

MORPHOLOGY AND MORPHOMETRY OF PYRAMIDALIS MUSCLE IN INDIAN POPULATION: A CADAVERIC STUDY

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Keywords:

Pyramidais muscle, Rectus sheath, Anterior pubic ligament, Adductor longus, Linea alba.

Abstract

Objectives: Aim was to evaluate the morphology, morphometry and variable incidence of pyramidalis because it is used as a surgical landmark, muscle transplant, in repair of inguinal hernia. Recently, a new anatomical concept of the pyramidalis–anterior pubic ligament–adductor longus complex is introduced.

Material and methods: Study was conducted on 72 (60 males and 12 females) cadavers of unknown age. During routine abdominal dissection conducted for medical undergraduates pyramidalis were carefully dissected; observed for its presence/ absence, shape, length, width and thickness were taken.

Results: Pyramidalis muscle was present on one or both sides in 83.32% of cases. Mean length on right and left side in males was 81 mm and 78.5 mm respectively and for females it was 75mm and 70 mm respectively. Mean thickness of muscle was in 4.52 mm on right side and 4.41 on left in males while in female it was 4.49 mm on right and 4.48 mm on left side.

Conclusion: Pyramidalis morphometry show variations. It is commonly involved with pyramidalis–anterior pubic ligament–adductor longus complex injuries which are typically associated with displacement of the pyramidalis muscle. Observations of present study will be helpful to surgeons, radiologist and anatomists.

Introduction

Pyramidalis muscle (PM) is a paired muscle present in rectus sheath on either side of the abdominal midline. It is triangular in shape and its medial margin is close to the midline. Its tendinous fibers take origin from anterior surface of the superior ramus of pubic bone, anterior pubic ligament and the ligamentous fibers from pubic symphysis. Fibers of this muscle run upwards and converge proximally to form a small aponeurotic apex to get attachment to linea alba. It receives its nerve supply through a small twig from the subcostal nerve and arterial supply by branches of the inferior epigastric artery [1]. Exact function of PM is not known but it is thought that both the muscles tense the linea alba and strengthen the anterior abdominal wall [1, 2].

Clinical importance of pyramidalis: Gynecologist and surgeons used PM as a surgical landmark to define the midline of the linea alba [3]. It may be used in muscle transplant and in repair of inguinal hernia [4]. Furthermore, PM has been used for the treatment of post-prostatectomy stress urinary incontinence as a source of striated muscle stem cells [5]. Recently, a new anatomical concept of the pyramidalis–anterior pubic ligament–adductor longus complex (PLAC) is introduced by Schilders et al. According to them, both PM and adductor longus muscle attached to the anterior pubic ligament and together they form PLAC [6]. Knowledge of this complex is essential for MRI interpretation and proximal adductor longus injury. PM shows a variable morphology. It may be present bilaterally, unilaterally, absent or have supernumerary muscle. It also varies in size may be larger on one side than another side. However, it shows variation with sex and race [7, 8]. Thus, the precise knowledge of its presence and variations are of clinical significance. The objective of our study was to evaluate the morphology, morphometry and variable incidence of the PM in Indian population.

Materials and methods

The present study was conducted on 72 (60 males and 12 females) embalmed cadavers of unknown age in our department after taking institutional ethical committee permission. We excluded the cadaver's having surgery scars or injury marks on anterior abdominal wall from our study. During the routine dissection of anterior abdominal wall the anterior wall of rectus sheath was reflected laterally to see the pyramidalis muscle. We studied the following parameters:

1. Presence or absence of pyramidalis muscle and any variation in no of bellies.
2. Shape, length, width and thickness of the muscle were recorded. Length was measured along the medial border of PM; width was taken at base and thickness at the mid-point of the PM was measured with digital vernier caliper.
3. Variation of the origin and insertion of the muscle were noted.

Results

Present study observed that, out of the 72 cadavers, the pyramidalis muscle was present in 60 (83.32%) cadavers (Fig.1, 2) and absent in 12 (16.66%) cadavers (Fig. 3). Detail prevalence of pyramidalis muscle was given in Table 1. In one male cadaver we observe supernumerary presence of PM (Fig.4) which was not included in above observations. In this cadaver we observed three bellies, two on left side and one on right (Fig. 4).

Table 1: Prevalence of pyramidalis muscle in male and female cadavers

Pyramidalis Muscle	Male (n=60)	Female (n=12)	Total
Bilaterally present (Fig. 1)	41(68.33%)	06 (50%)	47 (65.27%)
Unilaterally present- right side (Fig. 2a)	07 (11.66 %)	01 (8.33%)	08 (11.11%)
Unilaterally present- left side (Fig. 2b)	03 (5.00 %)	02 (16.66%)	05 (06.94%)
Bilaterally absent(Fig. 3)	09 (15%)	03 (25%)	12 (16.66%)

Dimensions: Detailed results of the length, width and thickness of PM were given in Table 2. We observed that the length of the muscle along medial border was different on right and left sides of the same cadaver while in some it was equal on both the sides. The breadth of the PM at the base was variable on right and left side of the same body so it was asymmetrical.

Table 2: Measurements of pyramidalis muscle in male and female cadavers

Parameters	Sex	Side	Maximum (mm)	Minimum (mm)	Mean (mm)
Length	Male	Right	106.0	56	81
		Left	103	54	78.5
	Female	Right	89	52	75.0
		Left	91	49	70
Width	Male	Right	08	23	15.5
		Left	09	25	17
	Female	Right	10	33	22
		Left	11	35	21.5
Thickness	Male	Right	5.20	3.2	4.52
		Left	4.91	2.90	4.41
	Female	Right	5.31	2.7	4.49
		Left	4.88	2.8	4.48

Mean thickness of the PM muscle in males 4.52 mm on right side and 4.41 on left while in female it was 4.49 mm on right and 4.48 mm on left side.

It was triangular in shape on either side with longitudinal orientation of fibers in all cadavers. We did not observe any anatomical variations related to origin or insertion of PM.

Figures:



Figure 1: Bilateral presence of pyramidalis muscle (PM) [R- right, L- left]

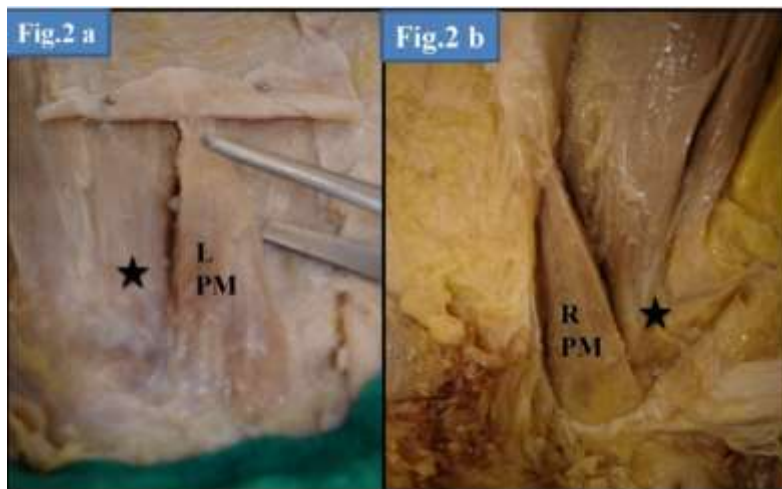


Figure 2a and 2b: Unilateral absence of pyramidalis muscle (PM) on right (2a) and left (2b) sides

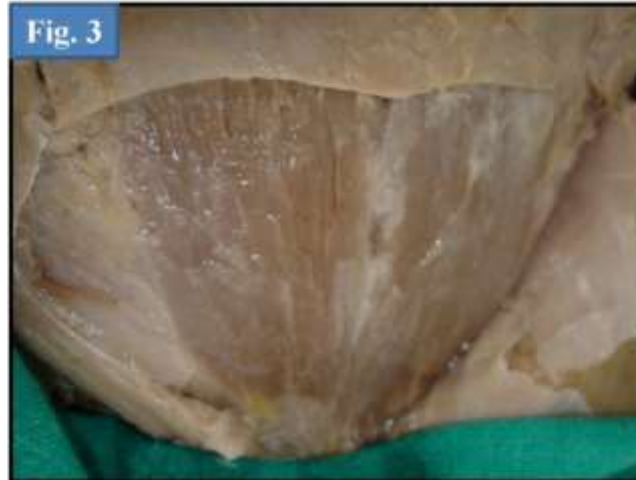


Figure 3: Bilateral absence of pyramidalis muscle (PM)

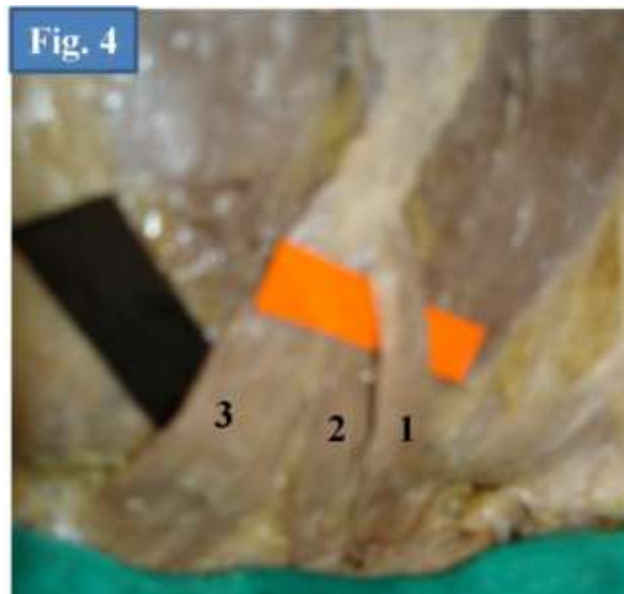


Figure 4: Duplication of pyramidalis muscle (PM) on left side

Discussion

In human, the vestigial muscles are tendinous in larger part or reduced in size when compared to the homologous muscles in other species or they are frequently absent within or between populations. The pyramidalis muscle is considered as a vestigial muscle by some researchers because they consider it as leftover from marsupials' and monotremes' pouch [8]. Phylogenetically, PM is linked to the pouch inside marsupials (kangaroo), monotremes (hedgehog) and the platypus [7]. According to some researchers PM is a constant feature of human and other primates and could be related to erect posture [9, 10, 11].

Kaur et al. stated that in 1536 Mass was the first anatomist to refer the pyramidalis muscle [11]. Morphometry of PM is variable. Average incidence of presence of this muscle was reported 83–90% in standard textbooks of

anatomy [1]. We observed presence of PM in 83.32% cadavers while Kaur et al. [12], Das et al. [8] and Bhasin et al. [13], reported incidence of 93.3%, 92% and 100% respectively in Indian population. The incidence of PM was less (83.32%) in present study as compared to other Indian studies which may be because of the sample size used in these studies (Table 3). However, its presence shows variations in populations which is probably influenced by racial and ethnic characteristics [7] as shown in table 3.

Table 3: Showing the Incidence of presence of pyramidalis muscle in various populations

Author	Population	Number of cadavers used	Incidence (%)
Wagenseil, 1927, [14]	Chinese	-	99
Mori, 1964, [15]	Japanese	-	94.5
Jit et al., 1986 [16]	North Indian	-	87
Didia et al., 2009, [17]	Nigerian	-	91.67
Natis et al., 2015, [7]	Greek	-	93.8
Kaur et. al., 2016, [12]	North Indian	15	93.3
Das et al., 2017, [8]	Indian	25	92
Bhasin et al., 2018, [13]	Indian	12	100
Hojaij et al., 2020, [10]	Brazilian	30	86.66
Present study, 2023	Indian	72	83.32

The mean length of the medial border in male was 78.5 mm on the left side and that on the right side it was 81 mm. In female the mean length of the medial border was 70 mm on the left side and that on the right side it was 75 mm. When we compared these values with other studies it was observed that our values are on higher side (Table 4) which may be due to variation in sample size and population used in study. Thickness of PM muscle is almost same in male and females on both the sides and these values found to be in consonance with the Das et al. [6] (Table 4). We reported supernumerary muscle in one male cadaver which had two bellies on left side and one on right (Fig. 4). Few authors reported the duplication of PM [10].

Table 4: Comparison of length, width and thickness of pyramidalis muscle

Authors	Length (mm)		Width (mm)		Thickness (mm)		
	Right	Left	Right	Left	Right	Left	
Natsis et al., 2015, (7)	Male	83.7	75	16.1	15.6	-	-
	Female	61.8	65.6	15	15.6	-	-
Kaur et al., 2016, (12)	Male	49.78	49.78	17.5	17.2	-	-
	Female	48.73	47.84	12.5	14.57	-	-
Das et al. 2017, (8)	Male	52.21	53.07	18.35	17.05	4.91	4.33
	Female	50.13	51.22	17.8	16.21	4.53	4.48
Hojaij et al., 2020, (10)	Male	70.6	68.0	18.5	18.3	-	-
	Female	64.2	63.8	19.1	19.4	-	-
Present study, 2022	Male	81.0	78.5	15.5	17.00	4.52	4.41
	Female	75.00	70.00	22.00	21.5	4.49	4.48

The inferior origin of the PM is at the pubic crest and the anterior pubic ligament and the proximal part of adductor longus attaches to the anterior pubic ligament and the pubic crest and this forms the pyramidalis–anterior pubic ligament–adductor longus complex (PLAC) [6]. Schilders et al. studied the injuries of the pyramidalis–anterior pubic ligament–adductor longus complex (PLAC) on MRI and found that there is the concurrent involvement of the

pyramidalis in adductor longus avulsions injuries. PLAC injuries are typically associated with displacement of the pyramidalis. According to them when there is proximal adductor avulsion in athletes, the pyramidalis muscle remained attached to the adductor longus. Knowledge of PLAC help to identify the injury patterns in athletes and helps in surgical planning and decision-making. PM is an important flap muscle for microsurgical transfer because it can be harvested easily and safely without complication [18].

Conclusion

Present study observed that, the pyramidalis muscle is present on one or both sides of the body in 83.32% of cases and always in triangular in shape with longitudinal orientation of fibers. The size of the muscle seems to be variable in different population. We found one case of muscle duplication on left side. PM is the only abdominal muscle which lies anterior to the pubis which is commonly involved with PLAC injuries and these injuries are typically associated with displacement of the pyramidalis muscle. Detailed cadaveric study of PLAC will throw more light on continuation of pyramidalis with adductor longus. Also it used as a flap to close the small wounds and to repair inguinal hernia. Observations of present study will be helpful to surgeons, radiologist and anatomists also.

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Conflict of Interest: NIL

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