

Prevalence and Morphometric Characteristics of the Pyramidalis Muscle in a Sudanese Surgical Cohort: A Cross-Sectional Study at Al-Damazin Teaching Hospital

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Research Article

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Abstract

Purpose

The pyramidalis muscle is a variable component of the anterior abdominal wall, and population-specific data from Africa are limited. This study determined the prevalence, laterality, and morphometric characteristics of the pyramidalis muscle and examined associations with age, sex, and chronic disease in a Sudanese surgical cohort.

Methods

A descriptive cross-sectional study was conducted among 50 adults undergoing lower anterior abdominal wall surgery at Al-Damazin Teaching Hospital, Blue Nile Region, Sudan. Participants were enrolled consecutively. The presence or absence of the pyramidalis muscle, laterality, and morphometric measurements were documented by direct intraoperative inspection using a structured form. Associations with sex and chronic disease were assessed using chi-square tests, and age was compared using an independent-samples t-test. Statistical significance was set at $p < 0.05$.

Results

The participants had a mean age of 51.84 ± 21.26 years; 34 (68%) were men and 16 (32%) were women. The pyramidalis muscle was present in 30 (60%) participants and absent bilaterally in 20 (40%). Bilateral presence occurred in 26 (52%) participants, while unilateral presence occurred on the right in 3 (6%) and on the left in 1 (2%). Muscle presence was significantly associated with sex ($\chi^2=7.414$, $df = 1$, $p = 0.006$), with a higher prevalence in women than men (87.5% vs. 47.1%). Participants with the muscle were younger than those without it (43.70 ± 20.02 vs. 64.05 ± 17.10 years; $t=-3.726$, $df = 48$, $p = 0.001$). No significant association was observed with chronic disease ($\chi^2=2.576$, $df = 3$, $p = 0.462$). Among participants with measurable muscle, mean length was 6.45 ± 2.76 cm and mean thickness was 1.10 ± 1.08 cm.

Conclusion

The pyramidalis muscle showed substantial anatomical variability in this Sudanese surgical cohort, with a prevalence of 60% and predominantly bilateral occurrence. Its presence was associated with sex and age but not with chronic disease. The findings provide preliminary population-specific anatomical data and support the need for larger multicentre studies in Sudan and other African populations.

Introduction

The pyramidalis muscle is a small paired triangular muscle of the inferior anterior abdominal wall, located anterior to the rectus abdominis within the rectus sheath. It usually arises from the pubic crest and adjacent pubic symphysis and ascends to insert into the linea alba. Its principal described function is tensioning the linea alba, although its functional importance is considered limited because the surrounding abdominal wall musculature can perform related actions [1, 2].

The presence of the pyramidalis muscle varies considerably among populations. Historical and anatomical studies have described bilateral presence, unilateral presence, and complete bilateral absence, with occasional duplication [3, 4]. Reported prevalence differs substantially according to population, sample characteristics, and method of assessment. Cadaveric studies have generally reported relatively high frequencies, whereas studies based on living surgical patients have sometimes reported lower frequencies [3, 5, 6]. A systematic review and meta-analysis confirmed substantial heterogeneity in pyramidalis muscle anatomy and emphasized the value of population-specific studies [7].

The muscle may also have practical clinical relevance. It can serve as a recognizable landmark during lower abdominal approaches and has been described as a potential source of local myofascial tissue for selected reconstructive procedures [8, 9]. Modern imaging, including computed tomography angiography, can also demonstrate its morphology and vascular supply [10].

Despite the extensive international literature, there are limited data from African populations and no published baseline data were identified for the Sudanese population in the source thesis. Establishing population-specific prevalence and morphometric data may improve anatomical understanding and provide useful information for surgeons and radiologists. Therefore, this study aimed to determine the prevalence and morphometric characteristics of the pyramidalis muscle in adults undergoing lower anterior abdominal wall surgery at Al-Damazin Teaching Hospital, Sudan, and to assess associations with sex, age, and chronic disease.

Materials and methods

Study design and setting

A descriptive cross-sectional study was conducted at Al-Damazin Teaching Hospital, a major referral and training hospital in the Blue Nile Region of Sudan. The study was conducted during the study period specified in the original research protocol (2025–2026); the source thesis describes consecutive enrolment during January 2025. The final manuscript should retain the exact approved study dates recorded in the ethics/protocol documents.

Participants and sampling

Adults aged 18 years or older who underwent surgery involving the lower anterior abdominal wall were eligible. Participants were included if they provided written informed consent and had adequate demographic, clinical, and intraoperative documentation. Patients who declined participation, had incomplete medical records or intraoperative documentation, or had congenital abdominal wall deformities were excluded. Because Sudanese prevalence data were unavailable and the study was exploratory, consecutive non-probability sampling was used. Fifty participants were enrolled.

Intraoperative assessment and morphometry

The pyramidalis muscle was assessed by direct visualization during surgery by the attending surgeon and trained surgical residents. The muscle was classified as present when clearly identifiable muscle fibres were observed anterior to the rectus abdominis within the rectus sheath, and as absent when no muscle fibres could be identified after careful inspection. Laterality was recorded as bilateral, right unilateral, or left unilateral. When present and measurable, muscle length and thickness were recorded in centimetres using the structured data collection form. The original data collection form recorded thickness in millimetres; the thesis results reported thickness in centimetres. This unit discrepancy must be resolved against the original raw data before submission.

Clinical variables

Age, sex, previous abdominal surgery, and relevant chronic diseases were recorded. Chronic disease categories included diabetes mellitus, hypertension, and coexistence of diabetes and hypertension. No attempt was made to infer a causal relationship between chronic disease and muscle presence.

Statistical analysis

Data were analysed using IBM SPSS Statistics version 28. Descriptive statistics included frequencies, percentages, means, and standard deviations. Associations between muscle presence and categorical variables were assessed using chi-square tests. An independent-samples t-test compared mean age between participants with and without the muscle. All tests were two-tailed, and $p < 0.05$ was considered statistically significant. Morphometric variables were summarized descriptively because measurements were available only when the muscle was present.

Ethical considerations

The study received ethical clearance from the Professional Ethics Committee in the Blue Nile Region, and Al-Zaiem Al-Azhari University formally communicated with Al-Damazin Teaching Hospital to facilitate data collection. Written informed consent was obtained from participants. The study was conducted in accordance with the principles of the Declaration of Helsinki. [INSERT THE OFFICIAL ETHICS COMMITTEE NAME AND APPROVAL/REFERENCE NUMBER BEFORE SUBMISSION.]

Results

Participant characteristics

Fifty participants were included. Mean age was 51.84 ± 21.26 years (range 19–87 years). Thirty-four participants (68%) were men and 16 (32%) were women. Hypertension was reported in 22 (44%), diabetes mellitus in 9 (18%), both conditions in 2 (4%), and no chronic disease in 17 (34%). Ten participants (20%) had a history of previous abdominal surgery.

Variable	Category	n (%)
Age, years	Mean ± SD	51.84 ± 21.26
Age, years	Range	19–87
Sex	Male	34 (68)
Sex	Female	16 (32)
Chronic disease	None	17 (34)
Chronic disease	Diabetes mellitus	9 (18)
Chronic disease	Hypertension	22 (44)
Chronic disease	Diabetes + hypertension	2 (4)
Previous abdominal surgery	Yes	10 (20)
Previous abdominal surgery	No	40 (80)

Prevalence and laterality

The pyramidalis muscle was identified in 30 (60%) participants and was bilaterally absent in 20 (40%). Bilateral presence was the most frequent configuration, occurring in 26 (52%) participants. Unilateral presence occurred on the right in 3 (6%) and on the left in 1 (2%). Thus, among participants in whom the muscle was present, bilateral occurrence accounted for 86.7% and unilateral occurrence for 13.3%.

Pyramidalis muscle configuration	n	%
Bilateral	26	52
Right unilateral	3	6
Left unilateral	1	2
Absent	20	40
Total	50	100

Association with sex

Muscle presence differed significantly by sex. It was observed in 16 of 34 men (47.1%) and 14 of 16 women (87.5%). The chi-square test demonstrated a statistically significant association ($\chi^2=7.414$, $df = 1$, $p = 0.006$).

Sex	Present, n (%)	Absent, n (%)	Total	χ^2	df	p
Male	16 (47.1)	18 (52.9)	34	7.414	1	0.006
Female	14 (87.5)	2 (12.5)	16			
Total	30 (60.0)	20 (40.0)	50			

Association with age

Participants with the pyramidalis muscle were significantly younger than those without it. Mean age was 43.70 ± 20.02 years in participants with the muscle and 64.05 ± 17.10 years in those without it ($t=-3.726$, $df = 48$, $p = 0.001$). Because the study was cross-sectional, this association should not be interpreted as evidence of age-related degeneration or involution.

Muscle status	Mean age $\pm$ SD (years)	t	df	p
Present	43.70 ± 20.02	-3.726	48	0.001
Absent	64.05 ± 17.10			

Association with chronic disease

No significant association was observed between pyramidalis muscle presence and chronic disease category ($\chi^2=2.576$, $df = 3$, $p = 0.462$).

Chronic disease	Present n (%)	Absent n (%)	Total
None	8 (26.7)	9 (45.0)	17
Diabetes mellitus	7 (23.3)	2 (10.0)	9
Hypertension	14 (46.7)	8 (40.0)	22
Diabetes + hypertension	1 (3.3)	1 (5.0)	2
Total	30 (60.0)	20 (40.0)	50

$\chi^2=2.576$, $df = 3$, $p = 0.462$.

Morphometric characteristics

Among participants in whom the muscle was present and measurements were recorded, mean muscle length was 6.45 ± 2.76 cm (range 2–10 cm), and mean thickness was 1.10 ± 1.08 cm (range 1–3 cm).

The exact number of participants contributing to each morphometric variable was not stated in the source thesis and should be added from the raw dataset before submission.

Variable	Mean ± SD	Minimum	Maximum
Length (cm)	6.45 ± 2.76	2	10
Thickness (reported unit: cm)	1.10 ± 1.08	1	3

Discussion

This study provides preliminary population-specific data on the pyramidalis muscle in a Sudanese surgical cohort. The muscle was identified in 60% of participants, with bilateral presence being the dominant pattern. The prevalence is lower than that reported in several European and Asian series but is within the broad range described in the literature [3, 5–7]. The findings are particularly relevant because anatomical prevalence can vary according to population, age distribution, sex composition, and method of examination.

The predominance of bilateral presence among participants with the muscle is consistent with previous anatomical literature. Natsis et al. reported substantial bilateral predominance in a large Greek series, while the systematic review by Cirocchi et al. similarly identified bilateral distribution as the most common configuration [7, 11]. Hojaij et al. also demonstrated considerable morphometric variability in Brazilian adults [12]. Differences between studies should nevertheless be interpreted cautiously because direct intraoperative examination, cadaveric dissection, and imaging do not necessarily identify the muscle with equal sensitivity.

The observed sex difference is notable. Pyramidalis muscle presence was significantly higher among women than men in this sample. A similar sex-related difference has been described previously [11]. However, the female subgroup in the present study was small (n = 16), and the estimate may therefore be unstable. The biological explanation for this difference remains uncertain. Proposed hypotheses involving pelvic morphology or functional demands on the abdominal wall should be considered speculative until supported by larger studies with appropriate developmental and anthropometric data.

Age was also associated with muscle presence. Participants without the muscle were approximately 20 years older on average than those with the muscle. This finding may reflect age-related changes, cohort effects, or selection characteristics of the surgical population. Importantly, a cross-sectional study cannot determine whether the muscle degenerates with age. Longitudinal imaging or histological studies would be required to distinguish true involution from differences established earlier in life.

No significant association was observed between muscle presence and chronic disease. This negative finding should be interpreted in the context of the small sample size and limited statistical power. The study was not designed to establish biological effects of diabetes or hypertension on pyramidalis muscle development or persistence.

The morphometric findings are broadly comparable with published anatomical measurements. Hojaij et al. reported mean lengths of approximately 6.6–6.8 cm in Brazilian adults, while other studies have demonstrated substantial dimensional variation [12–14]. The present mean length of 6.45 cm suggests that, when present, the muscle may have dimensions of potential surgical relevance. However, claims regarding specific reconstructive applications should remain cautious because the present study did not assess flap viability, vascular anatomy, functional outcomes, or postoperative results.

The study has several limitations. First, the sample was small and drawn from a single hospital, limiting precision and generalizability. Second, consecutive non-probability sampling may have introduced selection bias because the surgical population may not represent the general Sudanese adult population. Third, intraoperative identification and measurement were not subjected to formal inter-observer reliability testing. Fourth, the study could not distinguish congenital absence from severe atrophy. Fifth, the number of participants contributing morphometric measurements was not explicitly reported in the source thesis. These limitations should temper interpretation of the observed associations.

Despite these limitations, the study addresses a clear geographical evidence gap and provides a useful starting point for future research. Larger multicentre studies incorporating standardized morphometry, ultrasound or CT/MRI confirmation, and broader demographic sampling are needed to determine whether the observed prevalence represents a characteristic of Sudanese populations or of this particular surgical cohort.

Conclusion

In this sample of 50 adults undergoing lower anterior abdominal wall surgery at Al-Damazin Teaching Hospital, the pyramidalis muscle was present in 60% of participants and absent bilaterally in 40%. Bilateral presence was the predominant configuration. Muscle presence was significantly associated with sex and age but not with chronic disease. When present, the muscle had a mean length of 6.45 cm and mean thickness of 1.10 cm. These findings provide preliminary anatomical data for a Sudanese population and support further multicentre studies using standardized intraoperative and imaging-based methods.

Declarations

Funding

No funding was received for conducting this study or for preparing the manuscript. [CONFIRM BEFORE SUBMISSION.]

Competing interests

The authors declare that they have no competing interests.

Ethics approval

The study was approved by the Professional Ethics Committee in the Blue Nile Region and was conducted in accordance with the Declaration of Helsinki. [INSERT OFFICIAL COMMITTEE NAME AND APPROVAL NUMBER/DATE.]

Consent to participate

Written informed consent was obtained from all participants.

Data availability

The datasets generated and/or analysed during the current study are not publicly available because they contain participant-level clinical information but may be available from the corresponding author on reasonable request, subject to applicable ethical and institutional restrictions. [CONFIRM/REVISE ACCORDING TO INSTITUTIONAL POLICY.]

Author contributions

Omer Abdalazeez Mohamad Osman: Project development, data collection, data analysis, manuscript writing. Heitham Mutwakil Mohammed: Project supervision, interpretation of findings, manuscript writing/editing. Both authors approved the final manuscript and agree to be accountable for all aspects of the work.

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Figures

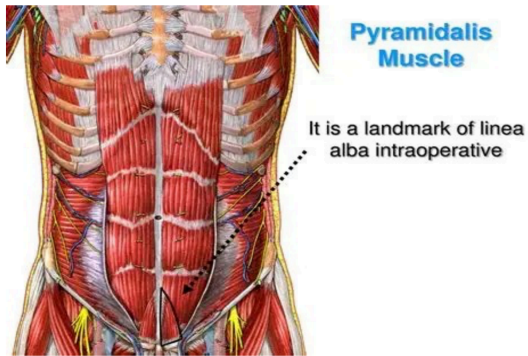
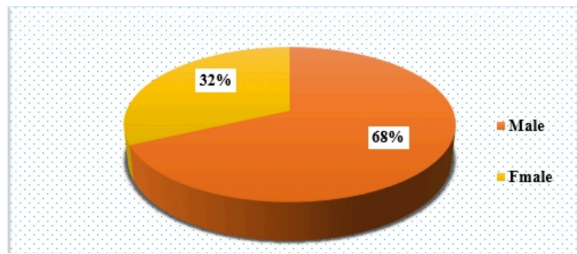


Figure 1.1: The anatomical location of pyramidalis muscle in the inferior anterior abdominal wall (Kaur et al., 2016)

side.

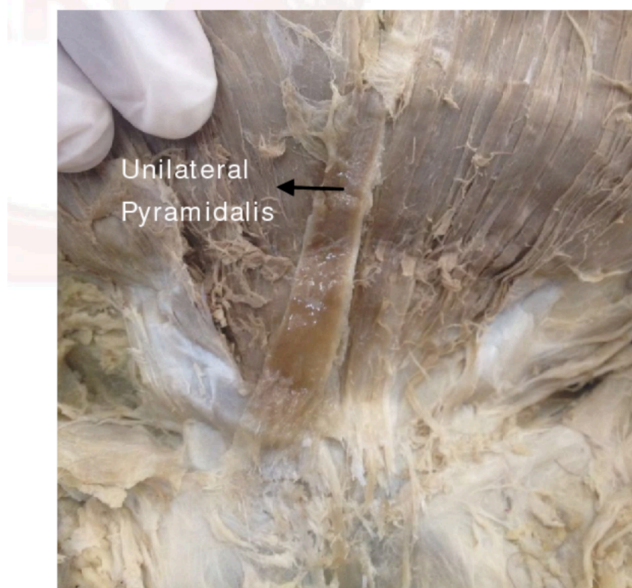


Figure 1.2: Illustrates unilateral presence of the pyramidalis on the right side body (Kaur et al., 2016).

Figure 1

Distribution of participants by sex

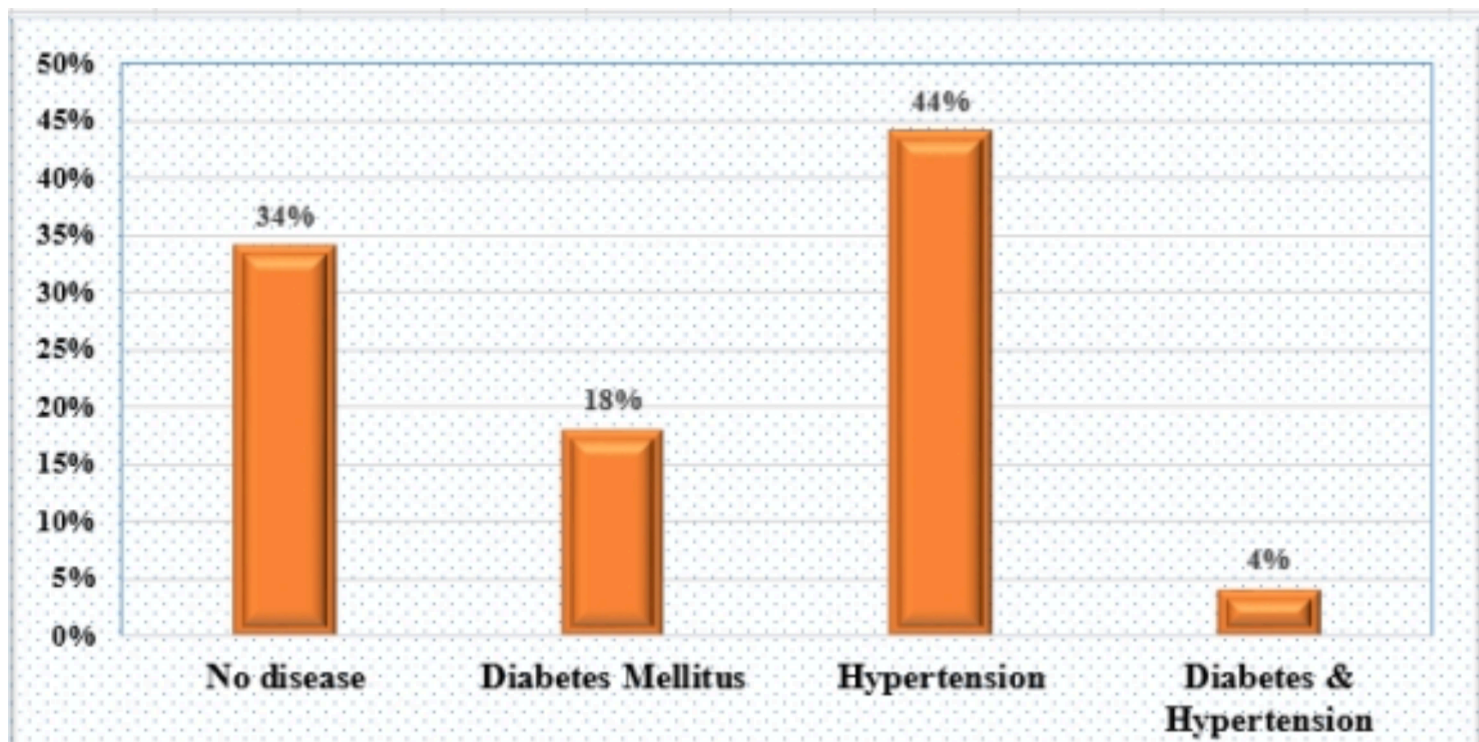


Figure 2

Distribution of chronic disease categories

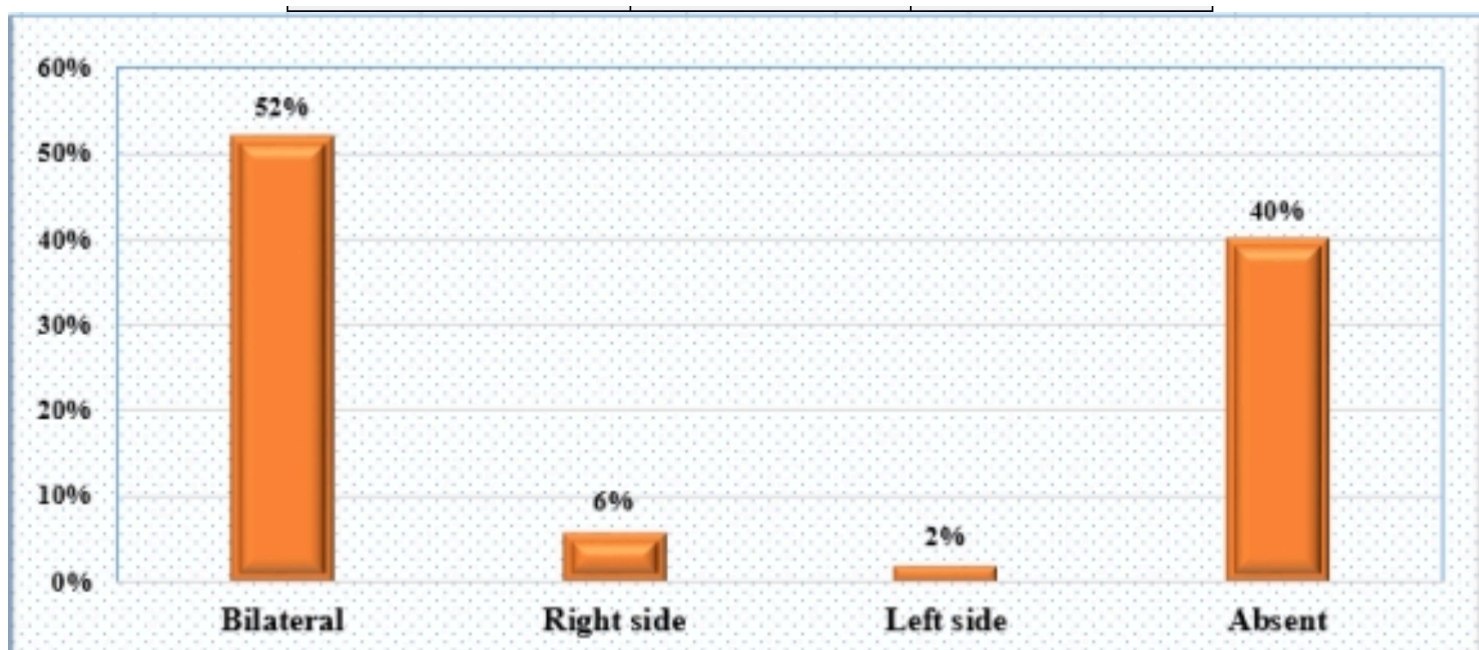


Figure 3

Distribution of pyramidalis muscle configurations

Supplementary Files

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