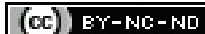


# A Cadaveric Study on Incidence and Morphology of Psoas Minor Muscle in South Indian Population

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## ABSTRACT

**Introduction:** The muscles of posterior abdominal wall on each side of vertebral column include psoas group, quadratus lumborum and iliacus. The psoas muscle group comprises of major, minor and tertius. The psoas major is present in all individuals. Psoas minor is often absent in 40% of the cases. Psoas minor muscle has racial and morphometric variations.

**Aim:** To find the incidence and morphology of psoas minor in South Indian population and discuss its clinical implications.

**Materials and Methods:** The present observational cadaveric study was done on 30 embalmed cadavers for teaching purpose from November 2017 to December 2020 at Karnataka Institute of Medical Sciences, Hubballi, Karnataka, India. Cadavers in the study were of the age group between 50-60 years. Out of 30 cadavers, five were females and 25 were males. In cadavers with presence of psoas minor muscle following parameters

were photographed and studied: unilateral or bilateral, origin, insertion, nerve supply, total length of musculotendinous unit, length of muscle belly, length of tendon, width and circumference at its widest point. Vernier calipers, measuring tape, scale and inelastic thread were used to note various parameters and were tabulated.

**Results:** Out of 30 cadavers, psoas minor was present in 10 cadavers (two female and eight male), bilateral in five and unilateral in five cadavers. The incidence of presence of psoas minor muscle in the present study is 33.33% (two female 6.67% and eight male 26.67%).

**Conclusion:** The psoas minor muscle being vestigial and inconstant, its morphology is highly variable. But the incidence of psoas minor is quite significant (33.33%). Hence knowledge of psoas minor is important to anatomists for academic purpose and to clinicians for proper diagnosis and treatment.

**Keywords:** Abdominal wall, Bilateral, Major, Unilateral, Variation, Vestigial

## INTRODUCTION

The psoas group, quadratus lumborum and iliacus are the muscles of posterior abdominal wall. The psoas muscle group comprises of major, minor and tertius. The psoas major is present in all individuals [1]. In about 40% of the cases psoas minor is often absent [2]. Among all the muscles in the body, psoas minor muscle have greatest propensity of agenesis. When present, it lies anterior to psoas major, entirely within the abdomen. It arises from the sides of the bodies of the 12<sup>th</sup> thoracic and first lumbar vertebrae, and from the intervertebral disc between them. It has a small fleshy belly and ends in a long, flat tendon that is attached to the pecten pubis, iliopubic ramus and, laterally, to the iliac fascia. Psoas minor lies on psoas major, and its proximal anterior relations are those of the anterior or anteromedial surface of that muscle. The main arterial supply to psoas minor is from the lumbar arteries, though there may be minor contributions from other vessels of the network that supplies psoas major [3,4].

Psoas minor is innervated by a branch from L1. Psoas minor is a weak flexor of the trunk, stabilises the hip joint and tenses the iliac fascia [3,4]. Although muscle is vestigial like palmaris longus and plantaris in humans, it is comparatively larger than psoas major in quadrupeds. It is utilised to run and leap by rabbits and to brachiate in apes. Psoas minor muscle has racial and morphometric variations [5]. It tends to disappear in primates which assume smaller in size in humans adapting erect posture and bipedal gait. At times one more muscle is found to origin from deeper aspect of psoas minor tendon and is named as psoas accessorius [6]. On review of literature prevalence of psoas accessories was 25% in a study by Joshi SD et al., [5] and 4% in a study by Bose P et al., [7]. In trisomy 18 psoas minor is always absent, in addition all muscles differentiating late during development are also affected [8].

When the occurrence of psoas minor is accurately diagnosed treatment modality includes tenotomy, physical rehabilitation and opioid analgesics. It is also important in investigations, differential diagnosis and treatment of abdominal emergencies like diverticulitis, ulcerative colitis, uretric calculi, ectopic pregnancy and on right side appendicitis by radiologists, surgeons and physiotherapists [9]. As there are only few studies [10] published in South Indian population, the aim of the present study was to find the incidence and morphology of psoas minor and discuss its clinical implications in South Indian population.

## MATERIALS AND METHODS

The present observational cadaveric study was done on 30 embalmed cadavers for teaching purpose from November 2017 to December 2020 at Karnataka Institute of Medical Sciences, Hubli, Karnataka, India. Institutional Ethical Committee approval was taken for the study with ethical approval no: No/KIMS/S/IEC/14/2017-18.

**Inclusion criteria:** Cadavers in the age group between 50-60 years of both sexes were included in the study.

**Exclusion criteria:** Cadavers were carefully looked for presence of any scar marks indicating surgery or injury on anterior abdominal wall were excluded from the study.

Dissection was carried out according to procedure described in Cunningham's manual [4]. Anterior abdominal wall was incised from xiphoid process vertically downwards and around the umbilicus to continue till pubic symphysis. The incision was extended horizontally from xiphoid process to mid-axillary line and from pubic symphysis along inguinal ligament to anterior superior iliac spine. The peritoneum was exposed and following which all abdominal organs were studied and preserved. Posterior abdominal wall was cleaned and visualised for presence or absence of psoas minor

muscle. In cadavers with presence of psoas minor muscle following parameters were photographed and studied: unilateral or bilateral, origin, insertion, nerve supply, total length of musculotendinous unit from its cranial attachment (origin) to its caudal attachment (insertion), and length of muscle belly from its cranial attachment (origin) to its junction with tendon, length of tendon from its junction with tendon to its caudal attachment (insertion), width and circumference at its widest point. Vernier calipers, measuring tape, scale and inelastic thread were used to note various parameters and were tabulated. For all parameters three readings were taken and average of the three readings was taken as final value.

## STATISTICAL ANALYSIS

The data collected was tabulated and interpreted in a descriptive statistical manner using Microsoft Excel sheet.

## RESULTS

Out of 30 cadavers, five were females and 25 were males. Psoas minor was present in 10 (33.33%) cadavers (two female 6.67% and eight male 26.67%), bilateral in five; unilateral in five. In all cadavers muscle, origin was from the sides of the bodies of the 12<sup>th</sup> thoracic and first lumbar vertebrae and from the intervertebral disc between them and inserted to the pecten pubis, iliopubic ramus and to the iliac fascia. Nerve supply was by ventral rami of first lumbar nerve. No variations noted in origin, insertion and nerve supply. The morphometric data of psoas minor muscle found in 10 cadavers are given in [Table/Fig-1].

The mean total length of musculotendinous unit on right side was 20.81 cm; on left side was 20.17 cm. The mean length of muscle belly on right side was 12.21 cm; on left side was 11.97 cm. The mean length of tendon on right side was 8.6 cm; on left side was 8.2 cm. The mean width on right side was 1.88 cm; on left side was 1.88 cm. The mean circumference on right side was 3.75 cm; on left side was 3.95 cm [Table/Fig-2]. In the present study the muscle belly was longer than the tendon, the cadaveric specimens showing psoas minor muscles have been depicted in [Table/Fig-3-6].

## DISCUSSION

The psoas minor muscle shows variations in its length, width and circumference in different populations. The incidence of presence of psoas minor muscle the present study is 33.33%. The incidence of present study is comparable with that of other Indian studies involving different places [Table/Fig-7] [1,2,5,11,12].

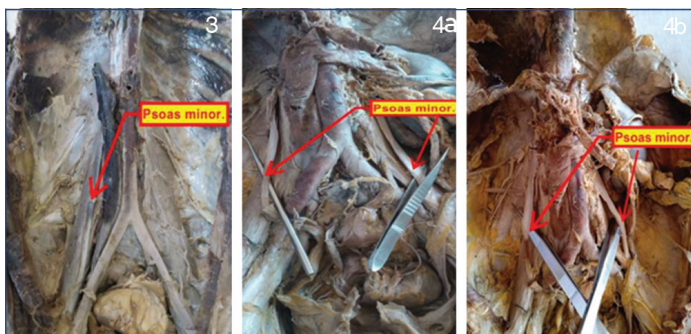
In this study, origin was from bodies of T12 and L1 vertebrae including adjoining intervertebral disc. On review of literature a rare case of double-headed psoas minor muscle was observed in a study by Protas M et al., in which psoas minor was two headed on left side. The lateral head originated from body of L1 and medial head from bodies of L4/L5 and adjoining intervertebral disc [13]. In a study by Garag P et al., psoas minor was found to arise from subdiaphragmatic fascia and medial arcuate ligament with few muscle fibers arising from the crus of the diaphragm [14]. Guerra DR et al., observed variations of insertion into the pectineal line of

S. No.	Gender	Side	Length (cm)		Width (cm)		Circumference (cm)	
			Right	Left	Right	Left	Right	Left
1.	Female	Bilateral	MTU-20	MTU-20	1	1	2.8	3
			LMB-12	LMB-12				
			LT-8	LT-8				
2.	Male	Bilateral	MTU-22	MTU-21.5	3	2.5	5	5
			LMB-13	LMB-12.5				
			LT-9	LT-9				
3.	Male	Bilateral	MTU-22	MTU-21	2	2.5	3.5	6
			LMB-13.5	LMB-12.6				
			LT-8.5	LT-8.4				
4.	Male	Unilateral (right)	MTU-21	-	2	-	4	-
			LMB-12.5					
			LT-8.5					
5.	Male	Bilateral	MTU-23	MTU-21	1.5	1.5	4	4.5
			LMB-13.7	LMB-13				
			LT-9.3	LT-8				
6.	Male	Unilateral (right)	MTU-18	-	1	-	3	-
			LMB-11					
			LT-7					
7.	Male	Unilateral (left)	-	MTU-21	-	1.5	-	4
				LMB-12				
				LT-9				
8.	Female	Bilateral	MTU-20.4	MTU-17.2	1.4	1	2.5	1.7
			LMB-11	LMB-10.2				
			LT-9.4	LT-7				
9.	Male	Unilateral (right)	MTU-20.1	-	3.2	-	5.2	-
			LMB-11					
			LT-9.1					
10.	Male	Unilateral (left)	-	MTU-19.5	-	3.2	-	3.5
				LMB-11.5				
				LT-8				

[Table/Fig-1]: Showing morphometric data of psoas minor muscle. MTU: Musculotendinous unit; LMB: Length of muscle belly; LT: Length of tendon

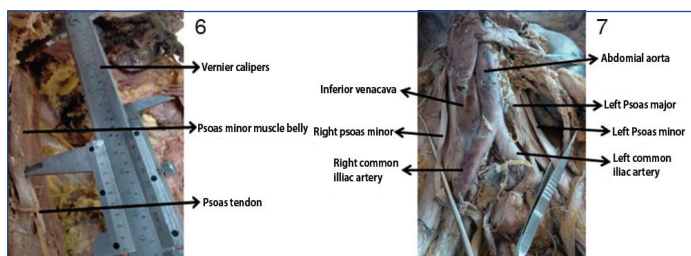
Parameters	Mean in (cms)		Standard deviation		Coefficient of variation	
	Right	Left	Right	Left	Right	Left
MTU	20.81	20.17	4.05	3.47	0.19	0.17
LMB	12.21	11.97	2.78	2.21	0.22	0.18
LT	8.6	8.2	2.07	1.68	0.24	0.20
Width	1.88	1.88	0.27	0.29	0.14	0.15
Circumference	3.75	3.95	0.32	0.49	0.08	0.08

**[Table/Fig-2]:** Showing mean of all morphometric data of psoas minor.  
MTU: Musculotendinous unit; LMB: Length of muscle belly; LT: Length of tendon



**[Table/Fig-3]:** Cadaver showing unilateral psoas minor.

**[Table/Fig-4a,b]:** Cadaver showing bilateral psoas minor. (Images from left to right)



**[Table/Fig-5]:** Measurement of length of muscle belly.

**[Table/Fig-6]:** Cadaver showing relation psoas minor with psoas major.

S. No.	Authors name, year	Place of study	Incidence of presence of psoas minor muscle (%)	Mean length of MTU (cm)	Mean width (cm)
1.	Dragieva P et al., [1] 2018	Bulgaria	60	19.66	1.73
2.	Ohja P et al., [2] 2016	India-Rajasthan	36.67	22.12	-
3.	Joshi SD et al., [5] 2010	India-Maharashtra	30	23.75	1.32
4.	Neumann DA et al., [11] 2015	USA	65.6	23.85	-
5.	Farias MCG et al., [12] 2012	Brazil	59	23.93	1.71
6.	Present study (2022)	India-Karnataka	33.33	R-20.81 L-20.17	1.88

**[Table/Fig-7]:** Comparison of incidence and morphometric data of psoas minor with the present study [1,2,5,11,12].

the femur, neck of the femur, lesser trochanter with the iliopsoas, the arched line, the iliac fascia, the inguinal ligament, or the pectineal ligament [15], the length of psoas minor tendon comprised about 57% of it's total length [15]. Jeyanthi M et al., observed in their study that muscle belly is longer than the tendinous part [16]. In the present study also the muscle belly was longer than the tendon. Due to presence of long muscle belly there are more chances of compression of neurovascular structures and performance of sports person hampered as it interferes activities like jogging, jumping, hopping and leaping [16].

On comparing the present study with those of other studies, incidence was higher in US, Bulgaria and Brazil [1,11,12], mean length of musculotendinous unit was shortest in Bulgaria. The mean

width in the present study was 1.88 cm and 1.73 cm in Bulgaria, 1.71 cm in Brazil [11,12]. However there was no significant difference in mean width in different population [17].

The clinical significance of psoas minor muscle is of psoas minor syndrome [18]. Another reason is, it has gained momentum in sports medicine after a reported incidence of spasm of psoas minor muscle following subluxation of T12 and or L1, and can manifest as low back ache in athletes [19]. Manifestations of psoas minor syndrome can be due to increased tension in psoas minor muscle, taught tendon and also due to compression of retroperitoneal neurovascular structures. In psoas minor syndrome patients presents with pain in iliac fossa, chronic lower abdominal or lumbar pain which gets exacerbated on palpation. These manifestations can mimic diverticulitis, appendicitis if on right side and extrauterine pregnancy [20]. Variation in the origin of psoas minor muscle from diaphragmatic fascia, medial arcuate ligament and crus of diaphragm can cause spread infection and malignancy to retroperitoneal region [14].

### Limitation(s)

The limitation of present study was the number of female cadavers were less compared to male cadavers.

### CONCLUSION(S)

The incidence of psoas minor was 33.33%. The psoas minor muscle is highly variable in its morphology. Detailed knowledge of psoas minor can be of utmost help for proper diagnosis and treatment. Incidence of psoas minor muscle is significant, hence gaining momentum in evolutionary aspects as well as clinically to Radiologists, Surgeons and Physiotherapists. Studies involving imaging techniques would be significant for invasive interventional procedures for diagnostic and therapeutic purposes to Surgeons, Radiologists and Physiotherapists.

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