

Bilateral Gastrocnemius Tertius Muscles: Cadaveric Findings of a Rare Variant

Review began 08/30/2023

Review ended 09/10/2023

Published 09/15/2023

© Copyright 2023

Arefi et al. This is an open access article distributed under the terms of the Creative Commons Attribution License CC-BY 4.0., which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Isaac A. Arefi¹, Ethan Kosco¹, Erica Werner¹, Aidan Maxwell¹, Andrew Fickert¹, Patrick W. Frank²

1. Department of Medicine, University of Toledo College of Medicine and Life Sciences, Toledo, USA 2. Department of Anatomy, Drexel University College of Medicine, Philadelphia, USA

Corresponding author: Isaac A. Arefi, isaac.arefi@rockets.utoledo.edu

Abstract

The posterior compartment of the leg typically contains three muscles in the superficial flexor group: the gastrocnemius, plantaris, and soleus. The gastrocnemius has medial and lateral heads (MH and LH) that originate from the medial and lateral condyles of the femur, respectively. However, a third head (TH) of the gastrocnemius, is a rare accessory muscle bundle of the gastrocnemius muscle that covers the surface of the popliteal fossa.

Bilateral THs of gastrocnemius were identified in a 67-year-old male during a routine educational cadaveric dissection. Both gastrocnemius TH muscles consisted of a superficial belly with distinct neurovasculature heads and originated from the lateral condyle of the femur and inserted into the Achilles tendon. To our knowledge, the co-existence of bilateral gastrocnemius TH muscles has only been reported once.

The male donor was found to exhibit an anatomical anomaly and could be clinically underdiagnosed due to its clinically silent nature and the lack of reports. Insight into the potential implications of bilateral and unilateral gastrocnemius TH and identification during clinical evaluation offers a path for future research to better identify and manage cases of gastrocnemius TH and its effects.

Categories: Pathology, Orthopedics, Anatomy

Keywords: popliteal fossa, gross anatomy, dissection, cadaver, accessory soleus, nerve entrapment, gastrocnemius tertius

Introduction

The gastrocnemius muscle forms the major bulk of the posterior compartment of the leg and is instrumental to walking and posture. During embryological development, the skeletal muscles are formed in the eighth week of gestation. The gastrocnemius muscles are derived from the paraxial mesoderm [1]. While both heads of the gastrocnemius muscle take origin from the capsule of the knee joint, the medial head (MH) of the muscle originates from the posterior surface of the medial condyle of the femur. The lateral head (LH) originates from a facet on the superior posterolateral surface of the lateral condyle of the femur. This biarticular muscle distally inserts into the posterior surface of the broad membranous Achilles tendon. This tendon descends over the posterior ankle joint and ultimately inserts into the middle part of the calcaneal tuberosity. The motor nerve supplying the two gastrocnemius heads is the tibial nerve, receiving fibers from the L5, S1, and S2 nerve roots. The posterior leg is cutaneously supplied by the L4-S2 nerve roots. The gastrocnemius is a powerful plantar flexor and knee flexor. Therefore, this muscle provides significant propulsive force in regard to gait mechanics.

Case Presentation

This case features a 67-year-old man who graciously donated his body to the University of Toledo College of Medicine and Life Sciences donor program. The patient died from complications related to vascular dementia. All other details of his past medical history were not available due to the anonymity of the donor program. During cadaveric dissection, as part of a medical school curriculum, an extra muscle belly was discovered bilaterally, medial to each gastrocnemius LH; we have determined them to be TH of the gastrocnemius muscle. The THs were separated from the gastrocnemius LHs and MHs by a fascial sheath. Muscle fibers were arranged in a unipennate pattern. The THs attached proximally to the lateral condyle of the femur - at the same attachment point of the LH - and distally contributed to the Achilles tendon. The belly length was 24 cm, and the width was 2.5 cm. The TH muscles were innervated by a unique branch of the tibial nerve that entered the TH belly. Vasculature to the THs originated from additional branches of the popliteal artery and veins. The proximal tendon and belly of this muscle were in close proximity to the tibial nerve and artery. Structure and neurovasculature were consistent bilaterally and shown in Figures 1-4.

How to cite this article

Arefi I A, Kosco E, Werner E, et al. (September 15, 2023) Bilateral Gastrocnemius Tertius Muscles: Cadaveric Findings of a Rare Variant. Cureus 15(9): e45316. DOI 10.7759/cureus.45316



FIGURE 1: Photograph of the popliteal fossa of the left leg.

Gastrocnemius third head (TH) is denoted by an asterisk (*), gastrocnemius medial head denoted by (M), gastrocnemius lateral head denoted by (L).



FIGURE 2: Photograph of the left and right popliteal fossa.

Gastrocnemius third head (TH) is denoted by an asterisk (*).



FIGURE 3: Photograph of popliteal fossa and neurovasculature of the left leg after incision and reflection of the gastrocnemius third head (TH).



FIGURE 4: Photograph of popliteal fossa of the left leg after incision and reflection of the gastrocnemius lateral head and gastrocnemius third head.

Discussion

There are multiple case reports of the presence of a TH of gastrocnemius. However, to our knowledge, the occurrence of bilateral TH's has only been reported once before [2]. Our goal is to discuss this rare anatomical variant and propose the clinical manifestations as a result of this anomaly.

The presence of a TH of the gastrocnemius has been reported frequency of 1.9%-5.5% with varying levels of muscle belly size from threadlike to larger head in MRI studies. While most of these are reported to originate laterally within the posterior compartment, there was one report of the TH beginning medially within the posterior compartment [3]. Other than the fact that this can go undetected, the position of this extra muscle head may increase the risk and severity of certain conditions in individuals. One disease that has been implicated as being associated with extra heads of the gastrocnemius is popliteal artery entrapment syndrome (PAES). PAES is a rare vascular disease where muscles behind the knee compress the popliteal artery. Reports have suggested that increased size and number of gastrocnemius muscle bellies leads to a higher incidence of popliteal nerve entrapment and incidence of deep vein thrombosis (DVT) [4]. It is uncertain whether this anatomical variation had an impact on this patient's death of vascular dementia. Therefore, understanding the complex relation between this anatomical variation and resulting clinical

outcomes is imperative. This results in vascular compromise within the popliteal fossa leading to pain with exertion [5]. The size of the TH varies from case to case; the correlation of larger gastrocnemius heads tends to cause more complications due to compression in local areas and vascular complications such as thromboembolism and ischemia [6].

Another implication is sural nerve entrapment. The sural nerve is a peripheral sensory nerve branch of the tibial nerve that provides sensation to the posterolateral aspect of the distal third of the leg and the foot and ankle. Thus, entrapment causes loss of sensation and numbness to the lateral leg and lateral malleolus due to gastrocnemius head size compressing the sural nerve [7]. Although traditionally believed to be a pure sensory nerve, some evidence suggests that the sural nerve also has a motor function [8]. Therefore, any entrapment of the sural nerve may have motor and sensory consequences for the lower leg muscles. On the contrary, we hypothesize that there may be increased power output from the additional head of the gastrocnemius muscle assuming no nerve or artery entrapment occurs. This would be in relation to the general difference in the size of the leg compared to a population without TH muscle presence. Additional research is also warranted for the possibility of exacerbation of nerve and artery entrapment through increased activity and underlying genetic correlation with the bilateral presence. We would like to speculate an increase in the success of gastrocnemius reconstruction in patients with dorsal leg trauma.

With the above clinical implication in mind, if a physician notes an extra head of the gastrocnemius is present, they may be inclined to intervene depending on the patient's relevant history and future risk. With PAES and sural nerve entrapment as potential negative outcomes, surgical resection of the TH may be implicated. Functional MRI can be used to detect these syndromes and to reduce the risk of later vascular comorbidities [9]. There are many routes to discover the causes and outcomes of TH of gastrocnemius. Further research could allow clinicians to more accurately diagnose patients leading to more optimal patient outcomes.

Conclusions

This case reports the rare presentation of bilateral TH muscles. Although believed to be a benign anatomical variant, this can potentially lead to pathologies such as DVT and PAES. Compression of these structures by the TH may cause numbness, tingling, swelling, and signs of muscle hypoxia in the posterior leg. Ultrasound, computed tomography (CT), or magnetic resonance angiography (MRA) can detect compression and warrant management in the form of resection or avoidance of strenuous lower body exercise. Therefore, clinicians should be aware of this variant and its clinical relevance. TH-related posterior leg vessel compression should be considered a differential when treating patients with signs and symptoms of lower leg swelling or pain. We recommend that gait-lab analysis be performed on patients with TH to study its impact on movement and biomechanics.

Additional Information

Disclosures

Human subjects: All authors have confirmed that this study did not involve human participants or tissue.

Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Acknowledgements

All authors contributed to the planning, writing, and editing of the manuscript. Isaac Arefi, Aidan Maxwell, and Andrew Fickert presented the background research, prevalence, and clinical implications of a gastrocnemius tertius muscle. Erica Werner and Ethan Kosco performed the dissection and made the initial finding of the gastrocnemius tertius muscle in the cadaver. Dr. Bill Frank provided guidance during the anatomy dissection lab and took the images displayed in this report. All authors read and approved the final manuscript.

References

1. Bordoni B, Varacallo M: Anatomy, Bony Pelvis and Lower Limb, Gastrocnemius Muscle . StatPearls Publishing, Treasure Island, FL; 2023.
2. Ishii T, Kawagishi K, Hayashi S, et al.: A bilateral third head of the gastrocnemius which is morphologically similar to the plantaris. *Surg Radiol Anat.* 2021, 43:1095-8. [10.1007/s00276-020-02670-w](https://doi.org/10.1007/s00276-020-02670-w)
3. Koplas MC, Grooff P, Piraino D, Recht M: Third head of the gastrocnemius: an MR imaging study based on 1,039 consecutive knee examinations. *Skeletal Radiol.* 2009, 38:349-54. [10.1007/s00256-008-0606-5](https://doi.org/10.1007/s00256-008-0606-5)
4. Iwai T, Sato S, Yamada T, et al.: Popliteal vein entrapment caused by the third head of the gastrocnemius muscle. *Br J Surg.* 1987, 74:1006-8. [10.1002/bjs.1800741117](https://doi.org/10.1002/bjs.1800741117)
5. Davis DD, Shaw PM: Popliteal Artery Entrapment Syndrome . StatPearls Publishing, Treasure Island, FL; 2023.

6. Sirasanagandla SR, Potu BK, Bhat KM: Popliteal vessels entrapment by a variant accessory belly of medial head of gastrocnemius. *Anatomy Physiol.* 2013, 3: [10.4172/2161-0940.1000116](#)
7. Rodrigues V, Rao MK, Nayak S: Multiple heads of gastrocnemius with bipennate fiber arrangement- a clinically significant variation. *J Clin Diagn Res.* 2016, 10:AD01-2. [10.7860/JCDR/2016/20094.8340](#)
8. Amoiridis G, Schöls L, Ameridis N, Przuntek H: Motor fibers in the sural nerve of humans . *Neurology.* 1997, 49:1725-8. [10.1212/wnl.49.6.1725](#)
9. Radonić V, Koplić S, Giunio L, Božić I, Mašković J, Buća A: Popliteal artery entrapment syndrome: diagnosis and management, with report of three cases. *Tex Heart Inst J.* 2000, 27:3-13.