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CASE REPORT

Congenital bilateral absence of the semimembranosus muscles

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Abstract
Variations of the anatomy of the hamstring muscle complex are uncommon. In particular, absence of some or all of the hamstring muscles is rarely described in the literature. This report presents a case of absent semimembranosus musculature detected incidentally on knee magnetic resonance imaging (MRI), then found to be bilateral on MRI of both thighs performed shortly thereafter. Imaging also demonstrated atypical morphologies of the semitendinosus and biceps femoris muscles in both thighs.

Keywords Semimembranosus · Semitendinosus · Biceps femoris · Hamstring · Variant

Introduction

The hamstring muscle complex comprises the semimembranosus, semitendinosus, and biceps femoris muscles. The hamstring muscles demonstrate little anatomic variation, with presence of accessory muscles and absence of conventional muscles both being rare phenomena [1]. For instance, in two radiological reviews of muscle variants and accessory muscles, no mention is made of any thigh muscle anomalies except for a single type of accessory semimembranosus [2, 3]. Other hamstring accessory muscles and variants have been described elsewhere in the literature but are uncommon and often based on cadaveric dissections that lack radiologic correlation [1].

The current case report presents imaging of bilaterally absent semimembranosus muscles and associated variant anatomy of the bilateral semitendinosus muscles. This report is presented for the rarity of these anatomic variants. It is also presented for its depiction of the muscle anomalies not only at the knee but also from the ischium throughout the full length of the thigh. Finally, consideration is given to the potential relevance for posteromedial knee injury and surgical planning.

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Case presentation

The patient was a 42-year-old man referred by his orthopedist for MRI of the left knee due to pain after a fall and associated ankle fractures sustained 3 months earlier. There was no history of knee or thigh surgery. MRI demonstrated a subacute fracture of the posterior margin of the medial tibial plateau and a meniscocapsular junction sprain in the medial compartment.

On all sequences, no semimembranosus muscle belly or tendon insertions were visible. The semimembranosus muscle fossa was filled with fat (Fig. 1). For better evaluation of this abnormality, bilateral thigh MRI was performed 1 week after the knee MRI study. This scan demonstrated complete absence of both the left and right semimembranosus muscles, and symmetry of the remaining hamstring anatomy between the two thighs.

At each of the ischia, the conjoint semitendinosus-biceps femoris tendon and the ischiocondylar origin of the adductor magnus tendon were clearly identifiable (Fig. 2). However, no semimembranosus tendon could be identified in the expected position anterolateral to the conjoint tendon. Throughout the proximal 25% of each thigh, each semitendinosus muscle had a conventional morphology. Throughout the middle 50% of each thigh, the medial portion of the semitendinosus assumed a broad medial border and overall triangular shape more typical of a semimembranosus muscle (Figs. 3 and 4). The lateral portion of the semitendinosus in this segment of each thigh was diminutive in size, whereas the long head of the biceps femoris was broad in the mediolateral dimension (Fig. 4). Throughout the distal 25% of each thigh, the semitendinosus muscle belly resumed a conventional oval morphology (Fig. 5). As had been observed on the knee MRI, the

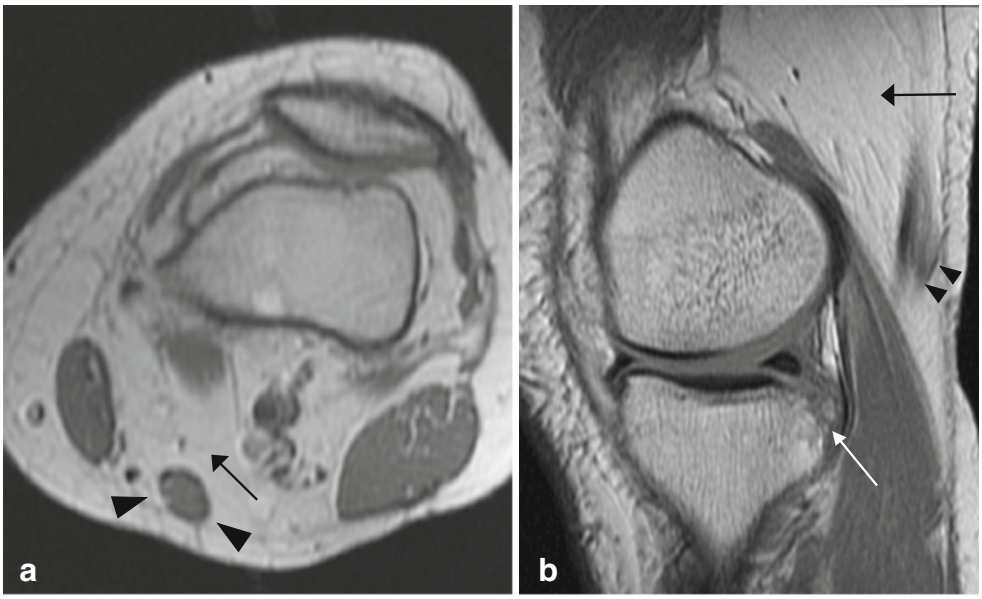

Fig. 1 **a** Axial T1-weighted image through the patient's distal thigh, and **b** sagittal PD-weighted image through the knee demonstrate an empty semimembranosus fossa (*black arrow*, both images), and a distal semitendinosus muscle belly (*arrowheads*, both images) that has not yet tapered into purely tendinous tissue at the level of the medial femoral condyle. Also demonstrated is a small fracture at the posterior margin of the tibia (*white arrow*)

semitendinosus muscle belly continued all the way to the level of the medial femoral condyle (Fig. 1) and became entirely tendinous just distal to the medial epicondyle, in contrast to the tendency of a conventional semitendinosus muscle to taper into tendon by the time it reaches the level of the distal femoral shaft. The distal tendon had the appearance and course of a conventional semitendinosus tendon (Fig. 6). Unlike the muscle belly, the tendon had no hybrid features resembling the semimembranosus tendon complex; that is, there was no tendon variant or additional tendon slip corresponding to any of the insertions that would be expected of a conventional semimembranosus tendon.

The sartorius, gracilis, and adductor magnus muscles and tendons were conventional in their appearances and insertions. No tendon or muscle duplications were observed in either thigh. There was no morphologic abnormality of the medial tibial plateau associated with absence of the semimembranosus muscle, although evaluation for any subtle changes in the bony morphology of the plateau was precluded by a small fracture at this site, presumably sustained during the patient's initial injury (Fig. 1).

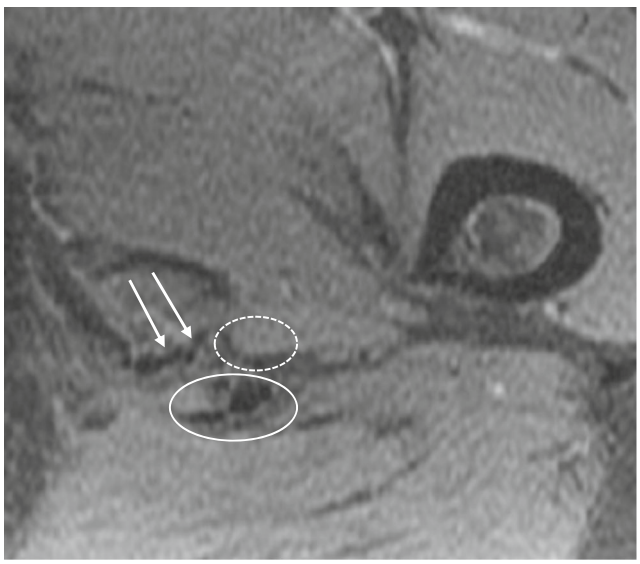

Fig. 2 Axial fat-saturated PD-weighted image approximately 15 mm distal to the patient's ischium demonstrates the conjoint semitendinosus-biceps femoris (ST-BF) tendon complex (*solid oval*). However, there is no semimembranosus tendon in the expected location anterior to the conjoint tendon (*dashed oval*). Also demonstrated is the normal adductor magnus tendon (*arrows*) separate from the ST-BF complex

Discussion

The hamstring complex comprises the semimembranosus, semitendinosus, and biceps femoris muscles. Except for the short head of the biceps femoris, the hamstring muscles cross both the hip and knee joints, aiding in extension of the former and flexion of the latter [4–6].

The normal hamstring complex originates from the lateral surface of the ischium. The biceps femoris and semitendinosus arise as a conjoint tendon. The semimembranosus tendon arises independently, just anterosuperolateral to this conjoint tendon. The proximal portion of the semimembranosus muscle belly is roughly triangular in shape, with the "base" facing medially (Fig. 4). The distal portion of the muscle is thick and round in shape, with the cordlike semitendinosus tendon sitting along its posterior surface. The semimembranosus fibers give rise to another aponeurosis that invests the posterior surface of the muscle before condensing into the distal semimembranosus tendon [5].

The semimembranosus distal tendon has five to six insertions, but the most readily identifiable on MRI are the anterior,

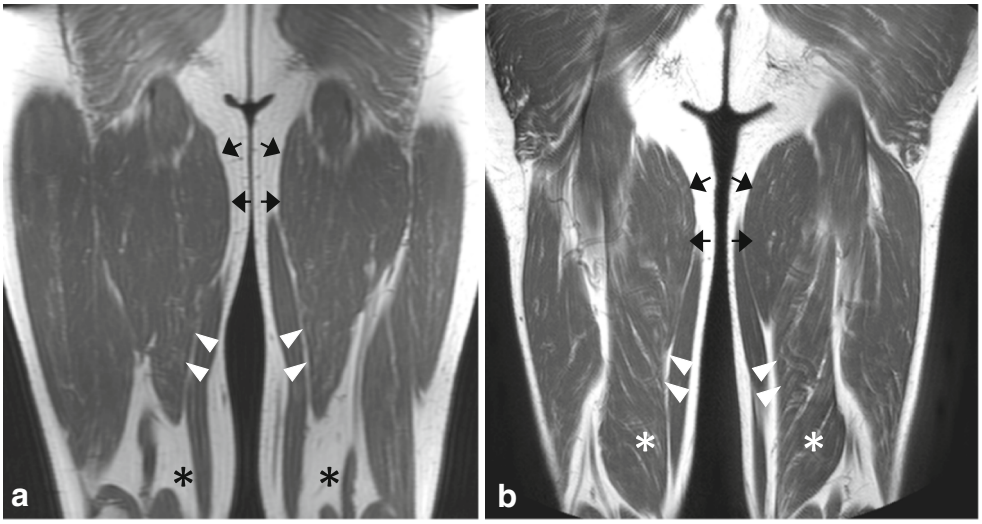

Fig. 3 **a** Coronal T1-weighted image of patient's thighs, compared to **b** thighs from a patient with conventional anatomy. Within the distal semimembranosus fossae (*black asterisks*) there is only fat, rather than the semimembranosus muscle tissue found in a patient with conventional anatomy (*white asterisks*). The proximal semitendinosus morphology resembles that of a conventional semitendinosus muscle (*black arrows*, both images). The semitendinosus morphology in the mid-thigh, however, partially resembles that of a conventional semimembranosus muscle (*white arrowheads*, both images)

inferior, and capsular arms of the tendon. The capsular arm inserts at the popliteus muscle fascia and posterior oblique ligament [5–7]. The anterior and inferior arms insert at the medial aspect of the tibia [6].

Variations of the hamstring complex anatomy are rarely described. Moncayo et al. present a case of an absent semimembranosus detected incidentally during knee MRI [1]. Their patient, like the one presented in this case report, had a long semitendinosus muscle belly. The hamstring musculature in the mid and proximal portions of the thigh was not described in their case since imaging had been limited to the knee. Moncayo et al. cite several reports of hamstring muscle variants observed at postmortem dissection; these reports date from the late 19th and early 20th centuries [8–10]. The anomalies described in these older accounts include complete absence of the semimembranosus muscle belly and tendon, absence of the muscle belly but preservation of the tendon, and absence of both semimembranosus muscles in association with absence of both quadratus femoris and gemelli muscles.

Aside from Moncayo's report, a literature search reveals one other radiologic depiction of absent semimembranosus musculature, which was observed unilaterally on computed

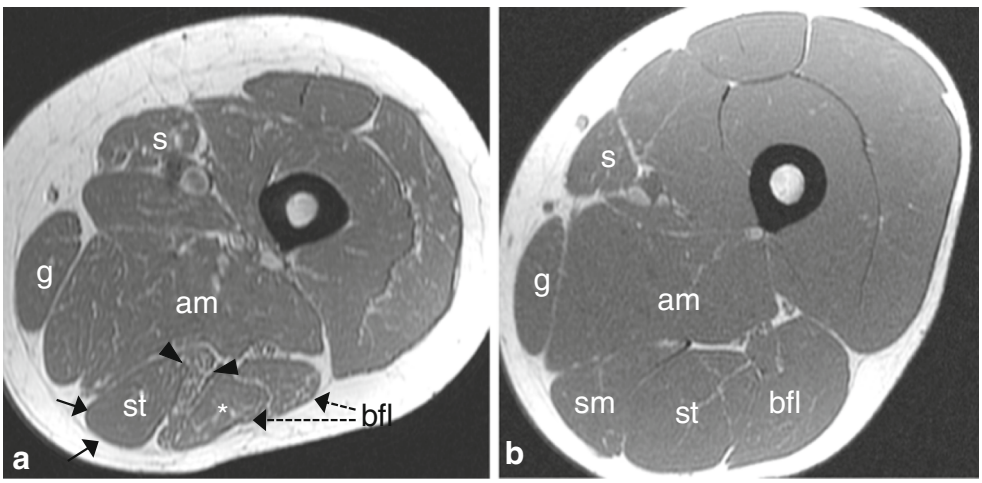

Fig. 4 **a** Axial T1-weighted image of the patient's left mid-thigh, compared to **b** a mid-thigh image from an individual with conventional anatomy. At this level, the patient's semitendinosus (st) muscle has a hybrid morphology with a triangular medial component simulating a semimembranosus (*arrows*) and a diminutive lateral component (*arrowheads*). The biceps femoris long head (bfl, *dashed arrows*) is somewhat broad, with its medial half (*asterisk*) occupying the space that would normally be occupied by the semitendinosus in someone with conventional anatomy. *s* sartorius, *g* gracilis, *am* adductor magnus, *sm* semimembranosus

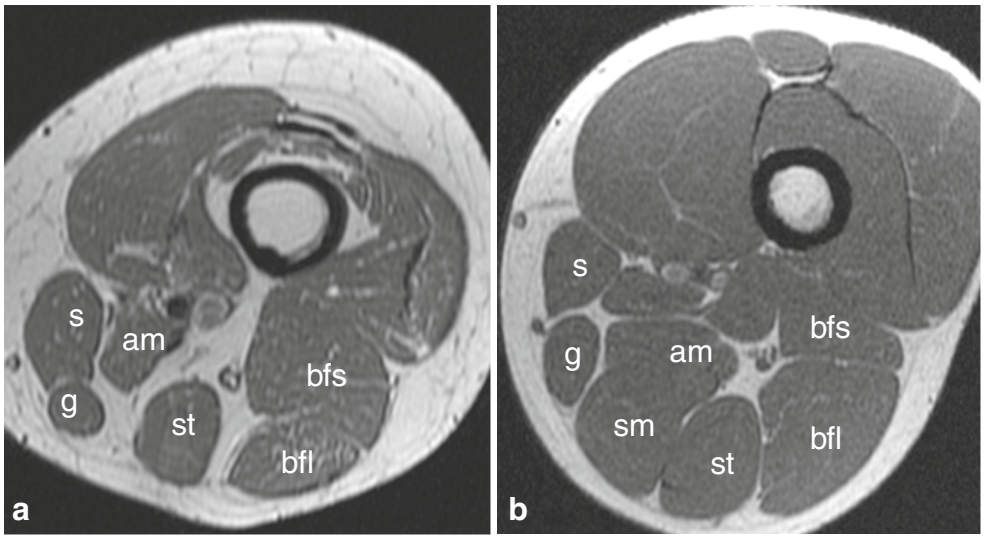

Fig. 5 **a** Axial T1-weighted image of the patient's left distal thigh, compared to **b** a distal thigh image from an individual with conventional anatomy. At this level, the patient's semitendinosus (st) muscle has a more typical, oval morphology. *s* sartorius, *g* gracilis, *am* adductor magnus, *sm* semimembranosus, *bfl* biceps femoris long head, *bfs* biceps femoris short head

tomography of an infant, and which was accompanied by absence of the semitendinosus, biceps femoris, and adductor muscles [11]. Bilateral absence of the semimembranosus was more recently described in the anatomy and biology literature, wherein the anomaly was observed only on cadaveric dissection, and was accompanied by absence of each of the quadratus femoris muscles in one case [12] and by hypertrophic semitendinosus and biceps femoris muscles in another case [13].

In the patient presented in the current case report, it is noteworthy that the absence of the semimembranosus muscles is accompanied by unconventional morphologies of the semitendinosus and biceps femoris long head muscles. The medial portion of the semitendinosus assumes a semimembranosus-like shape within the middle segment of the thigh, whereas the lateral portion of the muscle has a shape more typical of a conventional, albeit diminutive, semitendinosus. As a result, the semitendinosus morphology is hybrid. In contrast, the biceps femoris is somewhat larger and broader than would typically be expected. These variations in the semitendinosus and biceps femoris are perhaps compensatory for the absence of the semimembranosus muscle.

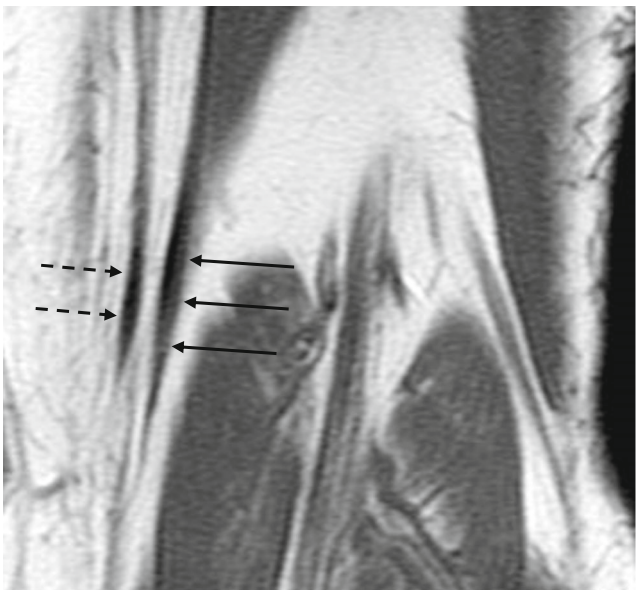

Fig. 6 Coronal T1-weighted image of the patient's left knee demonstrates tapering of the semitendinosus muscle into a single, conventional-appearing tendon (*arrows*). Also demonstrated is the gracilis tendon (*dashed arrows*)

The distal semimembranosus musculotendinous unit helps to reinforce the posterior capsule, restrain the tibia from excessive external rotation, assist internal rotation through synergy with the popliteus muscle, and pull the posterior horn of the medial meniscus posteriorly to prevent its being pressed between the medial femoral condyle and tibial plateau during knee flexion, described by Beltran et al. as a "suction cup" effect [5–7]. Therefore, through loss of these functions, a lower extremity lacking the semimembranosus muscle and tendon may be predisposed to medial meniscal posterior horn injury and/or posteromedial capsule injury, although this would be difficult to prove given the rarity of this variant.

Since posteromedial corner injuries also have an association with ACL tears, it is worthwhile for the radiologist to note any variant anatomy of the hamstring muscle complex. In particular, absence of the semimembranosus may be relevant for surgical planning in the case of ACL reconstruction. Hamstring tendon autograft, usually obtained from the semitendinosus and gracilis, has in some cases resulted in hamstring strength deficits even at 1 year postoperative, as well as varying degrees of semitendinosus and gracilis muscle atrophy [14]. Although the tendon tissue at the harvest sites often regenerates, the extent of regrowth and strength of the regenerated tendon tissue may not fully compensate for the losses due to harvest [15]. In light of potential hamstring

strength deficits that might thus result from a hamstring graft harvest, an absent semimembranosus may be worth considering a relative indication for bone-patellar tendon-bone grafts over hamstring-derived grafts.

Compliance with ethical standards

Conflict of interest The author declares that he has no conflict of interest.

References

1. Moncayo VM, Carpenter WA, Pierre-Jerome C, Smitson RD, Terk MR. Congenital absence of the semimembranosus muscle: case report. Surg Radiol Anat. 2010;32:519–23.
2. Sookur PA, Naraghi AM, Bleakney RR, Jalan R, Chan O, White LM. Accessory muscles: anatomy, symptoms, and radiologic evaluation. RadioGraphics. 2008;28:481–99.
3. Martinoli C, Perez M, Padua L, Valle M, Capaccio E, Altafini L, et al. Muscle variants of the upper and lower limb (with anatomical correlation). Semin Musculoskelet Radiol. 2010;14:106–21.
4. Beltran L, Ghazikhanian V, Padron M, Beltran J. The proximal hamstring muscle–tendon–bone unit: a review of the normal anatomy, biomechanics, and pathophysiology. Eur J Radiol. 2012;81:3772–9.
5. Koulouris G, Connell D. Hamstring muscle complex: an imaging review. RadioGraphics. 2005;25:571–86.
6. Beltran J, Matityahu A, Hwang K, Jbara M, Maimon R, Padron M, et al. The distal semimembranosus complex: normal MR anatomy, variants, biomechanics and pathology. Skelet Radiol. 2003;32:435–45.
7. De Maeseneer M, Shahabpour M, Lenchik L, Milants A, De Ridder F, De Mey J, et al. Distal insertions of the semimembranosus tendon: MR imaging with anatomic correlation. Skelet Radiol. 2014;43:781–91.
8. Symington J. Note on a case of absence of both semi-membranosus muscles. J Anat Physiol. 1884;18:461–2.
9. Turner W. Case of absence of the semi-membranosus muscle; also case of absence of the gemelli and quadratus femoris. J Anat Physiol. 1884;18:463.
10. Bing R. Ueber angeborene Muskeldefecte. Virchows Arch. 1902;170:175.
11. Peterson J, Currarino G. Unilateral absence of thigh muscles confirmed by CT scan. Pediatr Radiol. 1981;11:157–9.
12. Liu H, Fletcher J, Garrison MK, Holmes C. Bilateral absence of quadratus femoris and semimembranosus. IJAV. 2011;4:40–2.
13. Morrison N, Hervey S, Runyeon J. Case report of a bilateral absence of the semimembranosus muscle. FASEB J. 2016;30:1046.11.
14. Burks RT, Crim J, Fink BP, Boylan DN, Greis PE. The effects of semitendinosus and gracilis harvest in anterior cruciate ligament reconstruction. Arthrosc J Arthrosc Relat Surg. 2005;21:1177–85.
15. Battaglia TC, Miller MD. Strength and regrowth of hamstring tendons after hamstring autograft anterior cruciate ligament reconstruction. Tech Orthop. 2005;20:334–9.