

Unusually located inferior lateral genicular artery and an abnormally attached soleus with the absence of plantaris muscle

Özlem Elvan¹, Orhan Beğen², Zeliha Kurtoğlu²

¹School of Health, Mersin University, Mersin, Turkey

²Department of Anatomy, Faculty of Medicine, Mersin University, Mersin, Turkey

Abstract

In this report, two male cadavers (ages 54 and 68) are presented with a variative inferior lateral genicular artery passing superficial to the plantaris muscle instead of passing deep to it. A soleus muscle attached to popliteus tendon with the absence of plantaris was encountered in the other extremity of one of these cases. The cases were evaluated regarding clinical and developmental aspects. This case is the first to our knowledge to describe the inferior lateral genicular artery passing superficial to the plantaris. Positional variations of the inferior lateral genicular artery should be taken into account during radiological assessments to avoid misdiagnosis. The case with soleus attached to the popliteus tendon in the absence of plantaris muscle has not been described previously in the literature.

Keywords: inferior lateral genicular artery; plantaris; soleus; popliteus; positional variation

Anatomy 2018;12(1):49–52 ©2018 Turkish Society of Anatomy and Clinical Anatomy (TSACA)

Introduction

Inferior lateral genicular artery (ILG) arises from popliteal artery at posterolateral corner of the knee. It reaches infrapatellar fat pad by running superficial to popliteus and deep to fibular collateral ligament.^[1–3] ILG supplies the important structures of the knee, *e.g.* the anterior and posterior cruciate ligaments, and the lateral meniscus. It is an important clinical landmark for the ligaments of posterolateral part of knee.^[4,5] Post-operative hematoma due to the injury of artery can be significant during surgical interventions.^[1,6]

Plantaris muscle (PM) originates from the lower part of supracondylar line and the oblique popliteal ligament. At the proximal part, it is fusiform in shape and descends as a long and slender tendon between gastrocnemius and soleus. PM can be double or absent in about 7.4–13% of the cases.^[2,3,7] PM is supplied by lateral sural and popliteal

arteries superficially and lateral superior genicular artery deeply.^[2] No report has been encountered about variations regarding positional relation of the ILG with PM.^[3]

Soleus originates from posterior aspect of fibular head, soleal line, 1/3 part of tibia and interosseous membrane. Together with gastrocnemius, they form the calcaneal tendon.^[2] The cases with soleus attached to popliteus tendon is rare in literature.^[3]

In this study, two cases with variative course of ILG and in one of these cases positional variation of soleus with the absence of PM were observed and evaluated regarding to clinical and developmental aspects.

Case Report

During dissection of the popliteal region of 10 formalin-fixed male cadavers with a mean age of 66.9±18.9 (range: 45 to 104) years in the Department of Anatomy, School of Medicine, Mersin University, Mersin, Turkey, posi-

tional variations of ILG, PM and soleus were encountered in two cases (ages of 54 and 68).

Case 1

During the dissection of popliteal fossa and posterolateral corner of the knee at the left lower extremity, PM was observed as completely covered by lateral head of gastrocnemius, and the muscle fibers started from deep surface of lateral head as a separate entity. Its width in the origin was 2.2 cm and length of its venter was 4.9 cm. PM tendon continued its normal form inferiorly. ILG, arising from the popliteal artery, ran laterally by passing superficial to the PM, instead of deep to it (**Figure 1a**). Then, ILG continued deep to fibular collateral and fabellofibular ligaments. ILG was passing between superficial and deep parts of arcuate popliteal ligament as usual. The artery gave small branches to the joint capsule, fibular head and continued along the lateral meniscus.

On the right side, PM was absent, but the origin of soleus was attached to the both of muscle-tendon junction of the popliteus and popliteofibular ligament (**Figure 1b**).

Soleus then continued as its normal form below. No other variation was determined in the region.

Case 2

In the left lower extremity, PM was originating deep to lateral head of gastrocnemius and it was partially covered by that muscle. PM was exceeding 5 mm the medial margin of lateral head. Its width in the origin was measured as 1.5 cm and length of its venter was 9.1 cm. PM tendon was in a normal form towards below. ILG, emerging from the popliteal artery, was on the superficial surface of PM instead of deep to it (**Figure 1c**). Then, as normal, ILG passed deep to the fibular collateral, fabellofibular and between the two layers of arcuate popliteal ligaments. No variations related to those structures were seen on the right side and the attachment of soleus was normal.

Discussion

It has been previously reported that branching pattern of genicular arteries and their diameters are quite variable.^[3,8] It was underlined that the preservation of vascu-

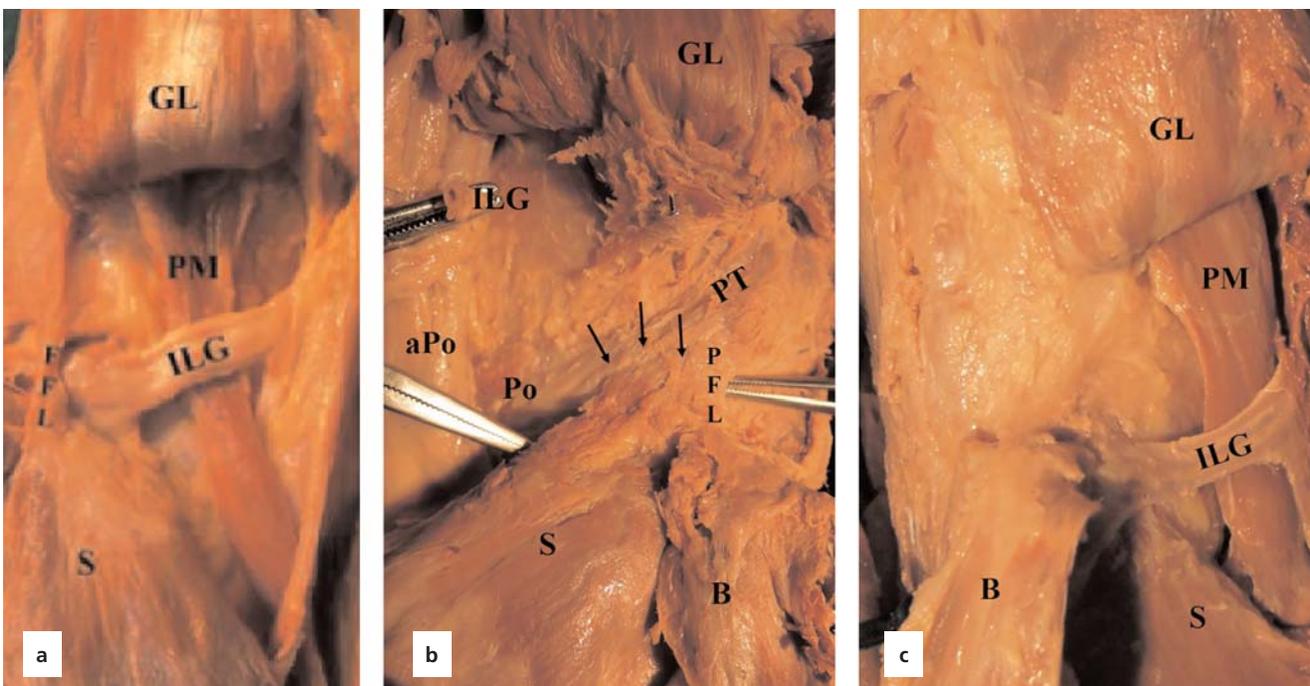


Figure 1. Posterolateral corner of the knees showing the positional variations of ILG and soleus. (a) ILG is running superficial to plantaris on the left side; (b) Soleus is attaching superiorly to the popliteus and popliteofibular ligament on the right; (c) ILG is running superficial to plantaris on the other knee. aPo: popliteal artery; B: biceps femoris (retracted inferiorly); FFL: fabellofibular ligament; GL: lateral head of gastrocnemius (retracted superiorly); ILG: inferior lateral genicular vessels; PFL: popliteofibular ligament; PM: plantaris; Po: popliteus; PT: popliteus tendon; S: soleus; black arrows: superiorly attached muscle fibers of soleus. [Color figure can be viewed in the online issue, which is available at www.anatomy.org.tr]

lar structures of the knee is essential in the recovery of surgical interventions such as the anterior cruciate ligament reconstruction, popliteal aneurysm repair and anterior horn meniscectomy of external meniscus.^[8,9] The antero-proximal region of patellar tendon is maintained by ILG and it can be damaged during total knee arthroplasty and Hoffa's fat pad removal.^[10] ILG can be unnoticed in posterolateral corner surgeries, but 3D images can be beneficial in understanding this region.^[4] This vascular bundle is between superficial and deep parts of arcuate popliteal ligament. This placement is used as a guideline in the identification of ligamentous structures on posterolateral corner during surgery.^[5] In our study, ILG passed from superficial surface of PM instead of deep surface in 2 out of 20 sides. A similar case has not been found in the literature.

It is known that at the early stages of embryonic development, femur articulates with the fibula and tibia. Then, the mesenchymal tissue including fibula and the attached lateral portion of the joint capsule shift inferior. At the end of that shift, the popliteus tendon attach to both distal femur and head of fibula and the fibular attachment is called as popliteofibular ligament.^[11] Also, plantaris is reported to be a remnant of the superficial layer of the common flexors of the digits, and the soleus is suggested to be a derivative of the lateral head of the gastrocnemius.^[3] It seems that the popliteus, plantaris and soleus originate from the lateral portion of the embryonic mesenchymal tissues around the knee joint. Accordingly, variative relation of soleus, plantaris and popliteus can be associated with development of those three components. We suggest that in the absence of plantaris, attachment of the soleus to the popliteus and popliteofibular ligament can be the result of two possibilities in the early stages. Deviated fibers of plantaris can drift inferiorly and attach to the head of fibula instead of lateral condyle of femur and then fuse with the mass of soleus and popliteus, or there can be any deviation in the movement of soleus resulting into high origin of the muscle. Nevertheless, these suggestions need to be confirmed by studies with large series that evaluate the origin of soleus within the absence and presence of plantaris.

Freeman et al.^[7] stated that PM is defined as normal form in 56%, varied form in 30.4% and absent in 13% of the cases. Unilateral absence of PM is reported to affect the main foot choice, therefore the leg with PM is likely to be chosen. In addition, the authors reported that absence of PM might also cause weakness in initiation of

flexion movement in knee ankle, that laxity can be seen during medial and lateral rotations and related increase in primary ligament sprains which stabilize the knee. A congenital absence is reported to cause serious functional losses in sportive tasks in young people.

In another study, it was reported that removal of PM did not affect lower extremity functions when both soleus and gastrocnemius were present.^[12] Tendon of this muscle is used successfully as a graft in flexor tendon replacements in hand and atrioventricular valve repair surgeries. While tears of PM can be the primary cause for unidentified lower extremity pain, it may not be distinguished by ultrasonography (USG) or magnetic resonance imaging (MRI).^[12] On the other hand, we suggest that misplaced ILG, similar to our case, may cause misinterpretation of USG or MRI. It is also proposed that PM supports gastrocnemius activity.^[2] Nevertheless, it should be investigated whether, in the absence of PM, the fibers of soleus anchoring to the popliteus tendon support the activity of gastrocnemius *via* this tendon or not.

Consequently, cases with ILG passing superficial to the PM should be kept in mind in the evaluation of posterolateral knee by MRI and USG. While any developmental and functional relations of the absence of PM with soleus anchoring to popliteus muscle have not been addressed previously, we suggest the possibility of such relations is worth investigating.

References

1. Hannouche D, Duparc F, Beaufile P. The arterial vascularization of the lateral tibial condyle: anatomy and surgical applications. *Surg Radiol Anat* 2006;28:38-45.
2. Standring S, Borley NR, Collins P, Crossman AR, Gatzoulis MA, Healy JC, Johnson D, Mahadevan V, Newell RLM, Wigley CB, editors. *Gray's anatomy: the anatomical basis of clinical practice*. 40th ed. London (UK): Elsevier Churchill Livingstone; 2008.
3. Tubbs RS, Loukas M, Shoja MM. *Bergman's comprehensive encyclopedia of human anatomic variation*. Hoboken (NJ): John Wiley and Sons; 2016.
4. Astur DC, Arliani GG, Kaleka CC, Jalikjian W, Golano P, Cohen M. A three-dimensional anatomy of the posterolateral compartment of the knee: the use of a new technology in the study of musculoskeletal anatomy. *Open Access J Sports Med* 2012;23:1-5.
5. Kurtoglu Z, Elvan Ö, Aktekin M, Çolak M. A descriptive and morphometric study of the fabellofibular, arcuate popliteal and popliteofibular ligaments. *Anatomy* 2015;9:51-9.
6. LaPrade RF. *Posterolateral knee injuries: anatomy, evaluation, and treatment*. 1st ed. New York (NY): Thieme Medical Publishers; 2006.

7. Freeman AJ, Jacobson NA, Fogg QA. Anatomical variations of the plantaris muscle and a potential role in patellofemoral pain syndrome. Clin Anat 2008;21:178-81.
8. Shahid S, Saghir N, Cawley O, Saujani S A cadaveric study of the branching pattern and diameter of the genicular arteries: a focus on the middle genicular artery. J Knee Surg 2015;28:417-24.
9. Lamo-Espinosa JM, Llombart Blanco R, Valentí JR. Inferior lateral genicular artery injury during anterior cruciate ligament reconstruction surgery. Case Rep Surg 2012;467198.
10. Pang J, Shen S, Pan WR, Jones IR, Rozen WM, Taylor GI. The arterial supply of the patellar tendon: anatomical study with clinical implications for knee surgery. Clin Anat 2009;22:371-6.
11. Covey DC. Injuries of the posterolateral corner of the knee. J Bone Joint Surg Am 2001;83:106-1.
12. Kwinter DM, Lagrew JP, Kretzer J, Lawrence C, Malik D, Mater M, Brueckner JK. Unilateral double plantaris muscle: a rare anatomical variation. Int J Morphol 2010;28:1097- 9.

Online available at:
www.anatomy.org.tr
doi:10.2399/ana.17.040
QR code:



deomed®

Correspondence to: Özlem Elvan, PhD
Department of Anatomy, Faculty of Medicine,
Mersin University, Mersin, Turkey
Phone: +90 324 361 06 83/29078
e-mail: ozlemelvan33@gmail.com

Conflict of interest statement: No conflicts declared.

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported (CC BY-NC-ND3.0) Licence (<http://creativecommons.org/licenses/by-nc-nd/3.0/>) which permits unrestricted noncommercial use, distribution, and reproduction in any medium, provided the original work is properly cited. *Please cite this article as:* Elvan Ö, Beger O, Kurtoğlu Z. Unusually located inferior lateral genicular artery and an abnormally attached soleus with the absence of plantaris muscle. Anatomy 2018;12(1):49-52.