

# Anatomical variations and clinical significance of the pyramidalis muscle: A detailed morphometric analysis in cadaveric population



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## ABSTRACT

**Background:** The pyramidalis muscle, often considered a minor muscle of the anterior abdominal wall, has variable presence and morphology across populations. Its clinical significance, particularly in surgical interventions involving the suprapubic region, necessitates a detailed understanding of its anatomical features. **Aims and Objectives:** This study aimed to assess the incidence, morphometric variations (length, width, and thickness), and clinical relevance of the pyramidalis muscle in the cadaveric population, offering insights that could enhance surgical outcomes in the suprapubic region. **Materials and Methods:** It conducted on 60 formalin-fixed cadavers from the Department of Anatomy at Guntur Medical College, Guntur, and Government Medical College, Ongole. This study utilized digital Vernier calipers and measuring tape for precise morphometric analysis. Parameters such as presence, number of bellies, length, width, thickness, and the Pyramidalis Pubo Umbilical Index were meticulously recorded. **Results:** The pyramidalis muscle was present in 83.3% of the cases, with 80% bilateral and 3.3% unilateral occurrences. The mean length was 66.2 mm on the right and 64.4 mm on the left. The width at the base averaged 23.4 mm (right) and 22.5 mm (left), with a consistent mean thickness of 4.1 mm on both sides. The Pyramidalis Pubo Umbilical Index was 39.82 (right) and 39.2 (left), indicating little variation between sides. **Conclusion:** The pyramidalis muscle exhibits a high incidence rate and specific morphometric characteristics in the cadaveric population. These findings underscore its potential impact on surgical approaches in the suprapubic area, providing valuable anatomical insights for healthcare professionals.

**Key words:** Pyramidalis muscle; Morphometric variations; Supra-pubic surgery; Cadaveric study

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## INTRODUCTION

The pyramidalis muscle, a small and often overlooked triangular muscle, is located in the lower abdomen, anterior to the rectus abdominis and posterior to the linea alba.<sup>1</sup> Its clinical and anatomical significance has been the subject of varied discussions, particularly in the context of surgical interventions in the suprapubic region.<sup>2</sup> Despite its relatively diminutive size and occasional absence in some individuals, understanding the nuances of this muscle's morphology and incidence across different populations can have

substantial implications for surgical practice, particularly in procedures that involve the anterior abdominal wall.<sup>3,4</sup>

The incidence and morphometric characteristics of the pyramidalis muscle have shown considerable variability across studies, with differences noted in terms of length, width, thickness, and presence or absence.<sup>5</sup> Such variations can influence surgical approaches, especially in surgeries requiring precise incisions in the lower abdomen.<sup>6,7</sup> Furthermore, the pyramidalis muscle's role in tensing the linea alba and its potential impact on abdominal

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surgeries underscore the need for a detailed anatomical understanding.

This study aims to fill gaps in the current understanding of the pyramidalis muscle's anatomical variations. By examining formalin-fixed cadavers, the research seeks to delineate the incidence, morphometric features, and clinical implications of this muscle, providing data that could guide surgeons in optimizing surgical outcomes. The findings are intended to contribute to a broader comprehension of anatomical variability, aiding in the development of more tailored and effective surgical strategies in the suprapubic region.

### Aims and objectives

The primary aim of this study is to investigate the morphometric characteristics and incidence of the pyramidalis muscle in a cadaveric population, enhancing our understanding of its anatomical variability and potential clinical implications.

The study aimed to determine the incidence rate of the pyramidalis muscle in both male and female cadavers to identify patterns of presence (bilateral, unilateral, or absent).

The aim of the study was to measure the morphometric parameters (length, width, and thickness) of the pyramidalis muscle, providing a detailed anatomical profile that can aid in surgical planning and anatomical education.

The study aimed to develop the Pyramidalis Pubo Umbilical Index and validate its usefulness as a new metric for assessing the proportionality and anatomical significance of the pyramidalis muscle relative to the torso.

## MATERIALS AND METHODS

### Study design and setting

This descriptive cadaveric study was conducted in the Department of Anatomy at the Guntur Medical College, Guntur, and Government Medical College, Ongole. The research focused on the detailed examination of the pyramidalis muscle, aiming to assess its incidence, morphometric variations, and potential clinical implications in a cadaveric population. The study utilized 60 formalin-fixed cadavers, comprising both genders, which were sourced from the anatomy departments' collections, adhering to ethical guidelines for cadaveric research.

### Cadaver selection

The sample consisted of 60 formalin-fixed cadavers, randomly selected, ensuring a representation of both male and female specimens.

### Inclusion criteria

The following criteria were included in the study:

- Formalin-fixed cadavers used for anatomical dissection
- Random selection from the available pool to ensure an unbiased representation
- Cadavers must have intact abdominal musculature for accurate morphometric analysis.

### Exclusion criteria

The following criteria were excluded from the study:

- Cadavers with known abdominal pathologies affecting the musculature or internal structure
- Cadavers with a history of abdominal surgeries, which may alter the natural state of the abdominal anatomy
- Cadavers with any deformities could potentially skew morphometric measurements
- Cadavers with poor preservation or significant decomposition that would compromise the study's standards for anatomical clarity and measurement precision.

### Measurement techniques

The primary focus was on the pyramidalis muscle, examining its presence, size (length, width, and thickness), and anatomical variations. The measurements were taken using digital Vernier calipers for precision, with length measured along the medial border, width at the base, and thickness at the midpoint. In addition, the distance between the pubic symphysis and the umbilicus was measured using a standard measuring tape to calculate the Pyramidalis Pubo Umbilical Index, defined as the total length of the pyramidalis muscle divided by the distance between the pubic symphysis and the umbilicus, multiplied by 100.

$$\text{Pyramidalis Pubo Umbilical Index} = \frac{\text{Total Length of Pyramidalis Muscle}}{\text{Distance between Pubic Symphysis and Umbilicus}} \times 100$$

### Dissection protocol

Each cadaver underwent a standardized dissection process. The abdominal region was carefully exposed, and the rectus sheath was dissected to reveal the pyramidalis muscle, ensuring minimal disturbance to its natural anatomy. The presence or absence of the muscle was noted, followed by detailed morphometric measurements. Special attention was given to identify any anatomical variations, such as differences in the number of muscle bellies or variations in origin and insertion points.

### Statistical analysis

The data collected from the measurements were analyzed using descriptive statistics. Incidence rates were calculated as percentages of the total sample. Mean values and ranges were

determined for length, width, and thickness measurements. The Pyramidalis Pubo Umbilical Index was also calculated for each cadaver where the muscle was present. The statistical analysis aimed to provide a comprehensive overview of the muscle's morphometric characteristics and its anatomical variability within the studied population.

### Ethical considerations

This study protocol was approved by the Institutional Ethics Committee of Guntur Medical College, Guntur, Andhra Pradesh, India.

## RESULTS

In our study, which examined 60 formalin-fixed cadavers from the Department of Anatomy at Guntur Medical College, Guntur and Government Medical College, Ongole. The pyramidalis muscle was identified with a notable incidence rate. It was present in 50 cadavers, accounting for an incidence rate of 83.3%. The majority of cases displayed bilateral presence (80%, n=48), while unilateral presence was observed in a minority of cases (3.3%, n=2). The absence of the muscle was noted in 16.7% of the sample (n=10) (Table 1 and Figure 1).

Morphometric analysis revealed variations in the size and shape of the pyramidalis muscle across the sample. The mean length of the muscle on the right side was 66.2 mm, with a range of 48.6 mm–81.3 mm, and on the left side, the mean length was 64.4 mm, with a range of 48.6 mm–80.4 mm (Table 2). In terms of width at the base,

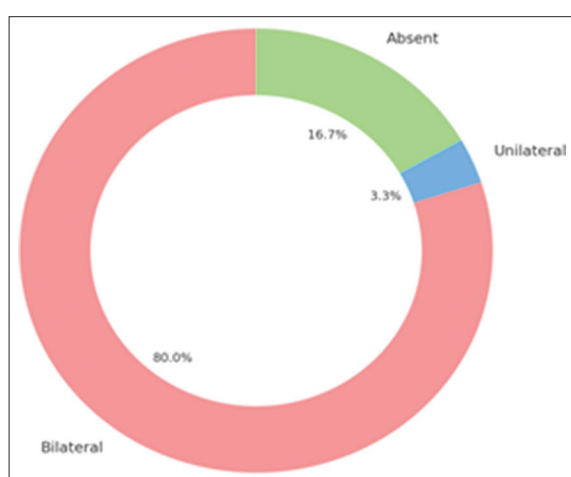


Figure 1: Incidence of pyramidalis muscle

Status	Number	Percentage
Bilateral	48	80
Unilateral	2	3.3
Absent	10	16.7

the right side exhibited a mean of 23.4 mm (range 12.6 mm–31 mm), and the left side showed a mean of 22.5 mm (range 11.6 mm–31 mm) (Table 3). The thickness of the muscle remained consistent on both sides, with a mean of 4.1 mm and a range from 3.6 mm–4.5 mm (Table 4).

The Pyramidalis Pubo Umbilical Index, calculated as the total length of the Pyramidalis muscle divided by the distance between the pubic symphysis and umbilicus multiplied by 100, was 39.82 on the right side and 39.2 on the left side (Table 5 and Figure 2). This metric provides additional insight into the proportionate size of the pyramidalis relative to the cadaver's body dimensions.

Observations concerning the anatomical characteristics of the pyramidalis muscle noted that there were no variations in terms of the muscle's origin and insertion points (Figures 3-6). A noteworthy finding was a small gap between the right and left pyramidalis muscles in some cases (Figure 7). While the length of the muscle was symmetrical in most cadavers, asymmetry in length was noted in some instances, with breadth being variable and generally asymmetrical on both sides. Anatomical consistency was observed in terms of origin from the pubis (both the symphysis pubis [SP] and pubic crest [PC]), insertion into the linea alba, innervation by the subcostal nerve, and arterial supply from a branch of the inferior epigastric artery. No instances of muscle duplication were recorded. Despite the observed morphometric variations,

Table 2: Morphometric measurements of the pyramidalis muscle (Length)

Side	Mean length (mm)	Range (mm)
Right	66.2	48.6–81.3
Left	64.4	48.6–80.4

Table 3: Morphometric measurements of the pyramidalis muscle (width at the base)

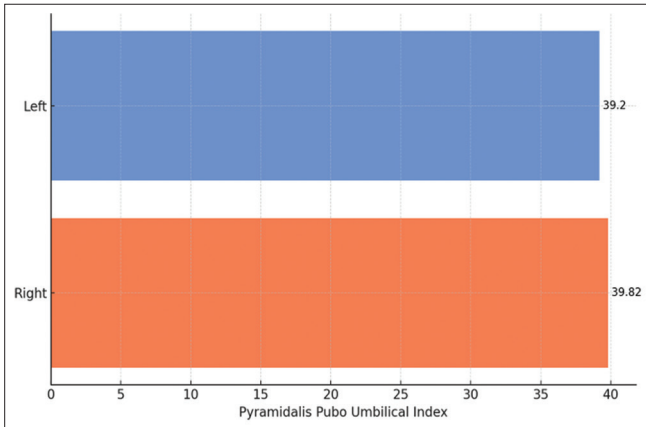
Side	Mean width (mm)	Range (mm)
Right	23.4	12.6–31
Left	22.5	11.6–31

Table 4: Morphometric measurements of the pyramidalis muscle (thickness)

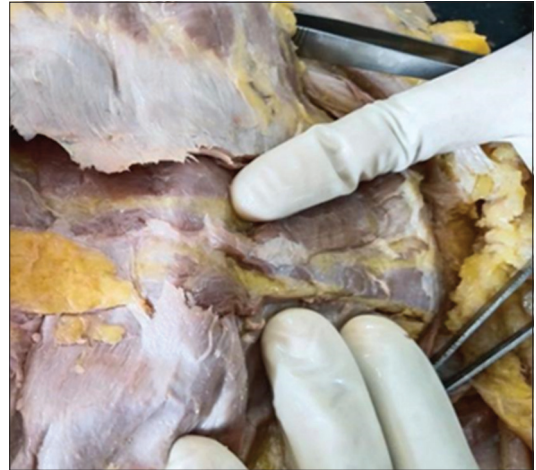
Side	Mean thickness (mm)	Range (mm)
Right	4.1	3.6–4.5
Left	4.1	3.6–4.5

Table 5: Pyramidalis pubo umbilical index

Side	Pyramidalis pubo umbilical index
Right	39.82
Left	39.2



**Figure 2:** Pyramidalis pubo umbilical index for right and left sides



**Figure 5:** Asymmetrical pyramidalis muscles



**Figure 3:** Bilateral presence of pyramidalis muscle



**Figure 6:** Long and thin pyramidalis muscle



**Figure 4:** Unilateral right sided pyramidalis muscle



**Figure 7:** Triangular interpyramidal gap observed between bilateral pyramidalis muscles

the pyramidalis muscle consistently maintained its triangular shape with longitudinal fibers in every examined case.

## DISCUSSION

The present study adds to the research investigating the anatomical variations and clinical implications of the

pyramidalis muscle. With an incidence rate of 83.3% and a notable prevalence of bilateral presentation, these findings align with previous research across diverse geographical regions, supporting the global nature of this anatomical feature.

In the Indian population, studies by Kaur *et al.*,<sup>8</sup> and Sumalatha *et al.*,<sup>9</sup> found a high incidence of the pyramidalis

muscle, consistent with our findings. Both studies revealed significant variability in the muscle's morphometry. For instance, Sumalatha *et al.*,<sup>9</sup> observed variations in length, width, and thickness, highlighting the potential surgical implications, particularly during supra-pubic interventions.

Similarly, studies conducted on Greek (Natsis *et al.*,<sup>10</sup>) and Kenyan populations (Kipkorir *et al.*,<sup>11</sup>) have also documented regional variations in the pyramidalis muscle's morphometric features. Natsis *et al.*,<sup>10</sup> noted notable differences in muscle length and incidence across gender lines, while Kipkorir *et al.*,<sup>11</sup> introduced the Pyramidalis Pubo Umbilical Index to quantify proportional differences in the Kenyan population. This novel index proved beneficial in understanding the morphological relationships, thereby assisting in surgical planning and pre-operative assessments.

### Clinical implications

Despite such variability in dimensions, our study confirms the constancy of the muscle's origin and insertion points, a finding that partially conflicts with the sensory nerve distribution documented by Haba *et al.*<sup>12</sup> Their study in a Japanese population observed a consistent sensory branch of the nerve to the pyramidalis, which has clinical relevance in avoiding inadvertent nerve damage during surgery.

Ranjan *et al.*,<sup>13</sup> further emphasized the qualitative aspects of the pyramidalis muscle's variations and their relevance in surgical procedures. Our study supports their conclusion by highlighting the importance of understanding individual anatomical characteristics to optimize surgical outcomes and minimize complications.

### Significance in surgical practice

These findings highlight the necessity of comprehensive pre-operative assessments. With the muscle's morphometric features varying across different regions and demographics, clinicians must adopt personalized surgical strategies that consider unique anatomical traits. This calls for incorporating detailed anatomical knowledge into surgical education to improve decision-making and minimize risks during abdominal incisions and reconstructions.

The introduction of the Pyramidalis Pubo Umbilical Index in this study presents a valuable tool that can refine surgical planning by providing a standardized framework for assessing the pyramidalis muscle's proportionality. As Suhani *et al.*,<sup>14</sup> emphasized, such indices can enhance clinical relevance by facilitating better patient outcomes through tailored approaches.

### Limitations of the study

Limitations of this study include its focus on a specific regional population and the inherent constraints of working

with cadaveric specimens, which may not fully represent the variability found in a living population. Future studies could expand upon this work by exploring the functional implications of the pyramidalis muscle's anatomical variations and investigating its role in conditions affecting the lower abdomen.

## CONCLUSION

This cadaveric study highlights the anatomical diversity of the pyramidalis muscle and its potential impact on surgical practices. By providing detailed morphometric data and introducing the Pyramidalis Pubo Umbilical Index, it enriches the anatomical understanding necessary for improving surgical approaches to the anterior abdominal wall.

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**PC**- Concept and design of the study, results interpretation, review of literature, and preparing first draft of manuscript. Statistical analysis and interpretation and revision of manuscript; **RD**- Concept and design of the study, results interpretation, review of literature and preparing first draft of manuscript, and revision of manuscript; **PKKV**- Review of literature and preparing first draft of manuscript, statistical analysis, and interpretation; **LV**- Concept and design of the study, results interpretation, review of literature, and preparing first draft of manuscript. Statistical analysis and interpretation; **SK**- Review of literature, revision of manuscript.

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