Original Article

Indian Journal of Anatomy
Volume 13 Number 4, October - December 2024
DOI: http://dx.doi.org/10.21088/ija.2320.0022.13424.2

Comprehensive Morphological Analysis of Psoas Minor Muscle: Insight From Cadaveric Studies And Clinical Relevance

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How to cite this article:
Mayur A Darshan, Sharada B Menasinka.Comprehensive Morphological Analysis of Psoas Minor Muscle: Insight From Cadaveric Studies And Clinical Relevance. Ind Jr Anat. 2024;13(4):141-146.

Abstract

Introduction: The psoas muscle group, including the major and minor muscles, shows variability among individuals. The psoas major is consistently present, while the psoas minor has a higher absence rate (40-60%). Evolution has influenced its absence in humans due to upright posture and bipedal gait.

Objectives: This study aims to provide insights into the incidence and morphology of the psoas minor in the South Indian population, addressing literature gaps and discussing its clinical significance.

Methods: Conducted at the Department of Anatomy, Adichunchanagiri Institute of Medical Sciences, B.G. Nagara, Karnataka, the study analyzed 16 cadavers. Measurements included muscle and tendon length, muscle width, origin, and insertion points.

Results: The psoas minor was found in 5 of the 16 cadavers, with unilateral and bilateral occurrences in 2 and 3 cadavers, respectively. The mean lengths of the muscle and tendon were 8.5 cm and 8.8 cm, respectively. The origin was from the body of T12 and L1 vertebrae, including adjoining vertebral discs, with variable insertion points. The mean muscle width was 1.70 cm.

Conclusion: Despite its vestigial and variable nature, the psoas minor was observed in 31.25% of the population studied. Its presence, though infrequent, may play a role in conditions like psoas minor syndrome, where muscle stiffness can occur. Detailed knowledge of the psoas minor is crucial for proper diagnosis and treatment.

Keywords: Bilateral, Major, Unilateral, Variation, Minor.

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Received on: 22.11.2024

Accepted on: 28.12.2024

INTRODUCTION

Psoas minor is known as 'Psoas parvus'. Psoas is a Greek word for loin the muscle of lower back. This muscle is although well developed and constant in most lower animals, is not constant in man. It begins to disappear in those primates who assume erect posture[1].

The psoas group quadratus lumborum and iliacus are the muscles of posterior abdominal wall. Psoas muscle group comprises major, minor and tertius. Psoas major is present in all the individuals. In about 40% of cases psoas minor is often absent. When present is lies anterior to psoas major. It arises from the sides it of bodies of T12 and L1 vertebrae and the intervertebral disc between them. It has a small fleshy belly and ends in a long flat tendon that is attached to pecten pubis and iliopubic eminence and laterally to iliac fascia. It is supplied by a branch from L1. It is a weak flexor of trunk, stabilises hip joint and tenses iliac fascia. It is vestigial in human and comparatively larger in quadrupeds. It tends to assume a smaller size in humans due to adaptation of erect posture and bipedal gait.[2-8]

Psoas minor, pyramidalis, peroneus tertius, palmaris longus, plantaris are the other 5 muscles undergo agenesis.[5] In a study on racial discrepancies psoas minor was absent in 50% of Orientals, 57% in Whites and 67% in Blacks.[1]

Unilateral contraction helps in lateral flexion of vertebral column. When highly tensioned it causes pain in inguinal region and abdominal wall causing reduction in hip movements. This occurs more commonly in athletes, such as golfers and soccer players, impairing their ability to run and jump.[7]

Clinically patients with psoas minor muscle may develop a disorder called psoas minor syndrome, characterised by a deficit in the growth of muscle. The syndrome is due to reduction in movement, causing pain. The importance of this phenomenon is that the symptoms are similar those of acute appendicitis, because of the location of pain in the lower quadrant of abdomen and to those of diverticulitis localised in iliac fossae. The symptoms are due to compression of retroperitoneal neurovascular structures.[7]

AIMS AND OBJECTIVES

1. To assess the prevalence of psoas minor muscle in our region (South India).
2. To analyse the morphological characteristics of the muscle.
3. To study the evolutionary significance and clinical implications of the muscle.

MATERIAL AND METHODS

The observational cadaveric study was carried out in the Dept of Anatomy AIMS. In the academic year 2022-23 and 2023-24 using the cadavers used for the purpose of undergraduate teaching. The present study was based on routine dissection of the post abdominal wall on total 16 cadavers.

Dissection process followed the guidelines outlined in Cunningham's Manual. After opening the abdominal cavity the organs were studied in situ and later removed one by one and later posterior abdominal wall was examined. Genitofemoral nerves, Kidneys, ureters, gonadal vessels were visualised. The diaphragm and Psoas muscles were cleaned. Presence of psoas minor muscle on the anterior surface was seen in 5 cadavers.

The origin of psoas minor muscle was noted in all 5 cadavers. The long tendon of psoas minor muscle was traced till insertion. The small branches from L1 nerve were traced supplying psoas minor. The length and width of muscle belly as well as long tendon were measured with the help of divider and inelastic thread, scale and digital vernier callipers. Photographs were taken where ever necessary. (Fig. 1,2)

RESULTS

Total number of cadavers studied were 16 (12 male+4 female). Psoas minor muscle was observed in 5 male cadavers. Psoas minor muscle was seen in 3 cadavers bilaterally and unilateral in 2 cadavers on left side. Mean length of fleshy fibres was 8.5 cm and tendon was 8.8 cm. mean total length was 17.5 cm. Mean width of fleshy fibres was 1.7 cm of Muscle - tendon unit (MTU).

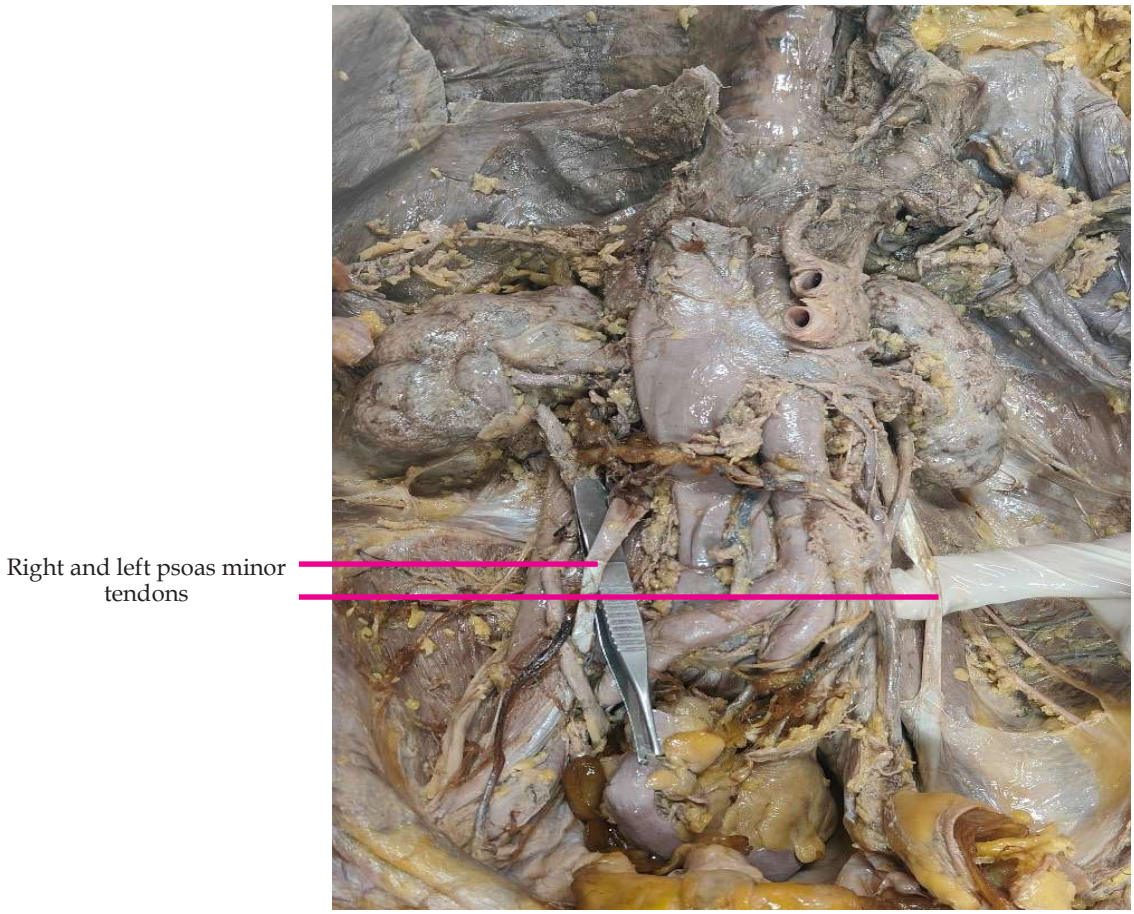

Fig. 1: Showing bilateral psoas tendon

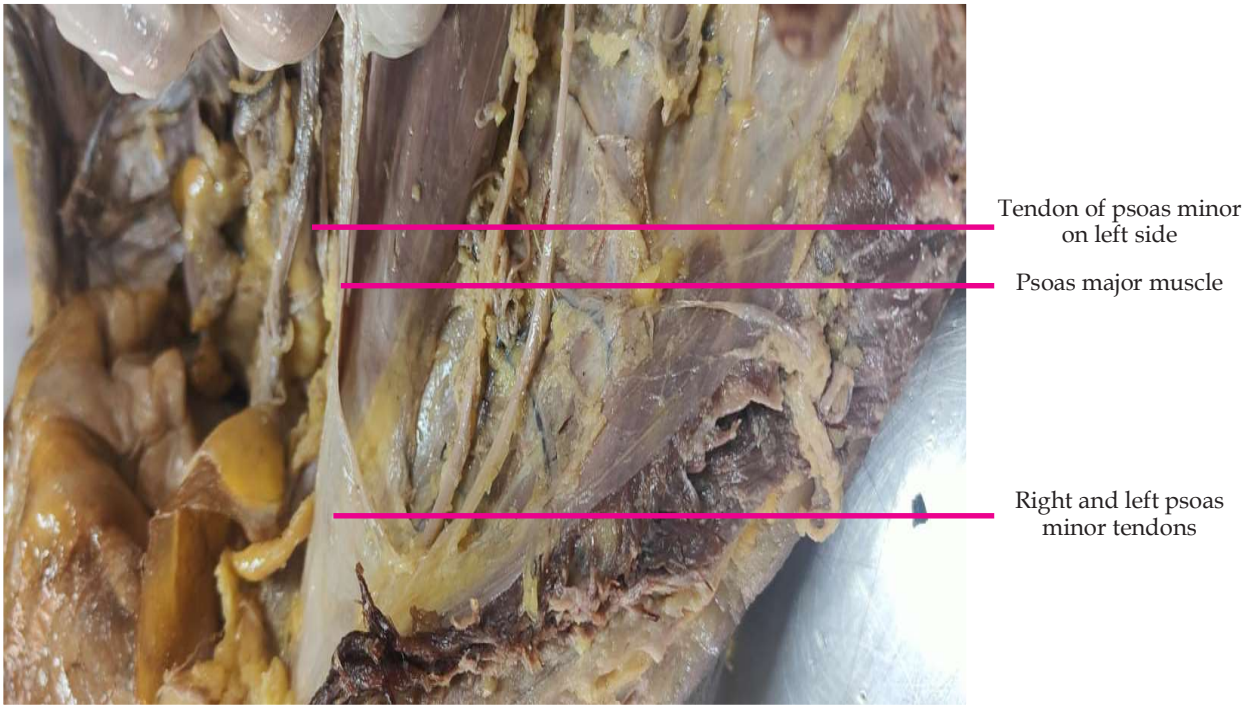

Fig. 2: Showing attachment of psoas tendon to iliac fascia

Table 1: Showing comparison of incidence of psoas minor muscle with other studies

Author	Region & year	Sample size	Psoas minor	%	Bilateral	Unilateral	MTU L in cm	Mean W cm
S D Joshi et al[1]	North India 2010	30	9	30	7	2	24	1.18
Dragieva P et al[3]	Bulgeria 2018	30	6	60	3	3	19.66	0.6
Prasenjit B et al[4]	North India 2020	25	12	48	3	9	19.7	-
Deepshika S et al[5]	North India 2021	9	5	55.55	2	3	24.45	2.9
Deepti S et al[6]	South India 2021	20	3	15	1	2	19.66	2.78
Drakshayani K et al[2]	South India 2022	30	10	33.33	5	5	20.81	1.88
Apurba P et al[8]	North India 2024	30	12	40	9	3	17.54	1.71
Present study	South India 2024	16	5	31.25	3	2	17.3	1.7

DISCUSSION

Psoas minor muscle is inconstant muscle and as its presence in human body may be present bilateral and unilateral with caudal insertion at different anatomical points. The length of the tendon is always more than that of muscle belly. Psoas minor muscle shows variations in length and width in different population. The incidence in the present study was 31.25%, and is comparable with other studies done on Indian population.

Dragieva P et al[3] in 2018 reported a study from Bulgerian population. Among the 10 cadavers in the study sample, psoas minor was seen in 6 specimens (60%), bilateral in 3 and unilateral in 3 (1 on left side & 2 on right side). Neumann et al[9] reported a study (2015) among 32 cadavers. The incidence of psoas minor muscle in USA population was 65.6%. Mean length was 23.84 cm.

S D Joshi et al[1] in 2010 reported a study of 30 cadavers (24 M+ 6 F) from Maharashtra state. Psoas minor was seen in 9 cadavers (29.9%). Bilateral in 23.3% & unilateral in 6.6%. Prasenjit B et al[4] in 2020 reported from Chhattisgarh region of India. Among the 25 cadavers psoas minor was seen in 12 (7 M+ 5 F) cadavers (48%). Among the 12 specimens it was bilateral in 3 and unilateral 9 (5 on right and 4 on left side). Deepshika S et al[5] 2021 reported a study of 9 (3 F + 6 M) cadavers in New Delhi region. Psoas minor was seen in 5 cadavers, bilateral in 2 & unilateral in 3 with incidence of 55.60%.

Apurba P et al[8] in 2024 reported a morphometric study of 30 cadavers in North Indian population. Psoas minor muscle was observed in 12 cadavers (40%). It was bilateral in 10 and unilateral in 2 cadavers. Average total length of fleshy belly and tendon was 17.54 cm and width was 1.71 cm. The studies on North Indian population shows the incidence range between 29.9% to 55.60%.

Deepthi S et al[6] reported a study of 20 cadavers from Telangana region. Psoas minor was seen in 3 cadavers (15%). Drakshayani K et al[2] in 2022 reported a study of 30 (5 F + 25 M) cadaver dissection in South Indian population, Psoas minor muscle was observed in 10 cadavers, 2 female & 8 male cadavers. Incidence of psoas minor was 33.33%. Psoas minor muscle was seen bilaterally in 5 and unilateral in 5 cadavers. There was one specimen with 2 heads of the muscle, 1st head was arising from body of T 12 vertebra & 2nd head from L4,5. The present study among South Indian Population is 31.25% is comparable with these studies.

Ana Poula et al[7] (2021) reported a review of 5071 articles finally 5 articles detailed after exclusion. Among 97 cadavers the incidence was 46.39% (bilateral 32.98%, unilateral 13.14%). Tanu Gupta et al[10] in 2024 reported a case study of bilateral presence of psoas minor muscle.

Clinical significance[11,13]

Psoas syndrome is an often missed and poses a diagnostic challenge. However, it is important to consider this condition as part of the differential diagnosis for patients presenting with low back pain. Many patients have certain symptoms in common, including pain in the lumbosacral region when sitting or standing, delay or difficulty in achieving a fully erect posture, pain in the contralateral gluteal region, and radiation of pain down the opposite leg (generally stopping proximal to the knee).

Symptoms may mimic those of a herniated nucleus pulposus. In the differential diagnosis, other musculoskeletal and visceral causes of pain, such as colon cancer, colon diverticulitis, femoral bursitis, hip arthritis, prostatitis, salpingitis, and ureteral calculi, must be ruled out as the source of low back pain. The pain is poorly localised because the pain from the viscera is carried by paleospinothalamic pathway whose tract fibres are distributed to limbic system, reticular formation and periaqueductal grey before terminating in sensory cortex.

When treating psoas syndrome, it is crucial to consider fascial connections, as fascia envelops the psoas muscle and adjacent organs, linking it to the diaphragm. The ureter's proximity to the psoas means that kidney stones can irritate the muscle. Dysfunction in the psoas can restrict diaphragmatic movement, and vice versa. Additionally, the parietal peritoneum covers both the psoas and the appendix, so an inflamed appendix may irritate the psoas.

However, there is "Thomas test" for diagnosis of this Iliopsoas muscle disorder, as the syndrome cannot be diagnosed by MRI. Skeletal muscle relaxants like cyclobenzaprine hydrochloride are given initially with physiotherapy and tenotomy being last option.

Embryological significance

In patients with Trisomy 18 (Edwards syndrome) psoas minor is consistently absent.[5] In cases with aneuploidy, increased frequency of muscle anomalies reported. This is due to delayed developmental process developmental process in them and muscles involved are usually those that differentiate relatively late during embryonic growth.[15] The cell cycle has many checkpoints like G1, G2 and M in it which thoroughly check any anomalies in the cell and allow the repair of it. Due to the abrupt number of chromosomes in aneuploid cells, this makes the cell go slowly through the cycle due to several restrictions for it.

Evolutionary significance

Jean-Baptiste Lamarck in 1801 proposed his Theory of Evolution popularly known as "Lamarckism". According to his theory any alteration in the environment also alters the needs and behaviour of the organisms living in that environment. This subsequently leads to an increased or decreased use of a given structure or organ. Greater use would cause the structure to increase in size within an individual and gradually across generations, while disuse would trigger its atrophy or even disappearance.[14]

Psoas minor is well developed in quadrupeds that hop or run at high speed. This can also be applied to psoas minor as the quadrupeds eventually evolved into bipedal gait in plantigrade man where the need of the muscle is much less compared to the former gait hence the muscle has receded during evolution.[5]

However this theory was later rejected due to the lack of evidence and many other factors. Later Charles Darwin proposed his theory of evolution, where in he introduced concept of vestigial structures. Darwin defines vestigial structures as structures that persist within a species but have lost their function.[12] They are usually smaller than their homologues in other species, and are sometimes described as atrophied. However, Darwin's definition differs from the definition of vestigial structures used by later biologists. The lack of adaptability and its inconsistency is what make a structure vestigial. All the features listed above suit psoas minor well.

CONCLUSION

The psoas minor is an inconstant muscle and its presence in human body can be unilateral or bilateral with caudal insertion at different anatomical points. Detailed knowledge can be of utmost help for accurate diagnosis. The incidence is significant in evolutionary aspect. Even though it is vestigial its presence is noted in 60% of the population. Variations in terms of origin, insertion, morphology are reported in current and previous studies.

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