

MORPHOLOGICAL VARIATIONS OF THE VERMIFORM APPENDIX: A CADAVERIC STUDY CONDUCTED AT THE DEPARTMENT OF ANATOMY, ANNAPOORANA MEDICAL COLLEGE & HOSPITALS, SALEM, TAMIL NADU, INDIA

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Conflict of interest: Nil

Abstract

Background: The vermiform appendix is a narrow blind-ended diverticulum arising from the posteromedial wall of the cecum. Considerable anatomical variations exist in its position, length, mesoappendix, and relationship to adjacent structures. Knowledge of these variations is essential for anatomists, surgeons, and radiologists in diagnosing and managing appendicular pathology.

Aim: To study the morphological variations of the vermiform appendix in adult human cadavers and determine the frequency of different anatomical positions and morphometric characteristics.

Materials and Methods: A descriptive cross-sectional cadaveric study was conducted in the Department of Anatomy, Annapoorana Medical College & Hospitals (AMCH), Salem, Tamil Nadu, India, from December 2020 to October 2021. Eighty embalmed adult cadavers were examined during routine undergraduate dissection. The position, length, external diameter, mesoappendix extent, and cecal morphology were recorded using standard anatomical methods. Data were analyzed using SPSS version 25.0.

Results: Among 80 cadavers, the retrocecal position was the most common (45%), followed by pelvic (28.75%), subcecal (10%), postileal (8.75%), preileal (5%), and paracecal positions (2.5%). The mean appendix length was 8.34 ± 2.21 cm. Complete mesoappendix extending up to the appendicular tip was observed in 71.25% specimens. Morphological variations of the cecum were identified in 11.25% specimens.

Conclusion: Retrocecal position was the predominant anatomical location of the vermiform appendix. Significant variations were observed in length, position, and mesoappendix attachment. Awareness of these variations is important for accurate clinical diagnosis and surgical intervention in appendicular diseases.

Keywords: Vermiform appendix, Cadaveric study, Retrocecal appendix, Morphology, Anatomical variations, Cecum.

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Introduction

The vermiform appendix is a narrow worm-like diverticulum arising from the posteromedial aspect of the cecum

approximately 2 cm below the ileocecal junction [1]. Although traditionally regarded as a vestigial organ, recent

studies suggest its role in mucosal immunity and maintenance of intestinal microbiota [2]. Anatomical variations in the appendix are of considerable clinical significance because they influence the presentation of acute appendicitis and complicate diagnosis and surgical management [3-4].

The appendix exhibits remarkable variability in its position, length, direction, blood supply, and mesenteric attachment [5]. The position of the appendix determines the location of pain and tenderness in appendicitis [6]. Variations such as retrocecal, pelvic, preileal, postileal, subcecal, and paracecal positions have been documented across different populations [6]. Cadaveric studies provide direct anatomical evidence and remain the gold standard for understanding appendicular morphology [7-9]. Population-specific anatomical data are valuable for surgeons performing appendectomy and radiologists interpreting imaging findings.

Therefore, the present study was undertaken to evaluate morphological variations of the vermiform appendix in cadavers dissected at AMCH, Salem.

Aim: To study the morphological variations of the vermiform appendix in adult human cadavers.

Objectives

1. To determine the anatomical position of the vermiform appendix.
2. To measure the length and external diameter of the appendix.
3. To assess the extent of mesoappendix attachment.
4. To identify associated variations in cecal morphology.
5. To compare findings with previous anatomical studies.

Materials and Methods

This descriptive cross-sectional cadaveric study was conducted in the Department of Anatomy, Annapoorana Medical College

& Hospitals (AMCH), Kombadipatti, Salem, Tamil Nadu, India, over a period of eleven months from December 2020 to October 2021. The study was carried out on 80 embalmed adult human cadavers available for routine undergraduate medical dissection. Cadavers included in the study were adults aged above 18 years with well-preserved abdominal viscera and an intact ileocecal region suitable for detailed anatomical examination. Cadavers with damaged abdominal organs, evidence of previous abdominal surgeries, congenital anomalies involving the gastrointestinal tract, traumatic injuries affecting the appendix, or advanced decomposition were excluded from the study.

Following standard dissection procedures described in Cunningham's Manual of Practical Anatomy, the anterior abdominal wall was reflected, and the cecum along with the vermiform appendix was carefully exposed. The position of the appendix was identified and classified as retrocecal, pelvic, subcecal, preileal, postileal, or paracecal based on its anatomical relationship to the cecum and terminal ileum. Morphometric measurements including appendicular length and external diameter were recorded using a flexible measuring tape and digital Vernier calipers. The extent of mesoappendix attachment was examined and documented as extending up to the tip, distal two-thirds, or proximal half of the appendix.

Any associated variations in cecal morphology were also noted. All observations were systematically recorded in a predesigned data collection proforma. The collected data were entered into Microsoft Excel and analyzed using SPSS version 25.0. Descriptive statistics such as mean, standard deviation, frequency, and percentage were calculated, and the findings were presented in tables and figures. A p-value of less than 0.05 was considered statistically significant wherever applicable.

Dissection Procedure: The anterior abdominal wall was reflected according to Cunningham's Manual of Practical Anatomy. The cecum and vermiform appendix were identified. The appendix was exposed carefully preserving the mesoappendix and appendicular artery.

The following observations were recorded:

- Position of appendix
- Length of appendix
- External diameter
- Mesoappendix attachment

- Morphology of cecum

Measurements were taken using digital Vernier calipers and measuring tape.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 25.0. Descriptive statistics included: Mean, Standard deviation, Percentage, Frequency distribution. Chi-square test was used for categorical variables. A p-value <0.05 was considered statistically significant.

Results

Table 1: Distribution of Appendix Positions (n = 80)

Position	Frequency	Percentage
Retrocecal	36	45.0
Pelvic	23	28.75
Subcecal	8	10.0
Postileal	7	8.75
Preileal	4	5.0
Paracecal	2	2.5

The retrocecal position was the most common, accounting for 45% of specimens, followed by pelvic position (28.75%).

Table 2: Morphometric Measurements of Vermiform Appendix

Parameter	Mean $\pm$ SD
Length (cm)	8.34 $\pm$ 2.21
Diameter (mm)	6.12 $\pm$ 1.03

The average length of the appendix was 8.34 cm, ranging from 3.5 cm to 14.2 cm.

Table 3: Extent of Mesoappendix

Extent	Frequency	Percentage
Reaching tip	57	71.25
Up to distal 2/3	15	18.75
Up to proximal half	8	10.0

Complete mesoappendix extending to the appendicular tip was observed in most specimens.

Table 4: Variations in Cecal Morphology

Cecal Morphology	Frequency	Percentage
Normal	71	88.75
Conical	5	6.25
Quadrate	3	3.75
Asymmetrical	1	1.25

Most ceca demonstrated normal morphology.

The present study examined 80 adult cadavers. Retrocecal appendix constituted the predominant anatomical position

(Table 1). Morphometric analysis revealed considerable variation in appendicular length (Table 2). Complete mesoappendix was observed in the majority of specimens (Table 3).

Variations in cecal morphology were

identified in 11.25% of cadavers (Table 4).

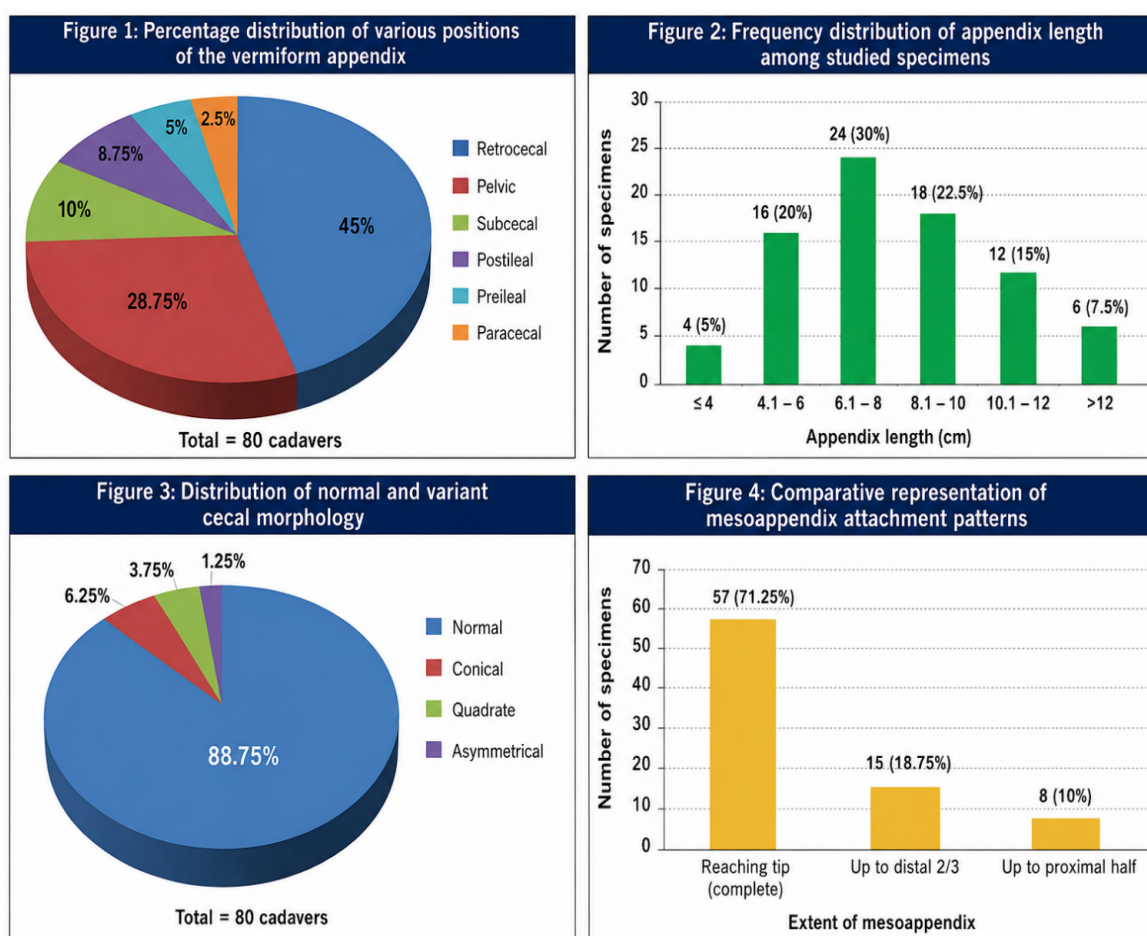


Figure 1-4:

Figure 1: Percentage distribution of various positions of the vermiform appendix showing retrocecal position as the most common.

Figure 2: Frequency distribution of appendix length among studied specimens.

Figure 3: Distribution of normal and variant cecal morphology observed during cadaveric dissection.

Figure 4: Comparative representation of mesoappendix attachment patterns.

Discussion: The present study demonstrated that the retrocecal position was the most common anatomical location of the appendix (45%).

Similar findings were reported by Wakeley (1933), who observed retrocecal appendix in 65.28% of cases. Shah and Shah (2015)

also reported retrocecal position as the predominant type. The mean appendicular length observed in this study (8.34 cm) closely corresponds with findings reported by Gray's Anatomy and Gopalipour et al., who documented average lengths ranging from 7 to 10 cm [10-14].

Pelvic appendix constituted 28.75% of specimens. This finding is comparable to studies by Ajmani and Singh, who reported pelvic positions ranging from 20–30%. Complete mesoappendix extending to the tip was observed in 71.25% of specimens. Similar observations were reported by Solanke and colleagues, who emphasized the clinical significance of mesoappendix extent in appendicular ischemia and susceptibility to inflammation [15-17].

Variations in cecal morphology observed in this study were comparable to findings reported by Treves and subsequent anatomical investigations. Such variations may influence surgical approaches during appendectomy and right hemicolectomy [18-22]. The present findings reinforce the importance of understanding regional anatomical variations of the appendix, particularly in the South Indian population.

Limitations

1. Relatively small sample size.
2. Single-center study.
3. Age and sex-specific analysis could not be performed for all specimens.

Recommendations

1. Multicentric anatomical studies involving larger populations.
2. Correlation of cadaveric findings with radiological investigations.
3. Development of regional anatomical databases for surgical planning.

Conclusion

The retrocecal position was the predominant anatomical location of the vermiform appendix in the studied South Indian cadaveric population. Significant variations were observed in appendicular length, mesoappendix attachment, and cecal morphology.

These findings provide valuable anatomical information for surgeons, anatomists, and radiologists and may contribute to improved diagnosis and management of appendicular diseases.

References

1. Wakeley CPG. The position of the vermiform appendix as ascertained by analysis of 10,000 cases. *J Anat.* 1933; 67:277-283.
2. Williams PL, Bannister LH, Berry MM. *Gray's Anatomy.* 38th ed. London: Churchill Livingstone; 1995.
3. Ajmani ML, Ajmani K. The position, length and arterial supply of vermiform appendix. *Anat Anz.* 1983;153:369-374.
4. Solanke TF. The blood supply of the vermiform appendix. *Br J Surg.* 1968;55:791-793.
5. Golalipour MJ, Arya B, Azarhoosh R. Anatomical variations of vermiform appendix in Iranian cadavers. *J Anat Soc India.* 2003;52:141-143.
6. Shah MA, Shah M. Anatomical variations of vermiform appendix. *Int J Anat Res.* 2015;3:1268-1272.
7. Singh V, Mitra AK. Morphological study of appendix. *J Anat Soc India.* 2004;53:30-33.
8. Katzarski M, Gopal Rao UK. Variations of appendix position. *Surg Radiol Anat.* 2007;29:93-96.
9. Bakheit MA, Warille AA. Anatomical variations of appendix. *Sudan Med J.* 1999;37:23-29.
10. Clegg-Lamprey JN, Armah H. Morphology of appendix in African population. *West Afr J Med.* 2006;25:217-220.
11. Standring S. *Gray's Anatomy.* 40th ed. London: Elsevier; 2008.
12. Snell RS. *Clinical Anatomy.* 8th ed. Philadelphia: Lippincott Williams & Wilkins; 2008.
13. Moore KL, Dalley AF. *Clinically Oriented Anatomy.* 6th ed. Philadelphia: LWW; 2010.
14. Sinnatamby CS. *Last's Anatomy.* 12th ed. Edinburgh: Churchill Livingstone; 2011.
15. Solanke TF, Arigbabu AO. Mesoappendix morphology. *Afr J Med Med Sci.* 1979;8:67-72.
16. Treves F. Lectures on anatomy of appendix. *Br Med J.* 1885;1:527-530.
17. Collins DC. A study of 50,000 specimens of human appendix. *Surg Gynecol Obstet.* 1955;101:437-445.
18. Gupta SC, Gupta CD. Morphology of appendix in Indian population. *J Anat Soc India.* 1981;30:48-54.
19. Bhatnagar KP, Sharma V. Position and length of appendix. *Anat Rec.* 1998; 252:150-156.

20. Solanke TF, Olayinka OS. Morphometric study of appendix. J Anat. 1970; 107: 321-329.
21. Buschard K, Kjaeldgaard A. Histology and anatomy of appendix. Acta Pathol Microbiol Immunol Scand. 1973;81: 89-95.
22. Golalipour MJ, Naderi F. Morphological variations of appendix. Anat Cell Biol. 2014;47:203-208.