

Prevalence And Variations Of The Pyramidalis Muscle In Adults And Fetuses: Relevance And Clinical Implications

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Abstract

Introduction: The pyramidalis muscle is a triangular shaped muscle that is located in the anterior abdominal wall, which originates from body of pubis and pubic symphysis and inserted into linea alba. The close relationship of pyramidalis with the rectus abdominis muscle has led to the belief that it develops embryologically as a doubling over the rectus abdominis muscle in the ventral portion.

Methods: Thirty-one adult cadavers (26 male and 5 female, embalmed in 10% formalin) and 30 fetuses (14-first trimester, 10-second trimester, and 6-third trimester; embalmed in 10% formalin) were dissected in the present study.

Results: The prevalence of muscle was found to be 87% in adult and 100% in fetus. In 77% of adult cadavers the muscle was present bilaterally and in 10% of adult cadavers the muscle was present unilaterally. In fetuses the muscle was present bilaterally. Few variations related to size and appearance of muscle were observed in both adult and fetus pyramidalis muscle.

Conclusions: The prevalence of pyramidalis muscle was 100% in fetus, whereas in adult it was 87%. The regression of muscle may be the reason behind this difference. In monkeys and prosimians, the pyramidalis tense the abdomen for compression of glands, helping in the expression of milk. Therefore it is speculated the pyramidalis muscle is atavistic owing to the loss of supernumerary nipples in humans.

The calculated Pyramidalis-pubo umbilical index was proportionately more in fetus than the adult pyramidalis muscle.

Key Words: Pyramidalis, Abdominal muscles, Rectus sheath, Anterior abdominal wall, Pyramidalis Pubo umbilical index

INTRODUCTION:

Pyramidalis Muscle (PM) is a small triangular shaped muscle in the lower anterior abdominal wall, situated within the rectus sheath. The muscle originates in the form of broad base, from the anterior surface of body of pubis and pubic symphysis. The insertion of the muscle is on the linea alba, mostly midway between umbilicus and pubis symphysis in the form of narrow apex [1]. The function of the PM is to

strengthen the abdominal wall [2] however some considered it as a rudimentary/atavistic muscle of the anterior abdominal wall [3]

PM demonstrates morphological variation in the different population. The symmetry of muscle may be bilateral, unilateral, duplicated on each side (showing 3 or 4 bellies), or absent. [1]. Function of PM is thought as a tensor of the linea alba [4]

It is innervated by a small branch of the subcostal nerve. PM is supplied by branches of the inferior epigastric artery [1, 4].

The PM is supplied by the inferior epigastric artery, however reports suggest cremasteric artery also supplying the PM in male [5, 6]. The muscle's venous drainage is carried out by venae comitantes of the arteries, as well as small veins draining into the deep inferior epigastric and external iliac veins on rare occasions. The PM receives motor innervation from the various sources like: 11th or 12th thoracic spinal nerves, the 1st and/or 2nd lumbar spinal nerves.

The PM has been used in various reconstructive procedures, it is a source of stem cells for striated muscle, especially in treatment of urinary incontinence associated with prostatectomy [7, 8, 9].

The aim of this study is to note the prevalence and variations in PM in adult humans and fetus and calculate pyramidalis pubo-umbilical index (PPUI) of PM.

The prevalence of PM have been well explored and reported in the literature [1, 2, 4, 7, 10], however variations and PPUI of the PM has been least explored especially in South Indian population.

MATERIALS AND METHODS:

Thirty-one adult cadavers (26 male and 5 female, embalmed in 10% formalin) and 30 fetuses (14-first trimester, 10-second trimester, and 6-third trimester; embalmed in 10% formalin) were dissected in the present study.

Cadavers used in this study were voluntarily donated bodies for Medical Education and Research purpose. The protocol was approved by Institutional Ethics Committee (IEC-617/2021) of Kasturba Medical College and Kasturba Hospitals.

Dissection of adult cadaver:

With surgical equipment, cadavers were dissected as part of a regular MBBS class dissection. At first, a vertical midline incision was made in the anterior abdominal wall running from xiphoid process to the pubic symphysis. Superior transverse incision was made from midline to the midaxillary line at tip of 9th costal cartilage and inferior transverse incision was made from midline to the anterior superior iliac spine. Following reflection of the skin and superficial fascia, the fat was carefully removed without affecting the rectus sheath. The anterior layer of the rectus sheath was incised and was reflected laterally on both sides. Following this, a small triangle PM was identified in the lower region of rectus abdominis muscle. The camera was used to capture pictures of the PM. Vernier callipers was used to measure the indices.

Dissection of fetus:

A vertical incision running from the umbilicus to the pubic symphysis was initially made in the anterior abdominal wall. The skin was reflected after making a transverse incision. Next, the rectus sheath and underlying fat were cleared. Later, the rectus abdominis muscle was located, and the PM was spotted by following its path downward. Vernier callipers was used to measure the indices.

PM occurrence in adult cadaver and fetus were observed (unilateral or bilateral) and recorded.

PPUI was calculated through formula, $PPUI\% = \frac{DUP}{length} * 100$

(DUP is distance between the umbilicus and pubic symphysis).

Descriptive statistics was used to calculate the prevalence, and to measure the length of PM, DUP.

RESULT:

Adult:

Prevalence of PM:

Out of 31 (26 males, 5 females) dissected cadavers, PM was present in 27 cadavers (87%) and in 4 it was absent. Out of 87% of prevalence 77% was bilateral (Figure 1A) and 10% was unilateral (Figure 1B). The PM was absent (Figure 1C) in 13%.

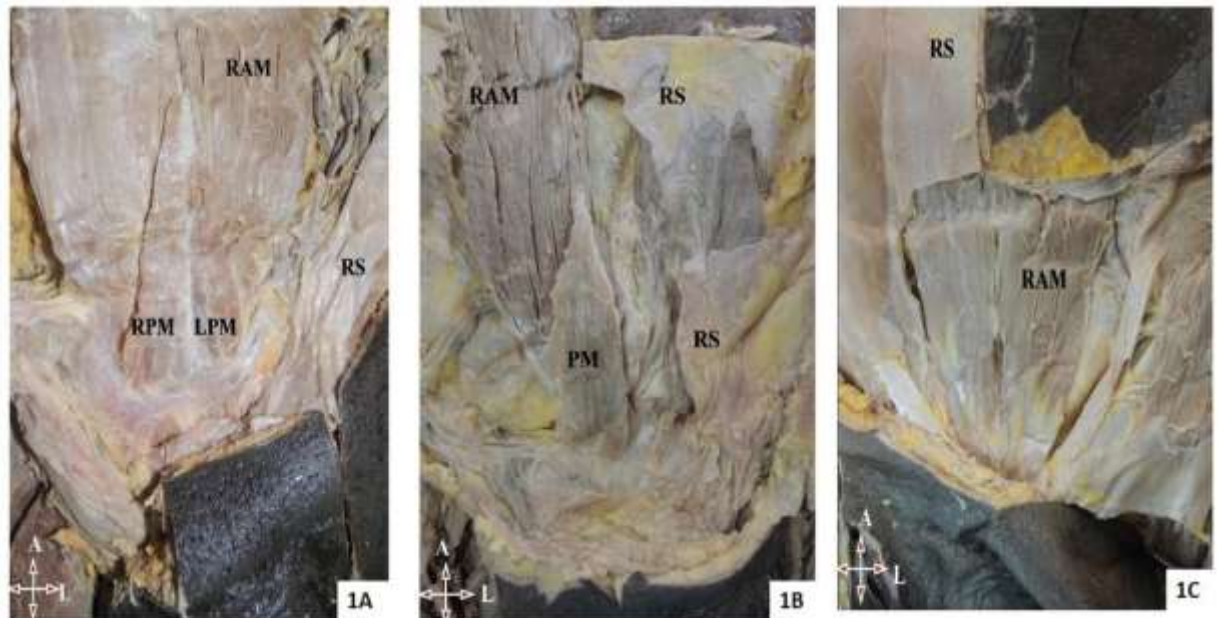


Figure 1: Showing anterior abdominal wall in adult cadaver with bilateral PM (Figure 1A), unilateral PM (Figure 1B), Absence of PM (Figure 1C). RS – rectus sheath, RAM – rectus abdominis muscle, RPM & LPM – right PM and left PM. A – above, L – left.

Variations found in adult PM muscle:

Overlapping of left PM fibres on the right PM near apex of muscle in one cadaver (Figure 2A)

The Right-side PM was narrow and underdeveloped in one cadaver (Figure 2B). Right side PM length was smaller than the left side (Figure 2C, 2D)



Figure 2: Adult anterior abdominal wall with PM showing overlapping of left side PM fibres on the right side muscle fibres (Figure 2A), with narrower right side PM (Figure 2B), with longer left side PM (Figure 2C), with shorter right side PM (Figure 2D). RAM – rectus abdominis muscle, RPM & LPM– right pyramidalis and left pyramidalis muscle, A – above, L– left.

Fetus:

Prevalence of PM:

The PM was observed in all fetuses (30) i.e., 100% prevalence and bilateral (Fig.3A).

Variations in occurrence of fetus PM muscle:

Membranous triangular shaped PM observed in an 18-week, female fetus (Fig. 3B).

Triangular tendinous PM was observed in a 22-week female fetus (Fig. 3C)

PM length was longer in a male fetus of 26-week age almost reaching the umbilicus (Fig. 3D)

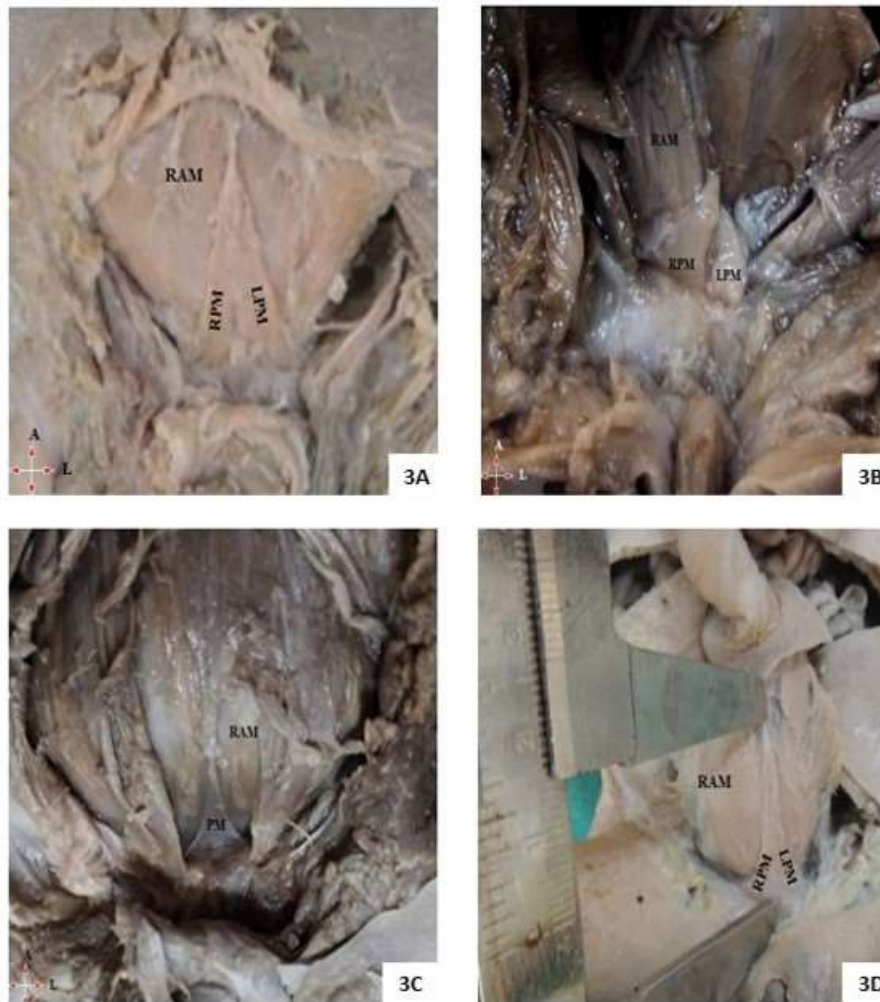


Figure 3: Fetus anterior abdominal wall with bilateral PM (Figure 3A), Membranous PM (Figure 3B) Tendinous PM (Figure 3C), Longer PM (Figure 3D), RPM & LPM- Right and left pyramidalis muscle, RAM – rectus abdominis muscle, A – above, L – left.

Pyramidalis Pubo-Umbilical Index (PPUI):

PPUI was calculated on cadavers stripped of all fat tissue. PPUI was calculated using length of PM and distance between umbilicus to pubic symphysis (DUP). PPUI specify the region/ portion occupied by the PM in the lower abdominal part.

In adult the PPUI ranged from 25.33%-60.6%. In fetus PPUI ranged from 13.79%- 72.22%. This indicates that the region of the lower abdominal wall covered by the fetal PM was larger than the region of the lower anterior abdominal wall occupied by the adult PM. So, we can conclude the length of PM in lower abdominal wall was longer in fetus. As the lower abdominal wall grows the length of PM begins to decrease proportionately in adult as compared to fetus.

DISCUSSION:

Prevalence of PM:

Prevalence of PM in adult Indian population was studied by Das et al. where in, the muscle was bilaterally present in 72% cases and unilaterally in 20%. It was also noted that prevalence of PM was more in males (94.11%) when compared to females (87.5%) [10]. Natsis K et al. found 93.8% prevalence of PM in Greek population, bilateral (79.2%) and unilateral (14.6%) [7]. Hojaij FC et al. in their study reported the prevalence of PM in 86.66% cases in Brazilian population, bilateral (83.33%) and unilateral (3.33%) [11]. In a study done in Northern Europe, prevalence of PM was studied only in female population, and PM was present in 30% of the cases [2]. Kaur H et al. in their study found the PM was bilateral in 14 of the 15 cadavers. [1]. Anson et al., in their study on American population observed out of 330, 295 (89.35%) had the PM [12]. In the current study prevalence of PM was calculated to be 87% with 77% bilateral and 10% unilateral.

Unilateral PM may result from limited relapse of the muscle across the evolutionary chain, while bilateral absence may result from total recession of the muscle [13]. Evolutionarily the PM is believed to be related to the pouch in marsupial and monotreme animals [10]. Since it is thought the PM was vestigial muscle and the pouch in humans has evolved, this causes the variety in PM occurrence. Thus, both demographic and demographic traits have an impact on the diversity of its prevalence.

Malcic-Gürbüz et al [14] reported aberrations in the PM i.e, the left PM was observed to be positioned in the right rectus sheath, placed in its medial and inner region, while removing the anterior layer of the lower rectus sheath. Owing to the crossing of PM over the midline position, the lower part of the linea alba wasn't really visible. Lovering et al [15] in their study reported variations like PM traverse the midline and attached to the deeper side of normal PM. They had also reported variations like longer PM and shorter PM with few fascicles in their selected sample. In our study we had also reported variations related to PM length as observed by Lovering et al [15]. Other variations reported in our study were overlapping of left side PM fibres on the right-side PM near the apex. In the present study we also observed variations in one fetus triangular shaped PM, in one fetus tendinous type of structure instead of muscle fibres, in one fetus the length of PM was longer at its tip almost reaching the umbilicus.

Pyramidalis -Pubo Umbilical Index:

A study by Kaur et al on north Indian population showed 36.05 % pyramidalis pubo umbilical index in male and 46.19% in females [1]. Das et al. in their study on Indian population noted 35.15 % & 36.01 PPUI index in male and female respectively [10]. Kipkorir et al recorded 38% & 35% PPUI in male and female of Kenyan population [13]. In our present study on south Indian population we have recorded 40.78% PPUI in adult and 39.65% PPUI in fetus (Table 1).

This index precisely specifies the PM portion in the lower anterior abdominal wall. The index was helpful to surgeons performing lower anterior abdominal surgery in roughly estimating the area covered by PM between pubic symphysis to the umbilicus [13]. The index could be useful for a variety of clinical and surgical purposes as it encloses about 40.78% of lower abdominal wall.

Table 1: Showing the Pyramidalis -Pubo Umbilical Index (PPUI) calculated in other studies

References	Year	Population	Pyramidalis -Pubo Umbilical Index (%)	
Kaur H et al.[1]	2016	North Indian	Male	36.05
			Female	46.19
Das SS et al.[10]	2017	Indian	Male	35.15

			Female	36.01
Kipkorir V et al.[13]	2021	Kenyan	Male	38
			Female	35
Present study	2022	South Indian	Adult	40.78
			Fetus	39.65

Clinical implications

The PM can be utilised for faraway transplant, particularly to the lower extremity region, either alone as a free flap or in association with the skin flap, as PM disappearance may not appear to significantly impair any activity. The PM flap was used to repair small unmanageable lesions that were successful in the treatment of minor chronic lesions in foot/ankle region. Even though role is uncertain, the PM can indeed be beneficial in certain surgical operations because its upper attachment can be used as a marker during abdomen procedures, such as, pubic incision [16, 17]

When screening groin pain, understanding the presence of the PM and its morphometry is crucial to prevent incorrect diagnosis of a lump [18, 19]. PM act as a landmark for the surgeons during infra-umbilical and suprapubic incisions while performing caesarean sections [2].

CONCLUSIONS:

The prevalence of PM was 100% in fetus, whereas 87% in adult. The regression of muscle may be the reason behind this difference. The calculated PPU (Pyramidalis-pubo umbilical index) showed the length of fetal PM in the lower anterior abdominal wall was proportionately more than the adult PM. PM though a vestigial muscle, it is a clinically important muscle.

REFERENCES:

1. Kaur H, Singla RK, Brar RS, Singla M. Study of the Morphometry of the Pyramidalis Muscle and Its Incidence in the Indian Population. *Int J Anat Res.* 2016 April 30; 4(2):2207–11.
2. Dickson MJ. The pyramidalis muscle. *J Obstet Gynaecol (Lahore).* 1999 July 02;19(3):300
3. Gilleard WL, Brown JMM. Structure and function of the abdominal muscles in primigravid subjects during pregnancy and the immediate postbirth period. *J Phys Ther.* 1996 July 1; 76(7):750-62
4. Ashley-Montagu MF. Anthropological significance of the musculus pyramidalis and its variability in man. *American Journal of Physical Anthropology.* 1939 Oct; 25(3):435-90.
5. Cruveilhier J. *Treatise on descriptive anatomy.* P. Asselin; 1867.
6. Winslow JB. *Anatomical exposition of the structure of the human body by JacquesBénigne Winslow.* unidentified publisher; 1732.
7. Natsis K, Piagkou M, Repousi E, Apostolidis S, Kotsiomitis E, Apostolou K, Skandalakis P (2016) Morphometric variability of pyramidalis muscle and its clinical significance. *Surg Radiol Anat* 38(3):285–292
8. Sumino Y, Hirata Y, Hanada M, Akita Y, Sato F, Mimata H (2011) Long-term cryopreservation of pyramidalis muscle specimens as a source of striated muscle stem cells for treatment of post-prostatectomy stress urinary incontinence. *Prostate* 71(11):1225–1230
9. Standring S (2020) *Gray’s anatomy E-Book: the anatomical basis of clinical practice.* Elsevier Health
10. Das SS, Saluja S, Vasudeva N. Biometrics of pyramidalis muscle and its clinical importance. *J Clin Diagnostic Res.* 2017;11(2):AC05–7.
11. Hojaij FC, Kogima RO, Moyses RA, Akamatsu FE, Jacomo AL. Morphometry and frequency of the pyramidalis muscle in adult humans: A pyramidalis muscle’s anatomical analysis. *Clinics.* 2020; 75(11):1–9.
12. Anson BJ, Beaton LE, McVay CC (1938) The pyramidalis muscle. *Anat Rec* 72:405–41
13. Kipkorir V, Olabu B, Ongeti K, Ndu’ngu B, Cheruiyot I, Misiani M, et al. Prevalence and pubo-umbilical index of pyramidalis muscle in a select Kenyan population. *Surg Radiol Anat.* 2021;43(9):1461–6
14. Malcic-Gürbüz J, Özdoğan Ö, Yüksel M. Unusual rectus abdominis and pyramidalis muscles: Clinical significance - A case report. *Marmara Med J.* 2001; 14(2):107–9.
15. R.M. Lovering, L.D. Anderson, Architecture and fiber type of the pyramidalis muscle, *Anat Sci Int.* 2008 Dec;83(4):294-7.

16. Van Landuyt K, Hamdi M, Blondeel Ph et al (2003) The pyra-midalis muscle free flap. *Br J Plast Surg* 56:585–592
17. Gu`rbu`z-Malcic J, O`zdog`mus,O,Yu`ksel M (2001) Unusual rectusabdominis and pyramidalis muscles: clinical significance—a casereport. *MMJ* 14:107–109
18. Koulouris G. Imaging Review of Groin Pain Approach to Imaging Findings. 2008; (October):962–72.
19. Garvey JFW. Computed tomography scan diagnosis of occult groin hernia. 2012; 307–14.