

Biometrics of Pyramidalis Muscle and its Clinical Importance

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ABSTRACT

Introduction: Pyramidalis is classified as a vestigial muscle which is frequently present. It is muscle of the anterior abdominal wall. It is thought to tense the linea alba. It has been used as a surgical landmark, source of muscle stem cells and in various surgical procedures.

Aim: The aim of this study was to describe the morphometry and morphology of pyramidalis muscle in an adult Indian population and its correlation with the clinical significance.

Materials and Methods: A cadaveric study on 25 formalin fixed cadavers (males-17, females-8) was conducted in context with prevalence, morphology and morphometry of pyramidalis muscle. Statistical analysis was done using the Chi-Square test and student's t-test using SPSS version 23.

Results: The pyramidalis muscle was present in 92% cases, usually bilaterally (72%) than unilaterally (20%) and more frequently in males (94.11%) than in females (87.5%). This study was conducted in Department of Anatomy, Maulana

Azad Medical College, New Delhi, India from August 2014 to August 2016. Bilateral asymmetry was reported. The mean length of the muscle in males and females was 52.21 ± 14.32 and 50.13 ± 13.62 mm on the right and 53.97 ± 15.11 and 51.22 ± 13.78 mm on the left side. No significant gender predominance existed on the right and left-sided pyramidalis lengths. The mean width of the right-sided pyramidalis in males and females was 18.35 ± 5.15 and 17.05 ± 4.99 mm and the left-sided was 17.8 ± 4.80 and 16.21 ± 4.23 mm without gender dimorphism. The mean thickness of the right-sided pyramidalis in males and females was 4.91 ± 1.33 and 4.53 ± 1.29 mm and the left-sided 4.33 ± 1.28 and 4.38 ± 1.27 mm without gender differences. The mean pyramidalis-puboumbilical index was $35.15 \pm 4.38\%$, $36.01 \pm 4.97\%$ in males and females respectively. No anatomical variations with regard to origin and insertion were seen.

Conclusion: This study provides valuable information on pyramidalis muscle which may help in appropriate understanding of anatomy, functions and clinical significance of the muscle.

Keywords: Linea alba, Morphometry, Rectus sheath

INTRODUCTION

Pyramidalis is a small triangular muscle located anterior to the lower part of rectus abdominis muscle within the rectus sheath. It is attached by tendinous fibres to anterosuperior margin of pubis and by the ligamentous fibres in front of the pubic symphysis. The muscle decreases in size as it runs upwards and ends as a pointed apex that is attached to the linea alba midway between umbilicus and pubis but can extend to a higher level. It is innervated by a small branch of the subcostal nerve. Pyramidalis is supplied by branches of the inferior epigastric artery [1,2].

The defined function of pyramidalis muscle is vague, but it is thought to tense the linea alba [1,2]. Many authors have related the pyramidalis muscle with erection of the penis or assumption of upright posture in humans [3]. In making longitudinal incision for a classical caesarean section, the pyramidalis muscle is used to determine the midline and location of the linea alba [4]. Furthermore, after long-term cryopreservation, pyramidalis muscle specimens have been used as a source of striated muscle stem cells for the treatment of post-prostatectomy stress urinary incontinence [5]. Thus, its presence and the knowledge are of vital anatomical and clinical significance.

It varies considerably in size and may be larger on one side than on the other, sometimes absent on one or both sides, or occasionally doubled [1]. The incidence of this muscle also varies greatly with sex and race. So, the present study was undertaken to explore the morphological and morphometric diversity of the pyramidalis muscle.

MATERIALS AND METHODS

The present study was conducted on 25 (17 males and 8 females) embalmed cadavers in the age group 35-60 years in the Department

of Anatomy, Maulana Azad Medical College, New Delhi, India from August 2014 to August 2016. The cadavers with injury scars or surgery marks on abdominal wall were excluded from the study. During dissection of anterior abdominal wall, anterior wall of rectus sheath was reflected laterally to expose the pyramidalis muscle on the lower part of rectus abdominis muscle. Following variables were studied: Presence of pyramidalis muscle; total muscle length; width and thickness of the muscle; presence of any morphological variation of the origin and insertion of the muscle. The width and thickness was measured at the mid-point of the muscle. Measuring tape and digital vernier caliper were used for measurements. Pyramidalis-puboumbilical index which is the percentage of distance between pubic symphysis and umbilicus into which the pyramidalis extends (length along the medial border) was also determined.

STATISTICAL ANALYSIS

Statistical analysis was performed using the Chi-Square test for nominal categorical data and Student's t-test for normally distributed continuous variables in SPSS version 23 to assess the relationship between the examined variables. A level of significance of $p < 0.05$ was used. All the observations and results were tabulated and compared with previous studies.

RESULTS

The results of various biometric data of pyramidalis muscle is summarised in [Table/Fig-1-4]. Pyramidalis muscle was present in 23 (92%) cases. Out of which in 18 cases (72%) (13 males (76.47%), 5 females (62.5%)) it was bilaterally present, in 2 cases (8%) {1 male (5.88%), 1 female (12.5%)} it was bilaterally absent, in 3 cases (12%) {2 males (11.76%), 1 female (12.5%)} it was unilaterally present on

right side and in 2 cases (8%) {1 male (5.88%), 1 female (12.5%)} it was unilaterally present on left side [Table/Fig-1,5]. No anatomical variations related to origin or insertion of muscle was seen. The average value of total muscle length, width and thickness of muscle are depicted in [Table/Fig-2-4] respectively. The mean pyramidalis-puboumbilical index was $35.15 \pm 4.38\%$, $36.01 \pm 4.97\%$ in males and females respectively [Table/Fig-2]. No anatomical variations with regard to origin and insertion were seen.

DISCUSSION

Vestigial muscles in human beings are those muscles which are tendinous in larger part or reduced in size compared to the homologous muscles in other species or is frequently absent within

	Total	Male (n=17)	Female (n=8)	p-value
Bilaterally present	18 (72%)	13 (76.47%)	5 (62.5%)	0.47
Bilaterally absent	2 (8%)	1 (5.88%)	1 (12.5%)	0.57
Unilaterally present on right side	3 (12%)	2 (11.76%)	1 (12.5%)	0.96
Unilaterally present on left side	2 (8%)	1 (5.88%)	1 (12.5%)	0.57

[Table/Fig-1]: Prevalence of pyramidalis muscle.

Side	Male		Female		p-value between male and female of same sides
	Range (mm)	Mean±Standard deviation (mm)	Range (mm)	Mean±Standard deviation (mm)	
Right	29.52 - 78.31	52.21±14.32	32.93 - 69.62	50.13±13.62	0.89
Left	28.61 - 78.99	53.97±15.11	33.75- 70.83	51.22±13.78	0.92
p-value between right and left side	0.98		0.95		
Pyramidalis- Puboumbilical Index	30.12% – 42.03%	35.15±4.38%	31.09%– 43.68%	36.01±4.97%	

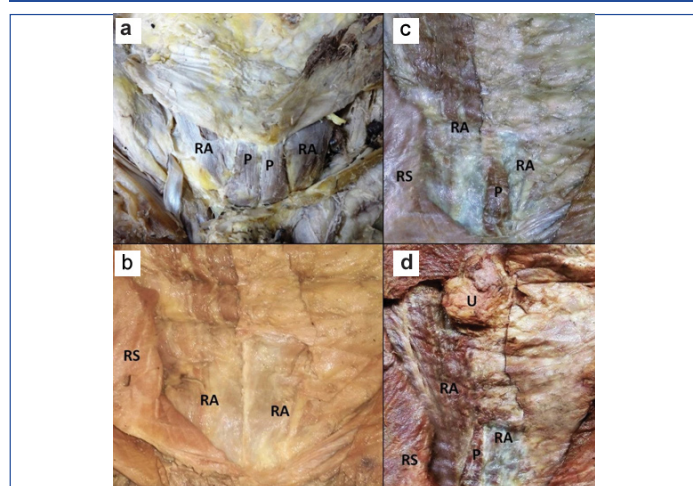
[Table/Fig-2]: Measurement of length of pyramidalis muscle.

Side	Male		Female		p-value between male and female
	Range (mm)	Mean±Standard deviation (mm)	Range (mm)	Mean±Standard deviation (mm)	
Right	12.38-25.91	18.35±5.15	10.56-24.77	17.05±4.99	0.81
Left	10.33-24.34	17.8±4.80	9.51 – 23.93	16.21±4.23	0.88
p-value between right and left side	0.78		0.56		

[Table/Fig-3]: Measurement of width of pyramidalis muscle.

Side	Male		Female		p-value between male and female
	Range (mm)	Mean (mm)	Range (mm)	Mean (mm)	
Right	3.37-6.76	4.91±1.33	3.49-5.99	4.53±1.29	0.54
Left	3.52-6.82	4.33±1.28	3.31- 5.86	4.38±1.27	0.77
p-value between right and left side	0.47		0.59		

[Table/Fig-4]: Measurement of thickness of pyramidalis muscle.



[Table/Fig-5]: Lower part of anterior abdominal wall showing- A) Bilateral presence of pyramidalis muscle, B) Bilateral absence of pyramidalis muscle, C) Unilateral left side pyramidalis muscle, D) Unilateral right side pyramidalis muscle. P- pyramidalis muscle, RA – rectus abdominis muscle, RS- rectus sheath, U- umbilicus.

or between populations. Pyramidalis muscle is also such muscle which is known to exhibit variations.

Phylogenetically, pyramidalis is linked to the pouch inside monotremes such as hedgehog and the platypus and marsupials such as the koala or kangaroo. In humans, standard anatomical textbooks describe the incidence of the pyramidalis muscle to be 83–90% [1]. Different authors around the globe had reported an incidence of pyramidalis in the range 82- 100% in various ethnic groups [Table/Fig-6] [3,6-9]. In our study in Indian population, an incidence of 92% (males-94.11%, females-87.5%) was reported. In Japanese [6] population, the incidence of pyramidalis was greater (94.5%) as compared to our study population. Incidence in the present study was greater than that reported in American blacks (82%) [3]. Kaur et al., and Jit et al., reported incidence of 87% and 100% in north Indian population [3,7]. Present study incidence fall between these data as our population included various subjects of different regions of India. The frequency of pyramidalis muscle in humans is probably influenced by racial and ethnic characteristics. Highest incidence of unilateral pyramidalis was reported in both the genders (male-17.64%, females-25%) of our study population as

compared to the rest of populations of the world. Bilateral presence of pyramidalis muscle (72%) was the most common variety. Males showed a greater incidence of bilaterality (76.47%) than females (62.5%). Unilateral pyramidalis on right side (12%) was more common than unilateral left side (8%). Unilateral left pyramidalis was more common in females (12.5%) than males (5.88%). These differences were not statistically significant.

The morphometry of pyramidalis also varies with its frequency. Side asymmetry in length, width and thickness was noticed which was statistically insignificant [Table/Fig-3,4,5]. The biometric parameters of right side pyramidalis muscle were greater than the left side except the muscle length which was greater on left. The average muscle lengths in both the genders were lesser than the corresponding Greek ethnicity [8] and almost equal to the north Indian population [3,7]. The difference may be due to racial variations i.e., difference of stature in different populations. In contrast the average muscle width was greater than the Greek population [8] and roughly equal to the north Indians [3,7]. No statistically significant gender dimorphism was found on the basis of muscle length, width and thickness [Table/Fig-2-4]. No anatomical variations related to origin or insertion of muscle was seen.

Since, pyramidalis muscle serves as a landmark for surgeon for making a midline infraumbilical incision [10], pyramidalis-puboumbilical index [3] was calculated which could be clinically significant. The average pyramidalis- puboumbilical index was $35.15 \pm 4.38\%$ in males and $36.01 \pm 4.97\%$ in females [Table/Fig-2]. These values may be useful for surgeons as pyramidalis muscle covers the lower 35-36% of distance between umbilicus and pubic symphysis.

S. No.	Authors	Year	Population	Total incidence (%)	Presence (%)		Bilateral absent (%)	Length (mm)		Width (mm)		Thickness (mm)		
					Unilateral	Bilateral		R	L	R	L	R	L	
1	Mori [6]	1964	Japanese	94.5	-	-	-	-	-	-	-	-	-	
2	Jit et al., [7]	1986	North Indian	87	Male- 6.45 Female -7.31	Male- 83.06 Female-73.17	Male- 10.48 Female-19.51	-	-	-	-	-	-	
3	Didia et al., [9]	2009	Nigerian	91.67	-	-	-	80.9	79.4	15.5	16	-	-	
4	Natsis et al., [8]	2015	Greek	93.8	14.6	79.2	6.2	Male	83.7	75	16.1	15.6	-	-
								Female	61.8	65.6	15	15.5	-	-
5	Kaur et al., [3]	2016	North Indian	100	6.67	93.33	-	Male	49.78	49.78	17.5	17.2	-	-
								Female	48.73	47.84	12.5	14.57	-	-
6	Present study	2017	Indian	92	Male- 17.64 Female -25 Total- 20	Male- 76.47 Female-62.5 Total- 72	Male- 5.88 Female-12.5 Total- 8	Male	52.21	53.97	18.35	17.05	4.91	4.33
								Female	50.13	51.22	17.8	16.21	4.53	4.38

[Table/Fig-6]: Comparison of morphometric data of pyramidalis muscle with other studies [3,6-9].

Though literature on the functions of pyramidalis has been vague yet it is unquestionably said to tense the linea alba. Some authors consider it to be immaterial and vestigial, but it is frequently encountered by gynaecologists during caesarean sections [11]. Lovering and Anderson studied the architecture and the fibre type of pyramidalis muscle and predicted that, this muscle generates less than 1% of the anticipated force generated by the rectus abdominis in normal sized adult [12]. This led them to the conclusion that the importance of this less amount of force on linea alba is not understandable. But, yet on a different note, it is frequently harvested to conduct electrophysiological experiments on muscles [13]. Apart from this, clinically the pyramidalis muscle has been used as a source of skeletal muscle stem cells for the treatment of post-prostatectomy stress urinary incontinence [5] and also been used for microsurgical transfer to treat small recalcitrant wounds in the foot/ankle region because of reduced donor site morbidity as compared to traditional free flaps [14]. Therefore, the biometric measurements of pyramidalis could help surgeons in proper sizing of pyramidalis muscle flaps. Pyramidalis muscle has been used successfully to treat severe dysuria due to insufficiency of the perineal floor muscles caused by upper and lower motor neuron lesions, by fixing the prostate with the pyramidalis muscle, associated with a bladderperxy [15]. Considering the above facts, the role of the pyramidalis muscle cannot be overlooked.

LIMITATION

The limitation of current study was that the sample size was less (25 cadavers). Also fetal specimens were not included in this study, which could have given appropriate idea about the development of this muscle.

CONCLUSION

This cadaveric study shows that, the pyramidalis muscle is nearly a constant feature in Indian population. The morphometry

of pyramidalis also varies along with its incidence. The muscle morphometric unevenness and its proven applications will help surgeons during lower abdominal wall surgeries.

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