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CASE REPORT

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The double-headed accessory iliacus muscle: a case report

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Background: *Numerous accessory muscles are present in the human body, many of which are clinically significant. We present a case of an anomalous accessory iliacus composed of 2 heads, whose occurrence and anatomical location indicate a high probability of causing femoral nerve compression.*

Materials and methods: *During a routine dissection of the posterior abdominal wall of a 78-year-old cadaver, a double-headed accessory muscle was noted, measured, and photographed.*

Results: *In addition to the normal anatomy of dissected structures from the posterior abdominal wall, an accessory iliacus muscle composed of superficial and deep heads was identified. In addition, the inferior roots of the divided femoral nerve located between the heads was found to follow an unusual course.*

Conclusions: *It is important to be aware of morphological variability around structures such as the double-headed accessory iliacus muscle presented in this study, due to their association with neurovascular bundles and hip joints. The reported atypical morphology is not widely known in the literature but might be of great clinical significance; therefore, knowledge of such variability might be regarded in order to diagnose properly and introduce accurate treatment.* (Folia Morphol 2024; 83, 4: 930–935)

Keywords: anatomical variations, accessory iliacus, femoral nerve compression

INTRODUCTION

The occurrence of morphological variations of anatomical structures such as muscles and their tendons was mentioned numerously in medically-oriented literature [14, 15, 18, 22, 31]. However, its diversity remains surprising, and hip muscles are no exception.

The iliacus (IM) is a triangular muscle of the inner hip with a vast origin encompassing two-thirds of the iliac fossa, the inner lip of the iliac crest, lateral aspect of the sacrum, anterior sacroiliac ligament, and iliolumbar ligament. It inserts onto the lesser trochanter of the femur [17]. Together with the psoas major and occasionally, if present, the psoas minor, this muscle forms the iliopsoas muscle complex, which is recognised as the strongest flexor of the hip joint. Numerous variations of iliopsoas muscle complex have been noted. One of those is the occurrence of the accessory iliacus muscle (AIM). In previously presented cases, this structure was usually described as a slim muscular slip arising from the middle third

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of inner lip of iliac crest; it was distinguishable from iliacus muscle mass and traced the iliopsoas muscle complex distally onto its site of insertion: the lesser trochanter of the femur [6, 26].

Variations such as the AIM are of great clinical importance due to its close relation to the neurovascular structures. The lumbar plexus (LP) is usually located posterior to, or between, the layers of the psoas major. One component of the LP is the femoral nerve (FN), a structure formed by the posterior division of the ventral rami of L2, L3, L4, and occasionally by L1 and/or L5 roots; it leaves the muscle mass via its lateral margin and descends through the anterior surface of the IM [17]. Additional structures might produce tension in the FN, which would most likely result in neuropathy, presenting as pain that refers from the hip towards the knee joint.

The present report presents the first description of the unusual occurrence of a double-headed AIM together with an atypical course of the FN that most likely resulted in FN entrapment.

CASE REPORT

An unusual muscle was noticed during the routine dissection of the right posterior abdominal wall of a male cadaver who was 78 years old at death. The dissection was performed according to standard techniques for research and teaching purposes, at the Department of Anatomical Dissection and Donation, Medical University of Lodz, Poland. Briefly, the cadaver was positioned in a supine position on the dissection table. The intestines were separated from the greater omentum, mesentery, and fatty tissue to expose the posterior abdominal wall structures. The iliopsoas muscle complex and components of lumbar plexus were identified. An additional muscular structure covered by common fascia together with the IM was noted.

The accessory muscle was composed of 2 heads characterised by a muscular origin: a superficial head that originated from middle third of the inner lip of the iliac crest, and a deep head that originated from both the middle third of the inner lip of the iliac crest and the muscular mass of the IM. The superficial head descended obliquely and medially over the deep head. At the level of the inguinal ligament, both heads merged and were completely distinguishable from the IM mass. Inferior to the inguinal ligament, an additional muscle was present, which developed a tendon that descended through the femoral triangle between the laterally located IM and medially positioned psoas major tendons before finally inserting into the lesser trochanter. At the insertion point, the tendons of iliopsoas muscle complex were completely separated from one another via the abnormal muscle tendon.

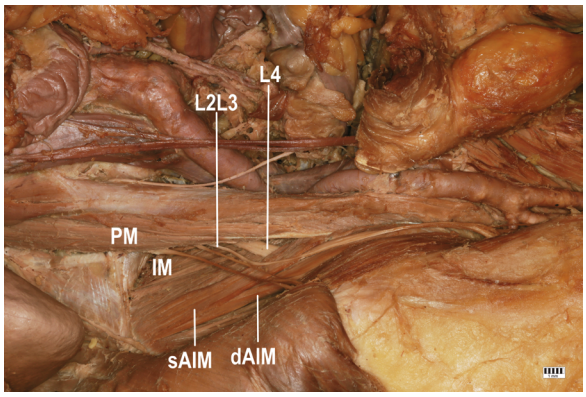

Figure 1. Structures of the right posterior abdominal wall after dissection. dAIM — deep head of the accessory iliacus muscle; IM — iliacus muscle; L2L3 — superior root of the femoral nerve; L4 — inferior root of the femoral nerve; PM — psoas major muscle; sAIM — superficial head of the accessory iliacus muscle.

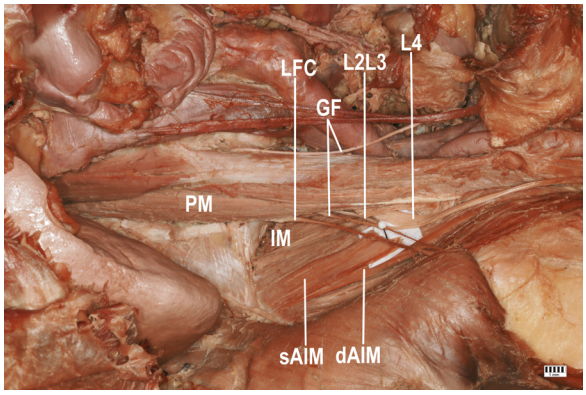

Figure 2. Structures of the right posterior abdominal with visible course of the femoral nerve.
dAIM — deep head of the accessory iliacus muscle; GF — branches of the genitofemoral nerve; IM — iliacus muscle; L2L3 — superior root of the femoral nerve; L4 — inferior root of the femoral nerve; LFC — lateral femoral cutaneous nerve; PM — psoas major muscle; sAIM — superficial head of the accessory iliacus muscle.

The FN left the psoas muscle mass as 2 disconnected roots created from the posterior ventral ramus: superior root formed of L2 and L3, and an inferior one formed from L4. The superior root descended through the anterior surface of the superficial head of the accessory muscle, while the inferior root was located between its heads. Both roots joined together and formed a common main trunk of the FN at the lateral border of the superficial head after the inferior root passed between the accessory muscle heads. No other deviations from the typical course of FN were noted — Fig. 1, 2.

Table 1. Morphometric measurements of individual parts of the AIM's superficial head.

Length	110.10 mm
Width	
Proximal attachment	17.93 mm
Point of fusion with deep head	6.68 mm
Thickness	
Proximal attachment	1.38 mm
Point of fusion with deep head	0.70 mm

Table 2. Morphometric measurements of individual parts of AIM's deep head.

Length	
Muscle belly	136.51 mm
Muscle belly to the fusion with superficial head	95.61 mm
Tendon	91.30 mm
Width	
Proximal attachment	46.68 mm
Musculotendinous junction	14.33 mm
Distal attachment	8.67 mm
Thickness	
Proximal attachment	3.47 mm
Musculotendinous junction	4.28 mm
Distal attachment	2.65 mm

The accessory muscle was subjected to detailed morphometric measurements and photographic documentation. The measurements were taken twice with up to 0.1 mm accuracy using an electronic caliper (Mitutoyo Corporation, Kawasaki-shi, Kanagawa, Japan). Morphometric measurements are presented in Table 1 and Table 2. The anomalous muscle was identified as a double-headed AIM.

DISCUSSION

Numerous morphological variations of the iliopsoas muscle complex components have been described in the literature. These were classified by Aleksandrova et al. [1] based on their relationship with the FN. This classification comprises type A, where the muscular mass of the IM from the anterior and middle part was replaced by fibrous slips [1]; type B, with complete separation of the IM and the psoas major [8, 13, 26]; type C, with complete fusion of the IM and the psoas major with typical course of FN [9]; type D, with highly originated muscular slips that include extremely rare reports of psoas tertius and psoas quartus [5, 11, 27]; type E, with an iliacus minor — a muscle arising from the anterior inferior iliac spine of the ilium and inserting onto the anterior trochanteric line, and the iliocapsularis, with a similar origin — anterior trochanteric line and insertion onto the ilio-femoral ligament [2, 29]; type F, with deep and superficial layers of IM [10, 16]; type G, with large muscular slips of iliacus [21]; type H, with one slip, separated from the IM by the FN [6]; type I, with 2 muscular slips (accessory psoas and accessory iliacus) that pierce the FN [10]; and type J, with a small muscular slip of IM piercing through the FN [1]. Some authors introduce variations as iliacus minimus or iliacus minor to describe additional muscular bands of IM that originate from the iliolumbar ligament or ala ossis sacri [1, 23].

A different classification was introduced by Philippon et al. [20], who classified the iliopsoas tendon unit into 3 types: 1 — single tendon generated by fusion of IM and psoas major (prevalence 28.3%), 2 — doubl--banded tendon composed of IM and psoas major tendons separately (64.2%); and 3 — triple-banded tendon composed of a medially located psoas major tendon, an intermediate IM tendon, and an AIM tendon in the most lateral position (7.5%) [20].

The case presented in this study, or more specifically its superficial head, seems to most closely resemble type H of the Aleksandrova et al. classification [1]; however, it cannot be classified as such, due to the existence of the second head. Our identified double-headed AIM also does not completely resemble type 3 from Philippon et al. [20] because it has a different arrangement of tendons: in our case, the IM tendon is positioned most laterally, the psoas major most medially, and they are separated by the AIM.

The critical zone for femoral nerve entrapment is believed to be the fibro-muscular ring bounded superficially by the inguinal ligament; however, regions such as the space around the iliopsoas are still regarded as entrapment risk in various FN entrapment syndromes [12, 24, 28]. Additional muscular bands of both the IM and psoas major, especially those that split the FM, were previously suspected as causes of FN compression [1, 4, 6, 28]. Interestingly, FN might be split by more than one variant muscle. Parker et al. [19] presented a study in which the FN was split into 3 parts by 2 additional muscles, identified as the iliacus minor and psoas quartus.

As accentuated by Bayrón-Ho et al. [4], when the FN passes under the muscle slip and continues its

usual route under the inguinal ligament and into the thigh, nerve compression and irritation are major concerns due to the variant muscle and route increasing the tension on the FN [4]. The possibility of clinically significant compression seems even more likely when a divided FN courses between muscular heads.

The FN has both motor and sensory functions. Its superior muscular branches innervate the pectineus, iliacus, and sartorius muscles, which participate in hip flexion. The inferior muscular branches innervate the quadriceps components that participate in knee straightening and hip joint stabilization, i.e., the rectus femoris and the lateralis, medialis, and intermedius vasti muscles [17]. The FN also innervates the anterior and medial parts of the thigh via its cutaneous branches. Compression of the FN at such high point on its course, i.e. between the AIM heads, could impair the function of the muscles innervated by the nerve resulting in numbness, tingling, or paraesthesia. It is possible that AIM constriction would intensify the compression, which may occur during iliopsoas muscle function, i.e. hip flexion. Nonetheless, to confirm such suspicions, further studies are required.

Wong et al. [30] presented a study in which muscle that originated from the anteromedial surface of the quadratus lumborum and fused with the tendon of the psoas major, identified as psoas quartus, split the FN into multiple parts. Authors emphasised that variation of the FN and variants within the iliopsoas muscle complex may interfere with numerous surgical approaches to the region, including lateral transpsoas interbody fusion procedures, lumbar plexus blockade, and femoral artery manipulation for angiography or other pelvic region procedures [30]. AIM occurring in accordance with the description presented in this study also may interfere with the mentioned procedures. It is important to note that due to the high variability of anatomical parameters it is impossible to develop standard recommendations for surgical procedures without prior imaging evaluation; therefore, pre-operation visualisation study seems compulsory in order to prevent complications caused by the occurrence of anatomical variation.

It is also possible that the AIM presented in this study could interfere with snapping hip syndrome. Two types of the snapping hip syndrome might be distinguished. The lateral snap, that corresponds to the sudden slip of the iliotibial band over the bulge of the greater trochanter with an abnormal insertion of the gluteus maximus muscle when there is coxa vara, dysplasia, or bi-iliac narrowness [25], and anterior snapping, which occurs most frequently when the hip moves from a position of flexion-abduction-external rotation to the neutral position [7]. During this movement, the medial part of the iliacus is restricted between iliacus and iliopsoas tendons. Such a syndrome manifests itself as a sudden, painful, and audible snapping of the hip and is usually seen among young ballet dancers [7].

Tatu et al. [25], who examined the anatomy of the femoral portion of the iliopsoas muscle, described the iliopsoas tendon as a musculotendinous complex made up of a main tendon arising from the psoas major, an accessory tendon arising from the IM, and proper muscular fibres belonging to the IM. Interestingly, snapping hip syndrome is treated via iliopsoas tendon release. Surgical techniques of release confirm the necessity of deep anatomical knowledge of the musculotendinous complex of the femoral portion of the iliopsoas muscle complex, especially since it is suspected that recurrence is connected with incomplete release, i.e. when only one tendon is released during the procedure; this seems probable when 2 or 3 tendons are present [20]. Such variations as abnormal tendon formation, like that presented in the study, are likely to disturb such treatment, not only by the occurrence of an additional tendon, but also due to its atypical presentation, which does not completely fit into existing classifications. However, further studies are needed to confirm this.

Battaglia et al. [3] reported co-presentation of unilateral FN and bilateral sciatic nerve variants in one cadaver. In this study FN emerged both lateral and deep to the psoas major between the psoas major and IM and was then pierced and divided into 2 separate divisions by an accessory slip of the IM [3]. In the described study the authors emphasise that both the course of the sciatic nerve and FN as well as the surrounding musculature may affect the results of nerve traction tests performed commonly to ascertain the presence of a lumbar disc herniation [3]. Reproduction of radicular leg pain in both sciatic and FN distributions with nerve traction testing is a common sign of lumbar disc herniation. Variation of the sciatic nerve or FN split via additional muscular structure may produce a clinical picture similar to that of a lumbar or lumbosacral radiculopathy [3]. Described variations together with the variant from this study should be considered when a suspected lumbar spine disc herniation is refractory to care,

because recognition of those variants may lead to earlier intervention of physiologic testing and better outcomes of treatment [3].

CONCLUSIONS

The study reports a case of accessory iliacus muscle composed of superficial and deep heads connected with a variable course of femoral nerve and a high possibility of nerve entrapment. In the authors opinion, morphological variation with particular definition is significant not only for anatomists, but also for clinicians, who should be aware of atypical structures that might interfere with numerous surgical procedures or neurovascular functions.

ARTICLE INFORMATION AND DECLARATIONS

Data availability statement

Please contact authors for data requests (Łukasz Olewnik PhD — email address: lukaszolewnik@gmail.com).

Author contributions

Marta Pośnik — project development, data collection and management, data analysis, and manuscript writing.

Nicol Zielinska — data collection, data analysis, and manuscript editing.

Piotr Łabętowicz — data analysis and manuscript editing.

Mariola Głowacka — data analysis and manuscript editing.

Łukasz Olewnik data analysis and manuscript editing.

All authors have read and approved the manuscript.

Ethics statement

The cadavers belonged to the Department of Anatomical Dissection and Donation, Medical University of Lodz.

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Conflict of interest

The authors declare that they have no competing interests.

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