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Entrapment of neurovascular structures in the (R) popliteal fossa by the third head of the gastrocnemius

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Abstract

Background: The anatomical arrangement of the structures in and around the gastrocnemius has clinical significance, particularly in understanding surgical and pathological conditions involving the popliteal fossa.

Case Description: The present case was reported during the routine dissection of the popliteal fossa in a 50-year-old male cadaver. An extra head of the gastrocnemius was observed on the right popliteal fossa. This additional head extended across the fossa from the lateral to the medial side. Further exploration of the contents of the fossa revealed a very low division of the sciatic nerve. The neurovascular bundle, including the popliteal artery, popliteal vein, and tibial nerve, was found entrapped between the medial head and the third head of the gastrocnemius.

Conclusion: Since the literature has recorded very few cases of third head gastrocnemius and popliteal artery entrapment syndromes, this study may help increase awareness of the anatomical variations of the gastrocnemius and the related structures involved.

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Highlights

What is current knowledge?

Anatomically, the medial and lateral heads of the gastrocnemius are related to the popliteal neurovascular structures.

What is new here?

An extra medial head of the gastrocnemius can cause entrapment of the neurovascular structures, which could be functional or nonfunctional.

Introduction

The popliteal fossa is an anatomical landmark located behind the knee joint. The arrangement of structures within and around the fossa holds both surgical and pathological significance in humans. Anatomically, the fossa is bounded by the biceps femoris superolaterally and the semitendinosus and semimembranosus superomedially. The inferior boundaries of the fossa are bounded by the two heads of the gastrocnemius. The gastrocnemius is a fusiform-shaped muscle, with medial and lateral heads, considered part of the superficial group of the leg's flexor compartment, along with the soleus and plantaris. Functionally, the gastrocnemius is related to both the knee and ankle joints (1).

Morphologically, there is a difference between the two heads of the gastrocnemius. They arise from the medial and lateral condyles of the femur, with the medial head being larger than the lateral head. Both muscle heads combine to form a common belly. Along with the soleus, they are collectively known as the triceps surae, which attaches to the calcaneum bone (2).

Even though the normal anatomy of the popliteal fossa typically involves the presence of two heads of the gastrocnemius, the incidence of more than two heads is recorded at around 2.9-5.5% (3). This variation can affect the contents of the popliteal fossa, including the popliteal artery, vein, and branches of the sciatic nerve, including tibial and common peroneal nerves. Consequently, this anatomical variation may lead to pathological conditions like popliteal vessel entrapment syndrome and nerve entrapment syndrome, highlighting the need for further knowledge of these variations for surgical and therapeutic management.

Case report

During a routine dissection conducted for teaching undergraduate MBBS students on the lower limb of an approximately 50-year-old male cadaver in the anatomy department, the popliteal fossa was exposed along with the posterior compartment of the thigh and leg on both limbs. The boundaries and contents of the left popliteal fossa appeared normal, but an extra head of the gastrocnemius was found in the right popliteal fossa, running across from the lateral to the medial side (Figure 1). This third head originated from the popliteal surface of the femur near the origin of the plantaris and merged with the medial head of the gastrocnemius, which then joined the lateral head to form the muscle belly. Further exploration revealed a low division of the sciatic nerve, with the popliteal artery, popliteal vein, and tibial nerve (A branch of the sciatic nerve) entrapped between the medial and third heads of the gastrocnemius. Moreover, the common peroneal nerve (Another branch of the sciatic nerve), instead of winding around the neck of the fibula, was sandwiched between the lateral head of the gastrocnemius and the plantaris muscle before subdividing into superficial and deep branches (Figure 2). The cause of death of the cadaver was unknown. However, this anatomical variation is significant, as a literature search revealed few cases of popliteal entrapment syndrome involving either the popliteal blood vessels or the tibial nerve being trapped by an extra head of the gastrocnemius (1-4) or a fibrous band (5,6) connecting the medial and lateral heads. In this case, the neurovascular structures in the popliteal fossa were compressed and trapped between the medial and third heads of the gastrocnemius.

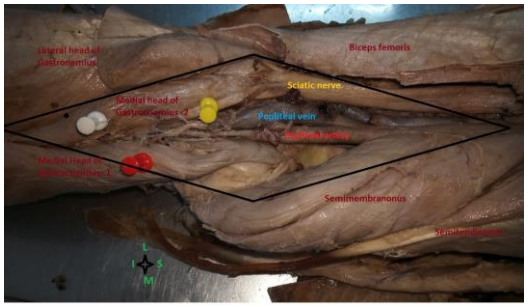

Figure. 1. Right popliteal fossa with boundaries and contents

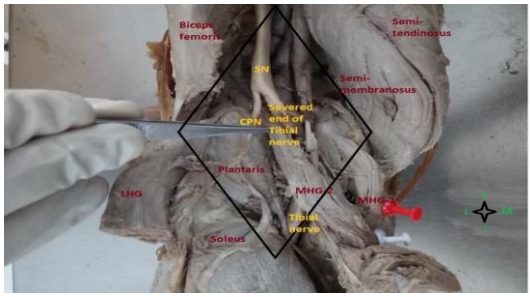

Figure. 2. Entrapment of neurovascular structures in the (R) popliteal fossa

SN: Sciatic Nerve, CPN: Common Peroneal Nerve, LHG: Lateral Head of Gastrocnemius, MHG-1: Medial Head of Gastrocnemius, MHG-2: Third Head of Gastrocnemius, S: Superior, I: Inferior, M: Medial, L: Lateral

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Discussion

The first report of an extra head of the gastrocnemius was made in the early 1800s, but the incidence rate and documentation of such cases remain minimal and rare. The origin of the third head of the gastrocnemius has been observed in various regions, including the linea aspera of the femur, as a slip of muscle from the long head of the biceps femoris, the lateral femoral epicondyles, and it may even arise from the knee joint capsule or the fascia of the leg.

In our present case report, the origin of the third head of the gastrocnemius is along with the plantaris muscle and the popliteal surface of the femur, which has been noted as the common type of third head of gastrocnemius (4,5). A similar origin of the third head has also been recorded in cadaveric studies conducted with the same demographic details (5,6). These cadaveric findings have also been substantiated in many radiological studies, where MRI has shown the presence of the third head of the gastrocnemius (4,7).

Our present case report also demonstrated the entrapment of the popliteal artery and the tibial nerve between the medial head and the third head of the gastrocnemius. Studies on popliteal artery entrapment syndrome, which classify the embryological basis of the popliteal artery, categorize the present case of popliteal artery entrapment as type 3. This classification signifies the entrapment of the artery between the medial head of the gastrocnemius and the additional head (4,8).

Not all cases of a third head of the gastrocnemius involve entrapment of the popliteal artery. Some cases of popliteal entrapment syndrome occur with normal anatomy but present with symptoms due to stress maneuvers, and these cases are termed "functional entrapment." A clinical case report described a young male patient who experienced claudication pain, followed by relief in the right leg after continuous walking. MR imaging revealed additional slips of the medial head of the gastrocnemius bilaterally, despite the patient having unilateral symptoms, illustrating the possibility of bilateral involvement (9).

In our report, along with the popliteal artery, the popliteal vein was also noted between the heads of the gastrocnemius, which could be involved in variations of the venous drainage system of the lower limb (10).

Our present report also described a variation in the nerves of the popliteal fossa, where the sciatic nerve exhibits a very low division into the tibial and common peroneal nerves. Additionally, the common peroneal nerve does not wind around the head of the fibula. Similar case reports have recorded bilateral popliteal artery entrapment with normal positioning of the arteries but with the tibial nerve trapped between the heads of the gastrocnemius (11).

Conclusion

Upon reviewing the literature, this study illustrates that an extra head of the gastrocnemius can compress neurovascular structures in the popliteal fossa, potentially causing claudication and limb ischemia. Most commonly, the extra head arises from the medial head of the gastrocnemius. Transection of this extra head can release the entrapped neurovascular structures and relieve symptoms. This condition should be considered in patients presenting with unexplained lower extremity swelling or other symptoms of lower extremity thrombosis.

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Ethical statement

Not Applicable.

Conflicts of interest

The authors declare that they have no competing interests regarding the publication of this article.

Author contributions

AN: Concepts, Design, Data Collection, Manuscript Editing, and Manuscript Review. R: Data Analysis, Manuscript Editing, and Manuscript Review. DMS: Literature Search, Manuscript Preparation, and Manuscript Editing.

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