ONLINE FIRST

This is a provisional PDF only. Copyedited and fully formatted version will be made available soon.

ISSN: 0015-5659

e-ISSN: 1644-3284

An unusual occurrence of a four-headed psoas major: a case report

Authors: Marta Pośnik, Nicol Zielinska, Konrad Kurtys, Krzysztof Koptas, Łukasz Olewnik

DOI: 10.5603/fm.98920

Article type: Case report

Submitted: 2024-01-14

Accepted: 2024-03-11

Published online: 2024-04-25

CASE REPORT

An unusual occurrence of a four-headed psoas major: a case report

Marta Pośnik et al., Psoas major muscle

Marta Pośnik[1], Nicol Zielinska[1], Konrad Kurtys[1], Krzysztof Koptas[1], Łukasz Olewnik[1]

[1]*Department of Anatomical Dissection and Donation, Medical University of Lodz, Łódź, Poland*

Address for correspondence: Łukasz Olewnik Department of Anatomical Dissection and Donation, Medical University of Lodz, Łódź, Poland, email: lukasz.olewnik@umed.lodz.pl

ABSTRACT

Background: While many structures within the human body demonstrate anatomical variations, this is not typically the case for the iliopsoas muscle complex. However, the present paper describes a case of an anomalous psoas major composed of four different muscular heads in a 78-year-old male cadaver.

Materials and methods: During a routine dissection of the right posterior abdominal wall, an unusual psoas major was observed, measured and photographed.

Results: The psoas major was found to possess four muscular heads, otherwise the anatomy of the wall was normal.

Conclusions: The presence of so many heads could interfere with the functions of the psoas major muscle. Therefore this anatomical variation merits further study.

Keywords: accessory heads, iliopsoas muscle complex, morphological variability, psoas major

INTRODUCTION

Due it frequent morphological variations, human anatomy remains full of surprises. Although the veins, arteries and nerves are typically presented as the most variable structures, muscles and ligaments also demonstrate significant variation [11, 17, 18, 21, 29].

Three muscles within the right posterior abdominal wall, *viz.* the psoas major, iliacus muscle and psoas minor, are typically categorised together as the iliopsoas muscle complex based on their shared function [13, 24]. They participate in hip and lumbar spine flexion, and aid in the stabilization of the lumbar spine and sacroiliac joint (SIJ) [13, 20, 22]. Of these muscles, the psoas minor appears to be the most variable between populations [5, 14, 22, 24]; however, the iliacus and psoas major also manifest certain variability [1, 3, 9, 19, 20, 25, 27].

This case study reports the novel case of a four-headed psoas major.

CASE REPORT

A 78-year-old male cadaver was subjected to routine anatomical dissection for research and teaching purposes at the Department of Anatomical Dissection and Donation, Medical University of Lodz, Poland.

The cadaver was positioned in supine position on the dissecting table. The intestines were separated from the greater omentum, mesentery and fatty tissue to obtain a clear view of the right posterior abdominal wall structures. The components of the lumbar plexus and iliopsoas muscle complex were cleared and identified. The psoas major was observed to have an unusual morphology.

The first head presented double origin. The first band originated from the lateromedial aspects of Th12–L4 vertebral bodies and the discs between them, descended downwards and merged with the second band, which originated solely from the lateral aspect of the Th12 vertebral body. The second head originated from the transverse processes of all Th12–L4 vertebrae and produced a muscular slip characterised by intermediate tendinous tissue, which merged with the muscle mass of the head. The third head originated from superior part of the L3 transverse process. The fourth head was also noticed, characterised by an origin positioned on the transverse process of L3, below the third head origin. All the described heads conjoined and produced a muscle belly that descended downwards and transformed into a tendon at the level of the inguinal ligament; the tendon inserted onto the lesser trochanter of the femur, medially to the iliacus muscle insertion.

The four-headed psoas major 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 dissected psoas major

Structure	**Measurement (mm)**
First head (first band)	

Proximal attachment	
Width	13.66
Thickness	4.38
First head (second band)	
Proximal attachment	
Width	11.34
Thickness	4.97
Length	218.62
Second head	
Proximal attachment	
Width	30.05
Thickness	2.23
Length	194.07
Third head	
Proximal attachment	
Width	4.123
Thickness	1.50
Length	140.43
Fourth head	
Proximal attachment	
Width	6.55
Thickness	2.38
Length	122.13
Musculotendinous junction	
Width	9.34
Thickness	3.18
Tendon	
Width	6.40
Thickness	2.69
Length	117.57

DISCUSSION

The psoas major is typically described as a structure composed of two heads. The heads are sometimes presented as layers; indeed, its fibrous origin can be divided into an anterior group originating from all anteromedial aspects of lumbar discs and bodies, excluding the disc between fifth lumbar/first sacral vertebrae, and a posterior group arising from all transverse processes of the lumbar vertebrae [13]. Therefore, anterior and posterior sites of origin are usually considered as corresponding to the two heads of the psoas major: 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 the iliacus muscle tendon onto the lesser trochanter of the femur. These muscles are sometimes accompanied by the psoas minor on their insertion site.

The most variable component of the iliopsoas muscle complex is the psoas minor; however, morphological variations of the psoas major have also been reported. The iliopsoas muscle complex is believed to have two accessory muscles. The first, the psoas tertius, is described as arising from the twelfth rib and first lumbar vertebra transverse process [2, 10]. The second, the psoas quartus, might arise as a slip from the quadratus lumborum muscle and fifth lumbar vertebra transverse process, as described by Clarkson and Rainy [2]. Alternatively, it may arise from the third lumbar vertebra transverse process and the quadratus lumborum as proposed by Tubbs et al. [25]. It is also possible that it originates solely from the anteromedial surface of the quadratus lumborum muscle as reported by Wong et al. [27]. In addition, Aleksandrova et al. classify the accessory muscles as muscular slips of iliopsoas muscle complex components according to their association to the femoral nerve, which takes into account the probability of nerve entrapment or compression [1].

Variations of the psoas major have also been noted, albeit rarely. Examples of the a tripartite muscle division have been noted. Jelev et al. [8] describe a psoas major split longitudinally into parts that extend downwards to form a muscular belly: a superior part from the L1 vertebral body and L1/L2 intervertebral disc, a middle part from L2/L3 intervertebral disc, and an inferior part from the lower border of L3 to the S3 vertebrae [8]. The morphology of the muscle described herein differs from those described previously.

The psoas major is known to play an important role in hip flexion. However, especially in this case, its function with respect to lumbar spine stability needs further investigation.

Nachemson [15, 16] proposes that the vertebral section of the psoas major is involved in maintaining an upright position as a lumbar spine stabilizer; electromyographic studies indicate the muscle is active during upright standing, forward bending and lifting. Additionally, the psoas major appears to stabilize lumbar lordosis when in an upright posture [4].

The influence of the muscle in lumbar spine stabilization is impaired in a range of clinical situations, such as adolescent idiopathic scoliosis (AIS) and other spine curvature disorders [26]. The paraspinal muscles are suspected to act as a turning or balancing mechanism that corrects spinal deformity and prevent its further progression [12]. Numerous studies have shown that the anatomy of the psoas major is associated with its stabilising function in AIS, especially considering its morphological imbalance. Xu et al. [28] report that the psoas major demonstrates an interesting imbalance of cross-sectional area between the convex and concave sides in AIS patients. The authors conclude that patients between 16–18 years old with AIS demonstrate bilateral hypertrophy of the psoas major compared to the control group; however, among these patients, the convex side became larger than average but not larger than the concave side [28]. The presence of muscular imbalance in the cross-sectional area of the psoas major was also connected with AIS progression after skeletal maturity [26].

Disturbances in the stabilization of the lumbar spine are also related with chronic lower back pain (LBP). Differences in morphological features between left and right psoas major muscles have already been noticed among athletes, such as cricketers [6], footballers [23] or golfers [7]. Interestingly, those dissimilarities were already clinically connected with the occurrence of LBP. A study of 31 elite Australian Rules football players found those with current LBP had asymmetrical and significantly larger psoas major muscles on the dominant kicking side compared with those without current LBP; the percentage difference between the means of the two groups was 8.9% [23].

The clinical significance of the variability described in this study in relation to lumbar spine stability remains unclear. It can be hypothesized that the occurrence of four different heads producing additional attachments to the lumbar spine vertebrae would enhance stabilization. However, it is important to note that the presented four-headed variation occurred only unilaterally, and therefore caused imbalance between the left and right psoas major muscles. The role of such dissimilarity is unclear. It cannot be ruled out that this arrangement may disturb the force distribution within the right psoas major, which would lead to differences in force arrangement patterns between the psoas muscles of both sides. This could interfere with various functions, such as lumbar spine stabilisation, and thus influence clinical conditions such as AIS or LBP, which are directly associated with psoas major function. There is also a need for further biomechanics studies on this matter, especially since the differences in muscle cross-sectional area were previously connected with disturbances in lumbar spine stabilisation.

CONCLUSIONS

We report a novel case of a four-headed psoas major found during dissection of the right posterior abdominal wall. As this configuration may interfere with the lumbar spine stabilisation provided by the psoas major, further studies are needed in this area.

Article information and declarations

Ethics statement

Ethical approval and consent to participate were not applicable.

Author contributions

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

Nicol Zielinska — data analysis, manuscript editing.

Konrad Kurtys — data analysis, manuscript edititng.

Krzysztof Koptas — data analysis and manuscript editing.

Łukasz Olewnik — management, data analysis and manuscript editing.

Funding

The authors have no financial or personal relationship with any third party whose interests could be positively or negatively influenced by the article's content. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest: The authors declare that they have no competing interests.

REFERENCES

1. Aleksandrova JN, Malinova L, Jelev L. Variations of the iliacus muscle: report of two cases and review of the literature. Int J Anat Var. 2013; 6: 149–152.
2. Clarkson RD, Rainy H. Unusual Arrangement of the Psoas Muscle. J Anat Physiol. 1889; 23(Pt 3): 504–506, indexed in Pubmed: 17231810.
3. Fabrizio PA. Anatomic variation of the iliacus and psoas major muscles. Int J Anat Var. 2011; 4: 28–30.
4. Hansen L, de Zee M, Rasmussen J, et al. Anatomy and biomechanics of the back muscles in the lumbar spine with reference to biomechanical modeling. Spine (Phila Pa 1976). 2006; 31(17): 1888–1899, doi: 10.1097/01.brs.0000229232.66090.58, indexed in Pubmed: 16924205.
5. Hanson P, Magnusson SP, Sorensen H, et al. Anatomical differences in the psoas muscles in young black and white men. J Anat. 1999; 194 (Pt 2)(Pt 2): 303–307, doi: 10.1046/j.1469-7580.1999.19420303.x, indexed in Pubmed: 10337963.
6. Hides J, Stanton W, Freke M, et al. MRI study of the size, symmetry and function of the trunk muscles among elite cricketers with and without low back pain. Br J Sports Med. 2008; 42(10): 809–813, doi: 10.1136/bjsm.2007.044024, indexed in Pubmed: 18065440.

7. Izumoto Y, Kurihara T, Suga T, et al. Bilateral differences in the trunk muscle volume of skilled golfers. PLoS One. 2019; 14(4): e0214752, doi: 10.1371/journal.pone.0214752, indexed in Pubmed: 31022190.

8. Jelev L, Shivarov V, Surchev L. Bilateral variations of the psoas major and the iliacus muscles and presence of an undescribed variant muscle--accessory iliopsoas muscle. Ann Anat. 2005; 187(3): 281–286, doi: 10.1016/j.aanat.2004.10.006, indexed in Pubmed: 16130828.

9. Joshi SD, Joshi SS, Dandekar UK, et al. Morphology of Psoas Minor and Psoas Accessorius. J Anat Soc India. 2010; 59(1): 31–34, doi: 10.1016/s0003-2778(10)80008-5.

10. Khalid S, Iwanaga J, Loukas M, et al. Split femoral nerve due to psoas tertius muscle: a review with other cases of variant muscles traversing the femoral nerve. Cureus. 2017; 9(8): e1555, doi: 10.7759/cureus.1555, indexed in Pubmed: 29021927.

11. Koptas K, Zielinska N, Tubbs RS, et al. An unreported infraspinatus muscle variation-two-headed infraspinatus minor muscle and three-headed fusion with the teres minor muscle. Surg Radiol Anat. 2022; 44(9): 1305–1308, doi: 10.1007/s00276-022-02999-4, indexed in Pubmed: 35962136.

12. Modi HN, Suh SW, Yang JH, et al. Spontaneous regression of curve in immature idiopathic scoliosis - does spinal column play a role to balance? An observation with literature review. J Orthop Surg Res. 2010; 5: 80, doi: 10.1186/1749-799X-5-80, indexed in Pubmed: 21047435.

13. Moore K, Dalley AF, Agur AM. R. Clinically Oriented Anatomy (7th ed.). Lippincott Williams and Wilkins, Philadelphia 2014.

14. MORI M. Statistics on the musculature of the Japanese. Okajimas Folia Anat Jpn. 1964; 40: 195–300, doi: 10.2535/ofaj1936.40.3_195, indexed in Pubmed: 14213705.

15. Nachemson A. Electromyographic studies on the vertebral portion of the psoas muscle; with special reference to its stabilizing function of the lumbar spine. Acta Orthop Scand. 1966; 37(2): 177–190, doi: 10.3109/17453676608993277, indexed in Pubmed: 5911492.

16. Nachemson A. The possible importance of the psoas muscle for stabilization of the lumbar spine. Acta Orthop Scand. 1968; 39(1): 47–57, doi: 10.3109/17453676808989438, indexed in Pubmed: 5730107.

17. Olewnik Ł, Zielinska N, Koptas K, et al. Accessory part of the deltoid muscle. Folia Morphol. 2024; 83(1): 226–230, doi: 10.5603/FM.a2023.0018, indexed in Pubmed: 36967626.

18. Olewnik Ł, Zielinska N, Ruzik K, et al. A new look at quadriceps tendon — Is it really composed of three layers? Knee. 2023; 40: 292–304, doi: 10.1016/j.knee.2022.11.005, indexed in Pubmed: 36549105.

19. Parker A, Olewnik Ł, Iwanaga J, et al. Iliacus minor and psoas quartus muscles traversing the femoral nerve. Morphologie. 2022; 106(355): 307–309, doi: 10.1016/j.morpho.2021.10.001, indexed in Pubmed: 34696972.

20. Protas M, Voin V, Wang JMh, et al. A Rare Case of Double-Headed Psoas Minor Muscle with Review of its Known Variants. Cureus. 2017; 9(6): e1312, doi: 10.7759/cureus.1312, indexed in Pubmed: 28690946.

21. Ruzik K, Westrych K, Tubbs RS, et al. Case report of the double-headed extensor hallucis longus. Folia Morphol. 2023; 82(2): 429–433, doi: 10.5603/FM.a2022.0018, indexed in Pubmed: 35187631.

22. Singh D, Agarwal S. Morphological Study of Psoas Minor Muscles with Embryological Basis and Clinical Insights. J Clin Diagn Res. 2021, doi: 10.7860/jcdr/2021/47305.14782.

23. Stewart S, Stanton W, Wilson S, et al. Consistency in size and asymmetry of the psoas major muscle among elite footballers. Br J Sports Med. 2010; 44(16): 1173–1177, doi: 10.1136/bjsm.2009.058909, indexed in Pubmed: 19474005.

24. Tsuyoshi S. Abdominal Wall uscles. In: Tubbs RS, Shoja MM, Loukas M. ed. Bergman's Comprehensive Encyclopedia of Human Anatomic Variation. John Wiley & Sons, Inc., Hoboken 2016.

25. Tubbs RS, Oakes WJ, Salter EG. The psoas quartus muscle. Clin Anat. 2006; 19(7): 678–680, doi: 10.1002/ca.20288, indexed in Pubmed: 16506239.

26. Watanabe K, Ohashi M, Hirano T, et al. The influence of lumbar muscle volume on curve progression after skeletal maturity in patients with adolescent idiopathic scoliosis: a long-term follow-up study. Spine Deform. 2018; 6(6): 691–698.e1, doi: 10.1016/j.jspd.2018.04.003, indexed in Pubmed: 30348345.

27. Wong TL, Kikuta S, Iwanaga J, et al. A multiply split femoral nerve and psoas quartus muscle. Anat Cell Biol. 2019; 52(2): 208–210, doi: 10.5115/acb.2019.52.2.208, indexed in Pubmed: 31338239.

28. Xu JJ, Zhu XL, Li T, et al. Assessment of the cross-sectional areas of the psoas major in patients with adolescent idiopathic scoliosis before skeletal maturity. Acta Radiol. 2021; 62(5): 639–645, doi: 10.1177/0284185120951961, indexed in Pubmed: 32903024.

29. Zielinska N, Tubbs RS, Łabętowicz P, et al. Two variant muscles in the gluteal region. Folia Morphol. 2024; 83(1): 235–238, doi: 10.5603/FM.a2023.0012, indexed in Pubmed: 36811138.