

Variation in Anatomical Position of Vermiform Appendix

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ABSTRACT

Background: Delaying acute appendicitis diagnosis may cause appendix perforation and abscess or peritonitis. Appendectomy is one of the most common surgeries in Pakistan, however little is known about vermiform appendix variation architecture. Hence, appendix anatomy may improve prognosis, this research identified appendix anatomical locations, length, and age and sex relationships.

Objective: This study aimed to identify the anatomical sites of the appendix, the length of the appendix and to examine the associations between these factors and age and sex.

Study Design: Retrospective cross-sectional study

Study Setting: This study was conducted in anatomy department of Islamic International Medical College, Rawalpindi from August 2022 to January 2023.

Methodology: This retrospective cross-sectional research was completed in the (department and hospital name) between (year). This study was approved from Ethical review committee with IRB (no). The patients reports were taken for the completion of the study. The CT scan of both gender from 8 to 60 years with the help radiologist suggestions were included in this study. Together with a radiologist, we analyzed CT axial images, a coronal of 1.5 mm thickness, and a sagittal reconstruction to assess the anatomical findings of the vermiform appendix retrospectively.

Results: There were 300 total participants in this research, 165 (55%) were female and 135 (45%) were male between 8 years to 60 years of age. In both sexes, the following sites were found Pelvic, Post ileal, Pre ileal, Retro caecal, Retro colic, Retro Para colic, and Sub caecal. Appendix length and site was shown to be significantly different in gender and age ($p < 0.001$). Children less than 10 years old were more likely to have an incomplete mesoappendix. According to our findings, males have a longer appendix than females do. On the other hand, we discovered that the appendix tends to become longer with age.

Practical implication: The location of the appendix reportedly varies among ethnic and geographical groups. Preoperative planning requires knowledge of these variations. Although appendectomy is one of the most common operations in Pakistan, very little is known about vermiform appendix variation anatomy in the country.

Conclusion: This study's findings showed that the vermiform appendix is most often seen in the pelvic position on CT in the Karachi-based population. In conclusion, the high prevalence of anterior location and full mesoappendix in our group suggests that acute appendicitis may be more easily and quickly diagnosed in our demographic, with fewer instances of sequelae including perforation and gangrene.

Keywords: Vermiform Appendix, Pelvic, Post ileal, Pre ileal, Retro caecal, Retro colic, Retro Para colic, and Sub caecal

BACKGROUND

In terms of location, size, peritoneal location, and organ connections, the vermiform appendix is the most malleable abdominal organ. In appendicitis, the vermiform appendix may be in a number of different locations, each of which can induce a different set of symptoms and indications that can easily be mistaken for those of another condition¹. Learning about these differences is also crucial for various types of abdominal surgeries². Acute abdominal symptoms might be complicated by factors such as the length of the vermiform appendix. The right lower abdominal quadrant to the vermiform appendix, a digestive organ. It has a wormlike shape and develops from the cecal posteromedial wall during embryonic life, around 2 centimeters below the ileocecal valve³. In 1924, Gladstone and Wakeley conducted the first extensive research of the appendix's location by analyzing data from more than three thousand dissections⁴. The majority of appendices are anteriorly located, that they are free, and that they dangle over the brim of the pelvis (based on necropsy or surgical observations). In spite of being a very stable human structure, the appendix may sometimes exhibit extremes of variance, such as complete suppression or even duplication. They may be anywhere from 2 centimeters to 20 centimeters long, with an average of 9 centimeters. While its tail is always attached to the cecum, the appendix's head might be in a number of distinct locations. Retrocecal, pelvic, subcecal, preileal, retroileal, and ectopic are the six places used to classify the variety of circumstances^{1,3}.

In young individuals, acute appendicitis is the most prevalent cause of acute abdomen. But it's also possible to notice it in people of any age⁵. The location of the appendix may vary with

age, race, sex, location, and diet. Nonetheless, the death rate of nonperforated appendicitis is 0.1%, which is somewhat greater than the mortality rate with general anesthesia. Nonetheless, perforated appendicitis has a mortality incidence of around 3%; in the elderly population, this number rises to as high as 30%⁶. Vermiform appendixes have been found in all locations, with the pelvic position being the most frequent (57.71%) and the para cecal position being the least common (3.17%)⁷. Medical history, physical examination, and laboratory tests are the strengths of acute appendicitis diagnosis. No imaging or laboratory test can provide a conclusive diagnosis. In order to make a prompt diagnosis of acute appendicitis, it is helpful to be familiar with the typical location(s) of the appendix. Changes in appendix location might confuse doctors and lead them to the incorrect diagnosis. Perforation of the appendix and subsequent abscess or peritonitis might result from a delay in diagnosing acute appendicitis^{8,9}. Although appendectomy is one of the most prevalent surgical operations in Pakistan, not much is known about vermiform appendix variant architecture in Pakistanis. Hence, correct knowledge of the appendix's anatomical position might enhance prognosis. This study aimed to identify the anatomical sites of the appendix, the dimensions of the appendix (length) and to examine the associations between these factors and age and sex.

METHODS

Study Design and Setting: This retrospective cross-sectional research was conducted in anatomy department of Islamic International Medical College, Rawalpindi from August 2022 to January 2023.. This study was approved from Ethical review

committee. The patient's reports were taken for the completion of the study.

Inclusion and Exclusion Criteria: The computed tomography (CT) of both gender from 8 to 60 years with the help radiologist suggestions were included in this study. Patients with a history of appendectomy, those who were pregnant, and those whose CT indicated perforation of the vermiform appendix were not included in the research.^{25,26}

Sample Size Calculation: On the WHO sample size calculator, a total of 295 subjects were chosen based on a prevalence of 30%⁶ appendicitis with 95% confidence interval and margin of error was 5%.

Study Protocol: Medical files and CT scans for a total of 300 patients were selected and examined. Patients of both sexes had their CT scans categorized into three groups based of every age group were enrolled in this study. Due to the retrospective nature of this study's data gathering we skipped getting patients' permission. For all patients, the scanning field of view extended from the level of the diaphragm to the pubic symphysis. Together with a radiologist, we analyzed CT axial images, a coronal of 1.5 mm thickness, and a sagittal reconstruction to assess the anatomical findings of the vermiform appendix retrospectively.

Statistical Analysis: The data analysis for this study was carried out using version 20.0 of the IBM-SPSS. Descriptive analysis was performed on demographic factors such as age, gender, BMI etc. Independent t test and Pearson's correlation were used to determine the mean and standard deviation of biochemical parameters. If the p-value was lower than 0.05, the data were considered to be statistically significant.

RESULTS

There were 300 total participants in this research, 165 (55%) were female and 135 (45%) were male between 8years to 60 years of age. In both sexes, the following sites were found Pelvic, Post ileal, Pre ileal, Retro caecal, Retro colic, Retro Para colic, and Sub caecal. The findings showed that the appendix was highly located in the pelvis in 108 (36.0%) of people, then in the retro para colic 68 (22.7%). The least anatomical position was found in sub caecal with 8 (2.7%) as shown in Table I.

Table 1: Demographic details of the patients.

	Frequency	Percent
Age (years)		
<10	139	46.3
>55	48	16.0
11--19	30	10.0
20-39	42	14.0
40-54	41	13.7
Gender		
Female	165	55.0
Male	135	45.0
Site		
Pelvic	108	36.0
Pre ileal	56	18.7
Post ileal	11	3.7
Retro Caecal	39	13.0
Retro colic	10	3.3
Rt. Para colic	68	22.7
Sub caecal	8	2.7
Length (mm)		
<40	72	24.0
>119	54	18.0
40-79	58	19.3
80-119	116	38.7

The whole data were categorized on the basis of gender to evaluate the gender anatomical position and length. According to sit the vermiform appendix, the highest frequency is pelvic position, and the least is sub caecal. The length of an appendix ranged from <40 mm to 119 mm. Males had an average appendix length of 93.6 mm, while females were only 81.2 mm long. When measured and categorized by appendix length, the majority were classified I between 80-119 (Table II). Appendix length and site was shown to be significantly different in gender (p<0.001).

Table 2: The comparison of site and length based on gender.

Site	Gender		p Value
	Female	Male	
Pelvic	57 (19)	51 (17)	<0.001
Post ileal	11 (3.7)	0	<0.001
Pre ileal	16 (5.3)	40 (13.30)	<0.001
Retro caecal	37 (12.3)	2 (0.6)	<0.001
Retro colic	10 (3.3)	0	<0.001
Rt. Para colic	34 (11.3)	34 (11.3)	<0.001
Sub caecal	0	8 (2.7)	<0.001
Length (mm)	Gender		p Value
	Female	Male	
<40	21 (7)	21 (7)	<0.001
>119	34 (11.3)	20 (6.7)	<0.001
40-79	28 (9.3)	30 (10)	<0.001
80-119	82 (27.3)	64 (21.3)	<0.001

The data is presented as frequency (percentage). The result was analyzed by using a Chi-square test. The p<0.05 is significant.

The patient's data were also divided based on the age groups. People between the ages of <10 years had the longest average appendix lengths. In the age <10 years to >55 years the pelvic anatomical position were dominant. A total of 162 of the sample had a fully developed mesoappendix. Children less than 10 years old were more likely to have an incomplete mesoappendix. According to our findings, males have a longer appendix than females do. On the other hand, we discovered that the appendix tends to become longer with age.

Table 3: The comparison of site and length based on age group.

Site	Age					p Value
	<10	11--19	20-39	40-54	>55	
Pelvic	47 (15.6)	6 (2)	12 (4)	17 (5.7)	26 (8.7)	<0.001
Post ileal	7 (2.3)	1 (0.3)	2 (0.6)	1 (0.3)	0	<0.001
Pre ileal	24 (8)	7 (2.3)	10 (3.3)	15 (5)	0	<0.001
Retro caecal	16 (5.4)	14	7 (2.3)	1 (0.3)	1 (0.3)	<0.001
Retro colic	7 (2.3)	0	0	3 (1)	0	<0.001
Rt. Para colic	36 (12)	0	9 (3)	3 (1)	20 (6.7)	<0.001
Sub caecal	2 (0.6)	2 (0.6)	2 (0.6)	1 (0.3)	1 (0.3)	<0.001
Length (mm)	Age					p Value
	<10	>55	11--19	20-39	40-54	
<40	31 (10.3)	7 (2.3)	6 (2.0)	17 (5.7)	11 (3.7)	<0.001
>119	20 (6.7)	8 (2.7)	8 (2.7)	1 (0.3)	17 (5.7)	<0.001
40-79	27 (9.0)	11 (3.7)	6 (2.0)	8 (2.7)	6 (2.0)	<0.001
80-119	61 (20.3)	22 (7.3)	10 (3.3)	16 (5.3)	7 (2.3)	<0.001

The data is presented as frequency (percentage). The result was analyzed by using a Chi-square test. The p<0.05 is significant.

DISCUSSION

We found that appendixes were most often found in the pelvic region. The results we obtained were consistent with those found by other researchers, including those by Kacprzyk, et al.⁷, Vieira et al.¹⁰, Lamture et al.³, and Tartaglia et al.¹¹. Yet, several other research have shown contradictory results with other anatomical positions^{12,13}. Several studies, including those by L. Ajmani and K. Ajmani in India¹⁴ and Ojeifo et al. in Bosnia¹⁵ have shown that the appendix most often resides in a retrocecal and pelvic position. Snyder et al., evaluated the size of the appendix via sonography; and during therapeutic laparotomy¹⁶. In this analysis, the appendix has been located more often in the pelvis. Appendicitis is a frequent cause of acute abdomen¹⁷, but the vermiform appendix may be in a variety of locations, which might complicate the diagnosis¹⁸. When seen from the perspective of the cecum, the appendix may be classified as either anterior (pelvic, pre-, and retroileal) or posterior (retrocecal, and paracecal). More than 75 percent of our sample group had their appendix in the front abdominal wall. Because of this, Pakistani patients are anticipated to benefit from earlier appendicitis diagnosis, shorter surgical procedures, and quicker recoveries. This may lessen the risk of complications during surgery for appendicitis¹⁶. The appendix most often occurs in the pelvic region, both in men and women. The prevalence was 32 (67%) among women and 80 (52.2%) among men. The data suggests that males and females are more likely to

have a pelvic location. On the other hand, it has been proposed that vermiform appendix may shift its location depending on the circumstances¹⁹. According to our findings, males have a longer appendix than females do. We found that children under the age of 10 had an incomplete mesoappendix at a higher rate than any other age group. The risk of gangrene and perforation at the appendix tip is increased in those with incomplete mesoappendix. There's a chance it's an indicator of a bad prognosis for kids with acute appendicitis¹⁸. Appendicitis in children may be particularly dangerous when the mesoappendix is incomplete. The vermiform appendix's anatomical location is a major issue for many reasons, including its evolutionary significance, surgical relevance, and pathological relevance²⁰. There are several disagreements amongst writers about how to classify appendices and where they are located anatomically. Several sources agree that the vermiform appendix is the only human body organ that may be found in more than one place in the abdomen. Many unusual locations of the caecum and appendix are the result of several developmental abnormalities that occurred during midgut rotation²¹.

Non-invasive imaging techniques allow doctors to see the vermiform appendix in its typical location. The high spatial resolution of the computer tomography (CT) has made it a reliable imaging tool for assessing the vermiform appendix²². Classification based on CT appendicular tip location was examined in this investigation. The caecum, ileocecal valve, and appendicular base may all be seen clearly in coronal and axial pictures thanks to the development of the most cutting-edge imaging technology²³. When comparing an appendix that is healthy and one that is sick, CT has a 99% accuracy rate. Accurate and timely diagnosis of acute abdomen may be aided by familiarity with the typical anatomical locations of the vermiform appendix in connection with appendicitis on CT. It is possible that knowing where the appendix is located anatomically can lead to better prognosis in the treatment of illness²⁴. Vermiform appendix was more often located in the postileal position in the inflammatory group, suggesting any association between appendicitis and this location¹⁰. The appendix often shows up in the body in a descending intraperitoneal position. As we've already shown, this development greatly aided in distinguishing between typical and uncommon forms of the appendix. Vermiform appendix was found to be at a significantly different location on CT of individuals with acute abdomen compared to cadaveric studies²².

The single institution setting, and small sample size of patients included in the analysis are two of the study's limitations. CT is a very accurate diagnostic technique for appendicitis; however, it cannot be used on pregnant women due to the risk of radiation exposure.

CONCLUSION

This study's findings showed that the vermiform appendix is most often seen in the pelvic position on CT in the Karachi-based population. In conclusion, the high prevalence of anterior location and full mesoappendix in our group suggests that acute appendicitis may be more easily and quickly diagnosed in our demographic, with fewer instances of sequelae including perforation and gangrene. Patients should spend less time in the hospital and less time in open or laparoscopic surgery. This research provides the gross data on anatomical location wise variation of vermiform appendix and its connection with appendicitis that is required for the diagnosis and treatment of acute appendicitis, allowing for prompt and accurate diagnosis at the earliest possible stage.

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