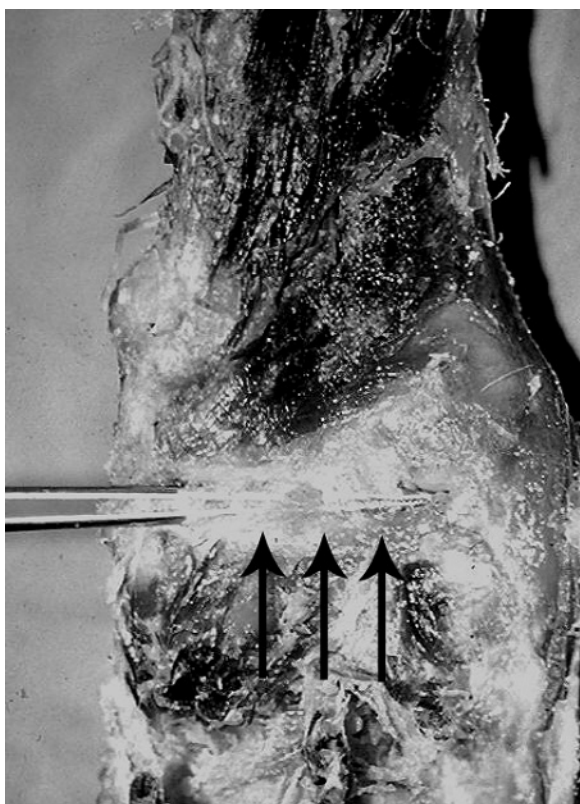
**Figure 1.** A fibular origin of the popliteus muscle is shown extending between the main tendon and the head of the fibula.

of a fibrous band extending obliquely between the head of the fibula and the tendon 1–1.5 cm below the level of the knee joint line. This band appeared in all the cases studied (100%) at the site of the posterior-lateral aspect of the knee joint (Fig. 1). The length of this band had a mean value of 1.2 cm (0.8–1.5 cm), while its width had a mean value of 0.4 cm (0.3–0.55 cm). Furthermore, in all the cases studied (100%) we found a fibrous attachment of the tendon to the posterior aspect of the fibrous capsule of the knee joint (Fig. 2).

Simultaneously, an additional ligamentous band was found extending between the popliteal tendon and the posterior horn of the lateral meniscus. In particular, a fibrous band extended from the superior margin of the terminal portion of the tendon to the superior margin of the posterior horn of the



**Figure 2.** A capsular origin of the popliteus muscle was found extending between the posterior aspect of the fibrous capsule of the knee joint and the main tendon.

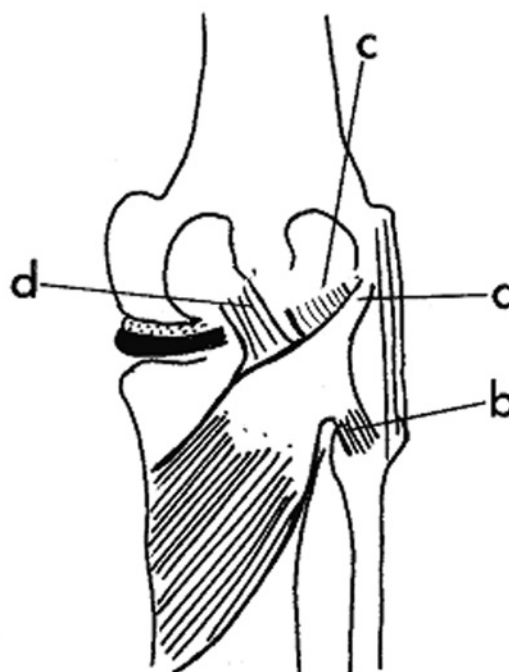


**Figure 3.** A fibrous band of the main tendon appears to be attached to the superior margin of the posterior horn of the lateral meniscus, leaving the inferior margin free.

lateral meniscus (Fig. 3). The mean length of the band was 0.35 cm (from 0.2 to 0.45 cm) and its mean width was 1.25 cm (0.95–1.45 cm). The fibrous band appeared in 22 out of 24 of the popliteal tendons studied, a percentage of 91.67%. In studying the morphology of the additional origins of the popliteus muscle we noticed that a Y-shaped ligament was formed that corresponded to that known as the arcuate ligament. One arm of the Y is formed by the fibular origin and the other arm by the meniscal origin of the popliteus muscle (Fig. 4). Finally, in all cadavers the belly of the popliteus muscle was inserted on the popliteal surface of the tibia above the soleal line.

### DISCUSSION

The first to report that the popliteus muscle is attached to the lateral meniscus was Higgins [8] in 1894. Later, in 1950, Last [10] brought an analytical approach to this additional attachment of the popliteus muscle. Similarly, the first mention that tendinous fibres originated from the head of the fibula was made by Higgins [8] in 1894. This tendinous band seems to be phylogenetically significant.



**Figure 4.** Posterior aspect of the right knee joint showing the popliteus muscle; a — main popliteal tendon, b — fibular origin, c — meniscal origin, d — capsular origin.

Taylor and Bonney [19] made a comparative study ranging from reptiles to primates and concluded that the popliteus muscle is a homologous anatomical structure of the deep part of the teres pronator and originated primitively from the fibula and the ulna respectively. During evolution these origins “transferred to the lateral femoral condyle and medial humeral epicondyle, respectively”. In our study we found the fibular attachment presented in 100% of our cases, while Lovejoy and Harden [12] found it in 95.83%. Only Higgins [8] mentioned that after external rotation of the tibia is completed the fibular origin acts as a check-rein, enabling the muscle to act to greater advantage on the meniscus and withdraw it as flexion is completed.

The popliteus muscle is a lateral rotator of the femur on the tibia when the foot is fixed on the ground or a medial rotator of the tibia on the femur in the free limb. It is usually regarded as the muscle that “unlocks” the joint at the beginning of flexion of the fully extended knee. According to Last [10], the tendon’s connection with the fibrous capsule (the arcuate popliteal ligament) and lateral meniscus suggests that it may retract the posterior horn of the lateral meniscus during lateral rotation of the femur and flexion of the knee joint, protecting the meniscus from being crushed between the femur and the tibia

during these movements. Dynamic electromyographic studies of the popliteus muscle during flexion show that the activity is related to rotation rather than to flexion. It is therefore inferred that the flexion action of the muscle is negligible [5]. Barnett and Richardson [2] reported that the muscle is markedly active during crouching, indicating that it may share the load on the posterior cruciate ligament in preventing forward dislocation of the femur. Basmajian [3] stated that popliteal tendon through its fibular insertion and especially by the extension of its meniscal attachment passing into the posterior cruciate ligament through the ligaments of Wrisberg and Humphrey. It is characteristic that, as Kaplan [9] claimed, there is no attachment of the posterior horn of the lateral meniscus to the tibia and therefore the lateral meniscus can be displaced laterally.

As with the "arcuate ligament", it has been described as a separate capsular structure, although this view was confirmed by our observations. Williams et al. [20] and Romanes [18] described the ligament as a Y-shaped mass of fibres springing from the back of the head of the fibula, arching upwards and medially over the popliteus tendon as it emerges from the joint and spreading out on the posterior aspect of the capsule. Moore [14] reported a Y-shaped band inserting into the intercondylar area of the tibia and posterior aspect of the lateral femoral epicondyle. McMinn [13] claims that the "arcuate ligament" can be traced upwards from its attachment to the styloid process of the fibula to blend with the capsule, sometimes as far as the lateral condyle of the femur; other fibres join the part of the popliteus tendon that is attached to the lateral meniscus.

In all our studies we concluded that the "arcuate ligament" is a part of various fibrous expansions of the popliteus muscle. Specifically, this ligament consisted of thickenings of fibres from the femoral, fibular and meniscal origins of the popliteus and posterior capsule of the knee, giving attachment to the muscle belly. In our study the ligament appeared in 96.7% of

cases. Moreover, we assessed the exact morphological features of that ligament. We are now able, finally, to present the exact dimensions of the fibular, capsular and meniscal origins of the popliteus muscle.

## REFERENCES

1. Anson B (1966) *Morris' human anatomy*, 12<sup>th</sup> ed. McGraw-Hill Book Co, New York, p. 231.
2. Barnett C, Richardson A (1953) The postural function of the popliteus muscle. *Ann Phys Med*, 1: 177-179.
3. Basmajian J (1967) *Muscles alive: their function revealed by electromyography*. 2<sup>nd</sup> ed. Williams and Wilkins, Baltimore, p. 213.
4. Basmajian J (1975) *Grant's method of anatomy*. 9<sup>th</sup> ed. Williams and Wilkins Co, Baltimore, p. 346.
5. Basmajian J, Lovejoy J (1971) Functions of the popliteus muscle in man. *J Bone Joint Surg*, 53A: 557-562.
6. Fürst C (1903) *Der musculus popliteus und seine Sehne*. Malmströms Buchdruckerei, Lund, p. 28.
7. Goss (1966) *Gray's anatomy of the human body*. 28<sup>th</sup> ed. Lea and Febiger, Philadelphia, p. 67.
8. Higgins H (1894) The popliteus muscle. *J Anat*, 29: 569.
9. Kaplan E (1957) Discoid lateral meniscus of the knee joint. Nature, mechanism and operative treatment. *J Bone Joint Surg*, 39A: 77-87.
10. Last R (1950) The popliteus muscle and the lateral meniscus. *J Bone Joint Surg*, 32B: 93-99.
11. Lindner H (1989) *Clinical anatomy*. Appleton and Lange, Norwalk, p. 630.
12. Lovejoy J, Harden T (1971) Popliteus muscle in man. *Anat Rec*, 169: 727-730.
13. McMinn R (1990) *Last's anatomy: regional and applied*. 8<sup>th</sup> ed. Churchill Livingstone, New York, pp. 181-182.
14. Moore K (1992) *Clinically oriented anatomy*. 3<sup>rd</sup> ed. Williams and Wilkins, Baltimore, p. 452.
15. Pansky B (1992) *Review of gross anatomy*. 5<sup>th</sup> ed. Macmillan Publishing Co, New York, p. 532.
16. Paturet G (1951) *Traite d' Anatomie Humaine*, Vol. 2, Masson et Cie, Paris, 861-862.
17. Rogers A (1992) *Textbook of anatomy*. Churchill Livingstone, Edinburgh, p. 301.
18. Romanes G (1991) *Cunningham's textbook of anatomy*. 12<sup>th</sup> ed. Oxford University Press, Oxford, p. 394.
19. Taylor G, Bonney V (1906) On the homology and morphology of the popliteus muscle: a contribution to comparative myology. *J Anat Physiol*, 40: 34-50.
20. Williams P, Berry M, Collins P, Dyson M, Dussek J, Ferguson M (1995) *Gray's anatomy*. 38<sup>th</sup> ed. Churchill Livingstone, Edinburgh, p. 886.