Case Report
https://doi.org/10.5115/acb.23.254
eISSN 2093-3673
Anatomy & Cell Biology acb

A biceps-bicaudatus sartorius muscle: dissection of a variant with possible clinical implications

Konstantinos Natsis[1], Christos Koutserimpas[2,3], Trifon Totlis[1], George Triantafyllou[2], George Tsakotos[2], Katerina Al Nasraoui[2], Filippos Karageorgos[1], Maria Piagkou[2]

[1]Department of Anatomy and Surgical Anatomy, School of Medicine, Faculty of Health Sciences, Aristotle University of Thessaloniki, Thessaloniki, [2]Department of Anatomy, School of Medicine, Faculty of Health Sciences, National and Kapodistrian University of Athens, Athens, [3]Department of Orthopaedics and Traumatology, 251 Hellenic Air Force General Hospital of Athens, Athens, Greece

Abstract: The current cadaveric report describes an unusual morphology of the sartorius muscle (SM), the biceps-bicaudatus variant. The SM had two (lateral and medial) heads, with distinct tendinous origins from the anterior superior iliac spine. The lateral head was further split into a lateral and a medial bundle. The anterior cutaneous branch of the femoral nerve emerged between the origins of the lateral and medial heads. SM morphological variants are exceedingly uncommon, with only a few documented cases in the literature, and several terms used for their description. Although their rare occurrence, they may play an important role in the differential diagnosis of entrapment syndromes, in cases of neural compressions, such as meralgia paresthetica, while careful dissection during the superficial inter-nervous plane of the direct anterior hip approach is of utmost importance, to avoid adverse effects due to the altered SM morphology.

Key words: Sartorius muscle, Variation, Anatomy, Entrapment, Neuropathy

Received October 4, 2023; Revised October 28, 2023; Accepted October 30, 2023

Introduction

The sartorius muscle (SM), the longest muscle in the human body, often exceeds the length of 50 cm [1]. It is situated superficially at the anterior thigh compartment [1, 2], extends obliquely from the anterior superior iliac spine (ASIS) to the medial side of the proximal tibia, at the pes anserinus, along with the gracilis and semitendinosus muscle' attachments [1, 3]. The SM is inserted into the superficial layer and the gracilis, and semitendinosus muscles are inserted into the deep layer on the medial surface of the tibia [1]. The SM inner border delineates the femoral triangle's lateral boundary [1, 3]. The SM extends through the hip and knee, leading mainly to their flexion [3], and also assists in hip external rotation and abduction and knee internal rotation [1-3]. The SM is supplied by the femoral artery and is innervated by the femoral nerve [1, 3].

SM morphological variants are exceedingly uncommon, with only a few documented cases of muscle absence [4], muscle duplication, or muscle emanation via two distinct heads (the biceps SM) or a muscle with variable origins referred to such as the pectineal line, the iliopectineal eminence, the femoral sheath, the inguinal ligament, and the pubic symphysis, along its proximal attachment [2, 5, 6]. The SM distal portion may exhibit bifurcation (the bicaudatus SM), with insertion on the patella medial aspect [2-6]. Several terms were also used for the identified SM variants, such

Corresponding author:
Maria Piagkou
Department of Anatomy, School of Medicine, Faculty of Health Sciences, National and Kapodistrian University of Athens, 75 Mikras Asias str., Goudi, 11527 Athens, Greece
E-mail: mapian@med.uoa.gr

as accessory SM, biceps SM, bicaudatus SM, and a duplicated (or double) SM, often leading to a misunderstanding of the described variant.

Hereby, an uncommon biceps-bicaudatus SM was identified in a donated male cadaver. The SM variant morphology was not a pure muscle duplication, as the muscle had two distinct heads, one of them further split into two bundles, and insertion of the whole complex (heads and bundles) at the pes anserinus, at two different attachments, one superior and one inferior (bicaudatus SM). A thorough discussion of the clinical implications of such a variant is also provided.

Ethical approval

As this is a single case report that is completely on a cadaver, no ethical clearance was required as the cadaver is used for teaching and research purposes.

Case Report

A 55-year-old male donated cadaver (of 74 kg weight and 1.68 m height) was routinely dissected, for teaching purposes, at the Anatomy and Surgical Anatomy Department. The body was donated through the "Anatomical Gift Program" after signed informed consent. The right lower limb was dissected, and the skin, subcutaneous tissue, and deep fascia were carefully removed. A variant SM was identified on the anterior surface of the thigh. The muscle had two distinct heads (lateral [LH] and medial head [MH]) heads originated in common from the ASIS with a parallel course. The SM was characterized as biceps SM. Distally to the middle third of the anterior thigh, the LH was further split into a lateral (LB) and a medial bundle (MB). The MB of the LH joined the MH of the muscle, at the proximal lower third of the thigh, and the complex was inserted into the pes anserinus, at an attachment area inferoposterior to the insertion of the LB of the LH. Thus, the SM based on its variant morphology was characterized as biceps-bicaudatus SM. Proximal to the LH and MH origins, the anterior cutaneous branches of the femoral nerve were identified, emerging in between the two heads (Figs. 1, 2). Concerning the muscle's morphometry, the SM length and width were measured with a digital sliding caliper (accuracy of 0.01 mm; Mitutoyo) and are summarized in Table 1. The MH was more elongated, with a total length of 56 cm (tendinous part of 26.7 cm length), and wider as its width, at the following three areas: origin, middle, and insertion were 8.2 cm, 10.6 cm, and 12.7 cm, respectively, compared to the LH that had a length of 53.2 cm (tendinous part

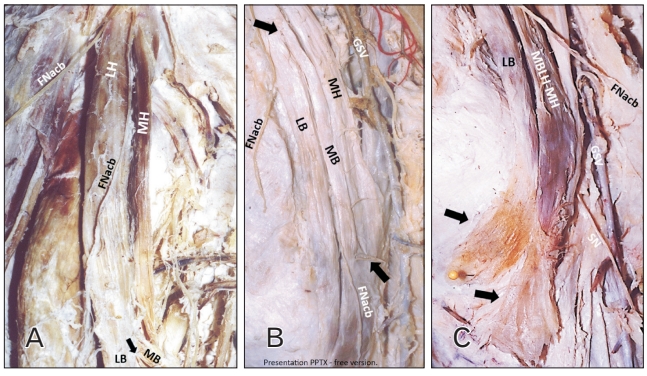

Fig. 1. (A–C) Dissection of the sartorius muscle (SM) variant and related nerves. (A) The SM division into LH and MH, and the LH division (arrow) into LB and MB. (B) The FNacb emersion (superior arrow) and the inferior black arrow depict the fusion of the MB with the MH. (C) SN-sural nerve with the GSV-great saphenous vein. Two arrows depict the superior and inferior attachments of the muscle's components at pes anserinus. FNacb, femoral nerve anterior cutaneous branch; MH, medial head; LH, lateral head; LB, lateral bundle; MB, medial bundle; SN, saphenous nerve; GSV, great saphenous vein.

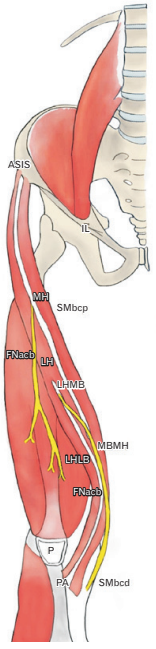

Fig. 2. Panoramic schematic view of the sartorius muscle (SM) variant. The biceps and bicaudatus SM (SMbcp and SMbcd). SM division into LH and MH, and the LH division into LB and MB. The complex MB-MH insertion into the pens anserinus (PA) inferior area. The insertion of the LB into the PA, superior area. ASIS, anterior superior iliac spine; IL, inguinal ligament; MH, medial head; LH, lateral head; MB, medial bundle; LB, lateral bundle; FNacb, the femoral nerve anterior cutaneous branch; P, patella; FN, femoral nerve.

Table 1. The measurements of the lateral and the medial head of the sartorius muscle

SM heads' dimensions	Lateral head (cm)		Medial head (cm)	
	Total	Tendon	Total	Tendon
Length	53.2	23.9	56.0	26.7
Width				
Origin	7.1	18.5	8.2	23.2
Middle	16.8		10.6	
Insertion	6.1		12.7	

SM, sartorius muscle.

of 23.9 cm length) and the relative widths of 7.1 cm, 16.8 cm, and 6.1 cm, respectively.

Discussion

SM morphological variants are uncommon and can be explained from the embryological background. During the development of the thigh musculature, incomplete cleavage of the muscle mass of the area may contribute to the development of several morphological variants. Concerning the SM variant morphology, the variant muscle's forms are atrophied remnants of a pelvic bundle commonly found in lower mammals [7]. These morphological variants may include the evolutionary implication of the lower limb muscles in adapting to human development. Further studies are required to confirm the embryological mechanism and effects of the SM morphological variations. In the present case, an atypical morphological variant of the SM is described, the biceps bicaudatus SM originating from two heads from the ASIS, distally partially fused and inserted into the pes anserinus (two distinct attachment areas). Meckel first described the muscle's absence [8] and Le Double [8] reported variants of the SM volume and direction. Meckel described some cases in which the SM fibers were interrupted by an intermediate tendon [8]. Le Double [8] described three variants of SM duplication: 1) two distinct muscles of the same length, 2) two distinct muscles (main and accessory one), with the accessory muscle located lateral or medial to the main SM, and 3) two SMs partially unified. There have been reports of an SM duplication with separate insertions, distal splitting of the muscle (bicaudatus SM), or a two-headed SM (biceps SM). Furthermore, variants of the SM origin and insertion have been reported [6, 7, 9], as well as cases of an accessory head originating from the iliopectineal eminence, the pectineal line the femoral sheath, and the pubic symphysis [10]. SM variant insertions include the distal attachment at the fascial lata, the central tendon, and the medial side of the knee joint capsule [7, 9].

Although SM morphological deviations are exceptionally uncommon, their occurrence may be the cause of entrapment syndromes. In the current case, the anterior cutaneous branches of the femoral nerve were identified, as emerging between LH and MH. The entrapment of the femoral nerve anterior cutaneous branches may lead to pain, numbness, and paresthesias in the anterior thigh [11], while if the saphenous nerve is involved symptoms may be noted in the anteromedial knee joint, medial leg, as well as the foot [12]. In these cases, a high suspicion level of such morphological variants could prove important. The superficial inter-nervous plane of this approach is between the SM (femoral nerve) and tensor fascia lata (superior gluteal nerve) [13]. Variants, such as the double-headed SM may confuse, while attention to the neural elements is of utmost importance since such injuries may lead to post-operative morbidity.

The SM insertion also plays a role in autologous graft harvesting in anterior cruciate ligament reconstruction surgery. Semitendinosus, gracilis, and SM have a common insertion into the pes anserinus. Semitendinosus and gracilis are harvested when hamstrings are being used [14]. The sartorius fascia must be incised to expose the underlying semitendinosus and gracilis tendons which can be seen closely attached to the sartorius fascia [14]. Variants at the insertion site may complicate the procedure, while the saphenous nerve and its branches are closely related to the medial hamstring tendons and could potentially be damaged during hamstring tendon harvesting. Finally, the SM may be used as a flap for complex femoral injuries [15]. Meticulous surgical exploration is needed in these cases, so that variants, such as the reported one do not lead to adverse effects, including neurovascular injuries.

In conclusions, SM morphological deviations are infrequent, such as the finding of the current cadaveric report. Recognizing the potential existence of such variants may hold significant clinical relevance, particularly for orthopaedic surgeons, neurologists, and rheumatologists, particularly in cases where distinguishing entrapment syndrome and its associated symptoms from other pathological conditions is essential. Furthermore, in the direct anterior hip approach, careful dissection is of utmost importance to avoid adverse effects due to SM variants.

https://doi.org/10.5115/acb.23.254

ORCID

Konstantinos Natsis:
https://orcid.org/0000-0002-9958-6368
Christos Koutserimpas:
https://orcid.org/0000-0002-1398-9626
Trifon Totlis: https://orcid.org/0000-0001-5729-7755
George Triantafyllou:
https://orcid.org/0009-0001-0122-2436
George Tsakotos: https://orcid.org/0000-0001-8559-8969
Katerina Al Nasraoui:
https://orcid.org/0009-0008-7508-5906
Filippos Karageorgos:
https://orcid.org/0000-0002-8260-2624
Maria Piagkou: https://orcid.org/0000-0002-4831-8005

Author Contributions

Conceptualization and dissection: KN. Methodology: CK, TT, MP. Data collection: George Tsakotos, George Triantafyllou, KAN, FK. Drafting of the manuscript: CK, MP. Schematic representation: KAN. Critical revision of the manuscript: KN, TT, George Tsakotos, George Triantafyllou. Critical revision of the manuscript: all authors. Approval of the final version of the manuscript: all authors.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Funding

None.

Acknowledgements

The authors would like to express their gratitude to body donors and their families for their highest contribution to medical education and anatomy research.

References

1. Bergman RA, Afifi AK, Miyauchi R. Illustrated encyclopedia of human anatomic variation. Anatomy Atlas; 2017.
2. Kim J, Lee JH. A unique case of an accessory sartorius muscle. Surg Radiol Anat 2019;41:323-5.
3. Buckland A, Pan WR, Dhar S, Edwards G, Rozen WM, Ashton MW, Taylor GI. Neurovascular anatomy of sartorius muscle flaps: implications for local transposition and facial reanimation. Plast Reconstr Surg 2009;123:44-54.
4. Lin SE, Auyong DB, Dahl AB, Hanson NA. Successful continuous adductor canal block placement in a patient with absent sartorius muscle: a case report. A A Case Rep 2017;9:101-4.
5. Zielinska N, Tubbs RS, Balcerzak A, Olewnik Ł. A very rare case report: accessory head of the sartorius muscle. Folia Morphol (Warsz) 2023 Feb 22 [Epub]. https://doi.org/10.5603/FM.a2023.0014
6. Patil J, Kumar N, Swamy RS, Guru A, Mohandas Rao KG, Aithal AP. Unilateral accessory Sartorius muscle: a case report on its functional and clinical implications. Saudi J Sports Med 2015;15:285-7.
7. Garbelotti JS, Rodrigues CFS, Nobeschi L, Seiji F, Olave E. Anatomical variation of the sartorius muscle. Rev Chil Anat 1999;17:95-7.
8. Ledouble AF. Traité des variations du système musculaire de l'homme. Tome 2. Paris; 1897.
9. Macalister A. Additional observations on muscular anomalies in human anatomy. Trans R Ir Acad 1875;23:1-134.
10. Brock GS. A two-headed sartorius. J Anat Physiol 1879;13(Pt 4):578.
11. Solomons JNT, Sagir A, Yazdi C. Meralgia paresthetica. Curr Pain Headache Rep 2022;26:525-31.
12. Chang KV, Mezian K, Naňka O, Wu WT, Lou YM, Wang JC, Martinoli C, Özçakar L. Ultrasound imaging for the cutaneous nerves of the extremities and relevant entrapment syndromes: from anatomy to clinical implications. J Clin Med 2018;7:457.
13. Petis S, Howard JL, Lanting BL, Vasarhelyi EM. Surgical approach in primary total hip arthroplasty: anatomy, technique and clinical outcomes. Can J Surg 2015;58:128-39.
14. Charalambous CP, Kwaees TA. Anatomical considerations in hamstring tendon harvesting for anterior cruciate ligament reconstruction. Muscles Ligaments Tendons J 2013;2:253-7.
15. Manjunath KN, Venkatesh MS, Shivaprasad A. Distal major pedicle of sartorius muscle flap: anatomical study and its clinical implications. Indian J Plast Surg 2018;51:40-5.