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A three-headed psoas major muscle: a case report

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ABSTRACT

Background: Multiple anatomical variations, from anomalous courses to additional structures, have been reported in muscles from different compartments of the human body. We report an extremely rare case of a psoas major muscle presenting as a three-headed structure with variable morphology.

Materials and methods: During a routine dissection of the posterior abdominal wall of a 82-year-old male cadaver, an anomalous PM muscle with supernumerary head was identified, photographed and subjected to further measurement.

Results: Although the anatomy of the dissected posterior abdominal wall structures was typical, a three-headed psoas major muscle composed of superficial, intermediate and deep heads was identified.

Conclusions: It is important to be aware of morphological variability of muscles, especially those considered to be constant, since an anomalous structure might interfere not only with their functions, but also lead to further clinical consequences.

Keywords: Psoas major muscle, iliopsoas muscle complex, anatomical variations, muscle disproportions

INTRODUCTION

The fibrous origin of the psoas major (PM) can be divided into two groups: anterior, i.e. originating from all anteromedial aspects of lumbar discs and bodies excluding the disc between fifth lumbar/first sacral vertebrae, and posterior, i.e. from all transverse processes of the lumbar vertebrae [12]. The anterior and posterior sites of origin are usually considered as corresponding to the two heads of the PM, the superficial head from the anterior group of origin and the deep head from the posterior. The presented heads constitute individual fascicles that fuse and form a common tendon that inserts together with iliacus (IM) tendon onto the lesser trochanter of the femur [12].

Common insertion and shared function - the strongest hip joint flexion, of both PM and IM, lead to associating those muscles together into iliopsoas muscle complex, that sometimes is considered as comprised of three components, if the psoas minor is present.

Numerous morphological variations have been reported among muscles from different compartments of human body [10, 16, 17, 30], including the iliopsoas muscle complex [1, 3, 7, 24, 28]. There are reports about complete separation or fusion of its components [23], presence of accessory muscular slips [1, 21] or accessory muscles, such as the ilio-capularis [1, 23], accessory iliacus [3], iliacus minimus [25], psoas quartus [18, 24, 28] or psoas tertius [9] and even the presence of an accessory iliopsoas muscle complex [7, 26]. However, on its own, the PM muscle seems a rather constant structure that does not present much morphological variability.

The present report describes the previously-unreported occurrence of a variable PM presenting as a three-headed structure.

CASE REPORT

An unusual muscular structure was revealed during the routine dissection of the right posterior abdominal wall of a 82-year-old male cadaver. 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 supine position on the dissection table. In order to obtain a clear view of the posterior abdominal wall structures, the intestines were separated from the greater omentum, mesentery and fatty tissue. Subsequently, the components of the lumbar plexus and iliopsoas muscle complex were identified and cleared. The psoas minor remained absent. The PM muscle was noted to have an anomalous morphology.

The identified PM muscle was composed of three heads characterised by their muscular origin: superficial, intermediate and deep. The superficial head originated by distinguishable muscular bands (medial and lateral), from the shafts of Th12 and L1 whose fusion produced a tendon strand. An intermediate head emerged within the tendinous strand of the superficial head and deep head originated from the transverse processes of L1-L5 vertebrae. All three heads descended downwards; they were completely distinguishable from one another until the point where the femoral component of the genitofemoral nerve exited from the PM muscle substance. At this point, the intermediate and deep heads joined together

and produced an intermediate tendon. The superior head merged with the component developed by the remaining heads via muscular bands, and the fusion was complete at the level of the inguinal ligament. The PM muscle descended further towards the insertion site, the lesser trochanter of the femur, where its tendon was positioned medially, without any connection to the laterally-inserted IM tendon.

The three-headed PM muscle was subjected to detailed morphometric measurements and photographic documentation. All the measurements were taken twice with an accuracy up to 0.1 mm using an electronic caliper (Mitutoyo Corporation, Kawasaki-shi, Kanagawa, Japan) and presented in Table 1.

Table 1. Morphometric measurements of individual parts of the three-headed psoas major.

Medial band	
Length	58.39 mm
Proximal attachment	
Width	23.05 mm
Thickness	0.53 mm
Lateral band	
Length	113.15 mm
Proximal attachment	
Width	36.19 mm
Thickness	0.54 mm
Superficial head	
Length	207.10 mm
Proximal attachment	
Width	7.81 mm
Thickness	0.33 mm
Intermediate head	
Length	164.80 mm
Proximal attachment	
Width	36.77 mm
Thickness	0.41 mm
Deep head	
Length	246.32 mm
Proximal attachment	
Width	77.39 mm
Thickness	4.46 mm
Distal attachment	
Width	33.31 mm
Thickness	0.39 mm

DISCUSSION

As previously stated, numerous anatomical variations of iliopsoas muscle (IM) complex have been described. Some accessory structures associated with the IM are rather frequently observed, such as the accessory iliacus [3], iliacus minimus [25] or additional muscular slips from both PM and IM, which interfere with the course of the femoral nerve (FN) [1, 19, 21]. The presence of an accessory iliopsoas muscle complex has also been noted

[7, 26]. The PM itself is considered to be relatively constant, and reports about its anatomical variations are rare. Khalid et al. [9] present a case of a psoas tertius that arose from the twelfth rib and the transverse process of L1 vertebrae, split the FN and fused with the iliopsoas tendon. The psoas quartus was introduced as a structure that arose from substance of the quadratus lumborum and fused with the PM tendon [18, 24, 28].

Jelev et al. [7] report a somewhat similar case to the present study, *viz.* a PM divided into three parts. The proximal attachment of the muscle was split longitudinally, in the frontal plane into parts, which extended downwards to form a muscular belly; however, their attachments and course varies greatly from those in present case. Jelev et al. [7] distinguished the following: a superior part from the L1 vertebral body and L1/L2 intervertebral disc, a middle part from L2/L3 intervertebral disc, an inferior part from the lower border of L3 to the S3 vertebrae. The PM muscle described in the present study was composed of a superficial head, that originated as two bands from the Th12 and L1 shafts, an intermediate head from the tendon strand of the superficial heads, and a deep head from the transverse processes of the L1-L5 vertebrae.

The action of the PM, as a component of the iliopsoas muscle complex, as a primary flexor of the hip joint is well established. However it has numerous other functions, especially with respect to lumbar spine stability and movement. Nachemson [14, 15] showed that the PM was active during upright standing, forward bending and lifting, which supported the idea that the vertebral portion of PM takes part in maintaining an upright position as a lumbar spine stabilizer. It was also suggested that the PM has a role in lumbar and pelvic flexion in positions when the femur is fixed, such as in a standing position. Gibbons et al. [4] suggest that the PM might play a dual role in lumbar spine movement: the anterior attachment acting as a flexor and the posterior as an extensor. The PM muscle was also considered as a part in controlling lumbar lordosis, when supporting difficult lumbar loads [2, 20].

In addition, the PM crosses the sacroiliac joint (SIJ) and is suspected to influence it. According to Myers [13], the PM and piriformis act as integral stabilizers in balancing the SIJ. It was previously assumed that the PM assists in the anterior rotation of the hip bone; however, according to Gibbons et al. [4], the force produced by the PM results in rather posterior rotation. It was also stated that during its contraction, the PM provides a pulling force toward its proximal, i.e. spinal, and distal, i.e. femoral, attachments [13]. Throughout muscle contraction while both attachments are stabilized, the PM is able to place a force upon the hip that could participate in positioning the pelvis and SIJ [13].

It is important to note that the variable, three-headed PM muscle introduced in this study was observed only in the right posterior abdominal wall. Since such anomalous muscle was presented unilaterally, it is unclear whether its occurrence could be a cause of significant asymmetry between function of the right and left PM muscles. It is possible that the occurrence of three heads and intermediate tendon strands would disturb the force distribution within the right PM, which would lead to differences in force arrangement patterns between the PM muscles of both sides. Such dissimilarity could potentially interfere in functions like stabilization of lumbar spine, support of lumbar lordosis or positioning of the pelvis, or lead to lower back pain (LBP). The impact of such asymmetry between PM muscles on their function

and the presence of LBP needs additional examination, especially since another kind of asymmetry in PM muscle morphology, *viz.* differences in muscle mass volume, have already been noted among athletes [5, 6, 22] and has been clinically correlated with chronic LBP [20, 29]. Nevertheless, further studies on the impact of the PM on lumbar spine stabilization and on PM variability and asymmetry are needed in order to investigate presented suspicions.

Interestingly, anomalous morphology could not only interfere with PM function associated with the lumbar spine, but also with the SIJ. It can be suspected that activation of the muscle with the structure presented herein could impair load transfer across the SIJ. Studies on LBP based on an active straight leg raise test indicate that such impaired load transfer across the joint might be connected to the SIJ pain [27]. It is also unclear whether the unilateral occurrence of such a muscular anomaly would additionally contribute to the presentation of SIJ pain. However, hypothetical link between anomalous PM muscle morphology, impaired load transfer and SIJ pain needs to be further examined to draw reasonable conclusions.

The cleft of PM is a potential cleft beneath the PM on the side of L5 vertebra [8]. Numerous anatomical structures, such as: great vessels, ascending lumbar vein, iliolumbar vein, obturator nerve and FN are distributed within described cleft [8]. Jianfei et al. [8] highlighted the cleft of PM as clinically relevant in lateral lumbar interbody fusion (LLIF) — technique that allows the surgeon to access the intervertebral space from a direct lateral approach either anterior to or through the PM. During LLIF procedure neurovascular damage of the PM cleft often occurs. Mentioned neural and vascular injuries sustain during the penetration and retraction of the PM, therefore understanding of the anatomical complexity surrounding the PM is crucial in LLIF [8]. It is important to note, that variable morphology of the PM, like described in this study might also impair surgical procedures like LLIF and lead to further complications.

It is also important to accentuate, that together with the obturator internus muscle, PM is a part of the lateral anatomical limit of the pelvic sidewall (PSW) [11]. Surgical procedures, such as treatment of gynecological tumors, excluding tumors diagnosed at the earliest stages and patients' desire for fertility preservation, metastatic iliac lymph nodes, recurrences located near the PSW, deep infiltrating endometriosis (e.g. within the sacral plexus), or procedures, such as a laterally extended endoplevic resection or a laterally extended parametrectomy, often require a dissection of the PSW [11]. Any kind of a variability within the PM muscle might potentially disturb the surgical treatment and lead to further complications, therefore knowledge of its variation seems important in order to consider different approaches during surgery.

In order to prevent from mentioned complications, a variable muscle might potentially be noticed during pre-surgery visualisation, e.g. during ultrasound imaging, however in current scientific literature there is a noticeable deficiency of reports on morphological variations of PM on ultrasound or other imaging studies. Therefore, further studies on this subject are compulsory.

CONCLUSIONS

We report a case of a three-headed psoas major composed of superficial, intermediate and deep heads with an atypical site of origin and an anomalous structure. In the authors' opinion, this morphological variation is significant not only because the psoas major is considered a structure with rather constant anatomy, but also because its rare occurrence may interfere in the functions of the muscle and potentially interfere with various surgical procedures. The circumstances surrounding of the anatomical variability of the psoas major and its influence in muscle function needs further exploration.

Article information and declarations

Ethics statement

The cadavers were the property of the Department of Anatomical Dissection and Donation, Medical University of Lodz, Informed Consents were obtained from all participants before they died.

Author contributions

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

Łukasz Olewnik — data collection and analysis and manuscript editing.

Mariola Głowacka — data collection and analysis and manuscript editing.

Piotr Łabętowicz (MD, PhD) – numerous consultations, observations, suggestions related to the paper. data analysis and manuscript editing.

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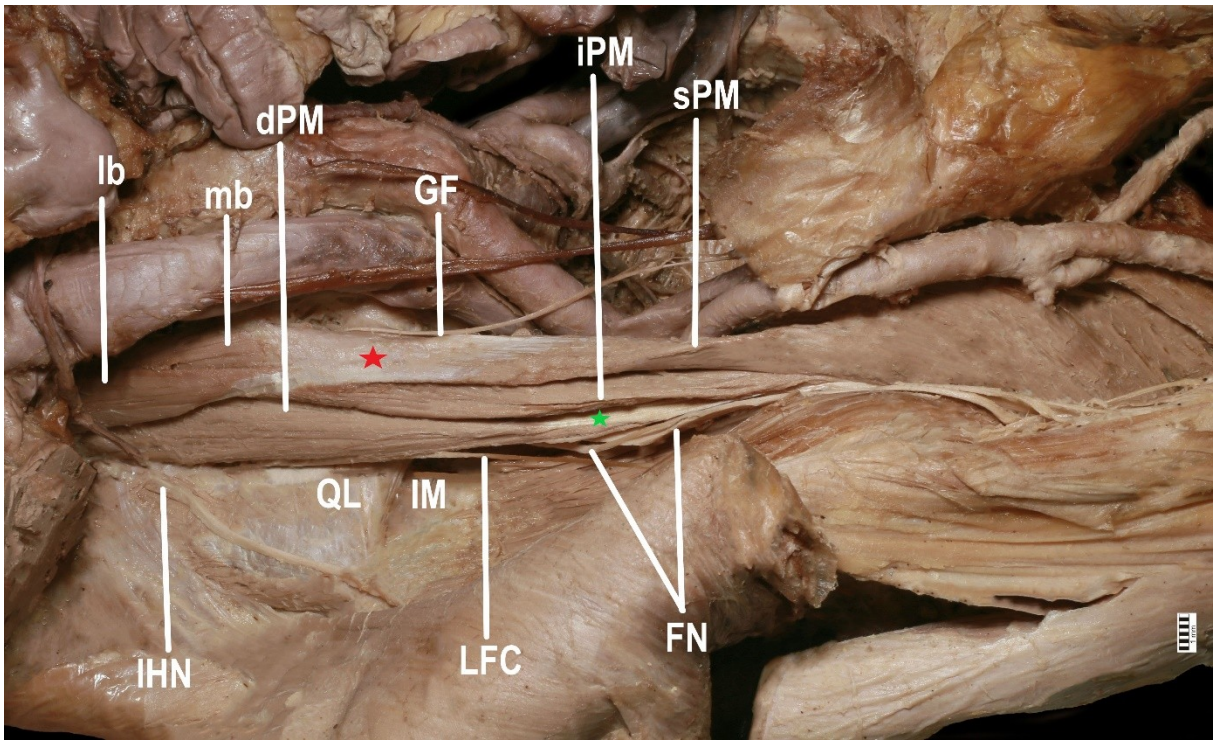

Figure 1. Right posterior abdominal wall after dissection. lb lateral band of the superficial heads origin, mb medial band of the superficial heads origin, *red star* intermediate tendon strand of the superficial head, sPM — superficial head of the psoas major, iPM — intermediate head of the psoas major, dPM — deep head of the psoas major, *green star* tendon strand of the deep and intermediate heads, GF — genitofemoral nerve, IHN — common trunk of iliohypogastric and ilioinguinal nerves, LFC — lateral femoral cutaneous nerve, FN — femoral nerve, QL — quadratus lumborum, IM — iliacus muscle

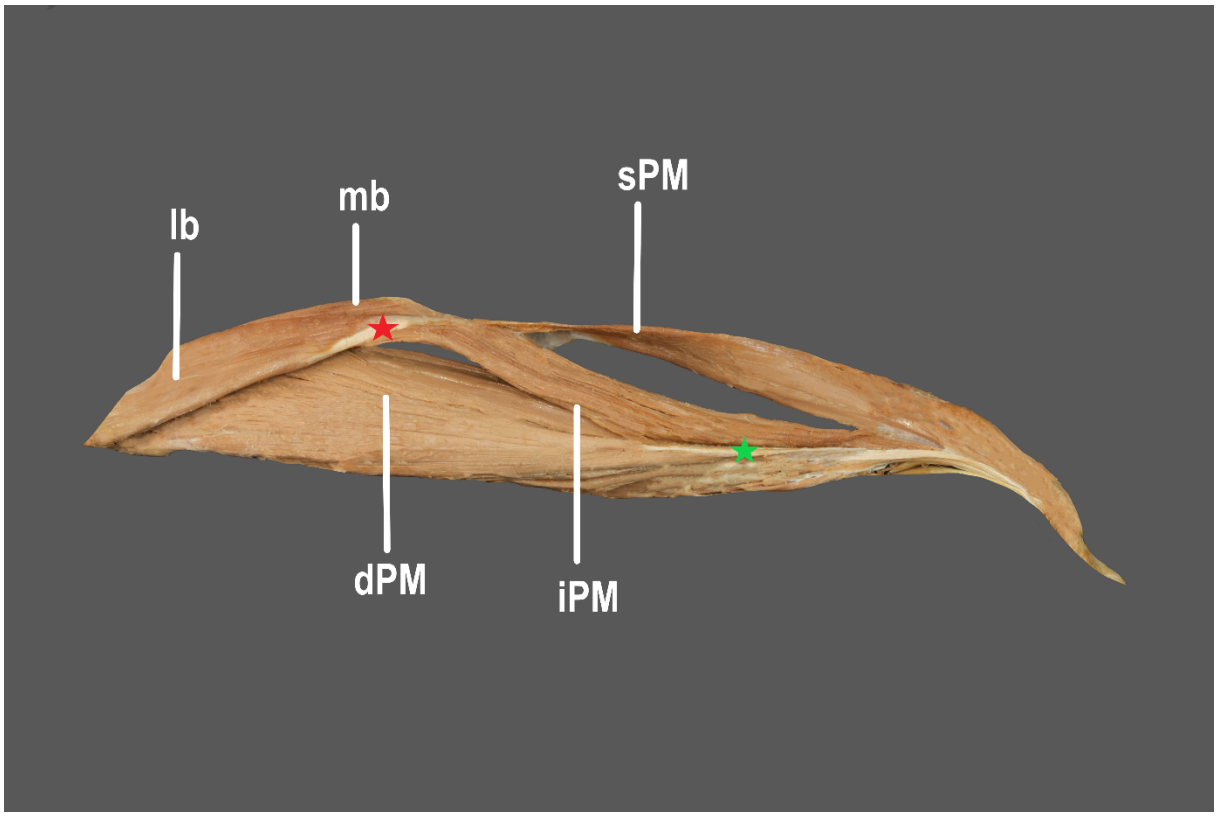

Figure 2. Three-headed psoas major after extraction. lb lateral band of superficial heads origin, mb medial band of superficial heads origin, *red star* intermediate tendon strand of superficial head, sPM — superficial head of the psoas major, iPM — intermediate head of the psoas major, dPM — deep head of the psoas major, *green star* tendon strand of the intermediate and deep heads