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# Anatomical Variations of Vermiform Appendix on Plain MDCT and Its Association with Acute Appendicitis in Adult Urban Population of Karachi, A Tertiary Care Hospital Experience

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**Abstract**

**Objective:** To evaluate the anatomical positions of vermiform appendix and its association with acute appendicitis on Multidetector computed tomography (MDCT).

**Study design and setting:** A cross sectional study based on hospital database was carried out in Department of Anatomy in collaboration with Department of Radiology, Liaquat National Hospital.

**Methodology:** A total of three hundred and six 306 adult urban patients CT axial images were evaluated retrospectively over period of 6 months from March 2021 to August 2021 who had abdominal MDCT scan for acute abdomen after getting approval from ethical committee to find out anatomical variations of position of vermiform appendix in a tertiary care hospital among adult urban Karachi population and its association with appendicitis. Data was analyzed using SPSS version 25. All categorical variables were summarized as frequencies and percentages.

**Result:** In present study 159(52%) were males and 147(48%) were females with mean age of 32.97 years. The subcecal anatomical position of vermiform appendix on MDCT was most common n=85(27.8%), followed by postileal n=78(25.5%), pelvic n=61(19.9%), postcecal n= 36(11.8%), preileal n=29(9.5%), ectopic n=17(5.6%). The association between appendicitis with anatomical position of vermiform appendix and age was analyzed by chi- square and was statistically significant (p =0.05). There was no significant association between position of vermiform appendix on MDCT and gender.

**Conclusion:** The subcecal position of vermiform appendix is most common on MDCT and the postileal position was more frequent in the inflamed group of vermiform appendix.

**Key words:** Anatomical variation, Appendicitis, Multidetector computed tomography, Vermiform appendix

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## INTRODUCTION:

The vermiform appendix originates from posteromedial wall of caecum in the large intestine. It is a narrow blind end like tube extension from caecum in the right lower abdomen approximately about 2cm in length just below the ileocecal valve.[1] It is supported by mesoappendix, which is a double layered fold of peritoneum suspending the organ from the terminal ileum. The appendix is most mobile structure of abdomen. An average length of appendix is 6-9 cm longer in males than in females. Anatomical variations in position of vermiform appendix can be associated with acute appendicitis.[2] Function of vermiform appendix is immunological. Its function is similar to tonsil which provides protection to upper GI tract. The appendix acts as a guard for small intestine from different microbes which are present in large intestine.[3] Appendix is an out pocket from caecum. Embryologically the proximal half of large intestine originates from midgut while distal half originates from hind gut. Superior mesenteric artery supplies the proximal half of large intestine while distal half is being supplied by inferior mesenteric artery. Both are the arteries of midgut and hind gut respectively.[4] A triangular shaped fold of peritoneum called mesoappendix extends throughout the whole length

of appendicular tube. It has free border through which vermiform appendix received its blood supply by appendicular artery which is a branch of ileocolic artery.[5] Appendicular vein drains venous blood which becomes ileocolic vein by joining with ceacal vein.[6]

The anatomy of appendix exhibit great variation in terms of position and length among different population, and still very few studies done which showed its variation in position associated with acute appendicitis. The earliest principle study on the position of appendix was done by Gladstone and Wakeley. This study concluded that 69.2% identified as postcecal, 27.5% identified as pelvic, 0.9% identified as preileal, 0.5% as post ileal and18.6% identified as subcecal.[7]

Acute appendicitis is one of the most common causes of abdominal pain and is the most frequent condition leading to emergent abdominal surgery. Appendicular inflammation usually results in acute abdomen. Due to gut rotation during the 6$^{th}$ and 10$^{th}$ week of development and different stages of cecal development, appendix is located at different positions in the abdominal cavity as it originates from caecum.[8]

Over the last few decades, CT is considered as most accurate and useful diagnostic tool for acute abdomen.[9] There is remarkable increase in preoperative CT scans from18% in 1996 to 93% in 2006, with very low false negative rate 0 %.[10] CT criteria for appendicitis include an enlarged appendix of greater than 6 mm in diameter, greater than 2mm thickness appendiceal wall, pericecal inflammation with fat stranding, appendiceal wall enhancement, the presence of appendicolith – a calcified deposit in appendix in approximately 25% of patients.[11]

Plain MDCT is extremely useful for visualizing the appendix. MDCT is an excellent modern technique to diagnose and allow images of high resolution for whole abdomen with cheap rates than MRI.[12] This study will assess the position of appendix and its association with acute appendicitis in adults on Plain MDCT (Multidetector computed tomography). MDCT is simple procedure with no intravenous or rectal administration of contrast material due to this it gains popularity for the fast detection of normal and abnormal anatomical position of vermiform appendix. Multidetector computed tomography is modified and advance form of CT scan and is highly diagnostic for patients with suspected acute appendicitis.

Traditionally clinical diagnosis was used to make final diagnosis for acute appendicitis. With recent advancements in modern technologies, CT evaluation is now considered a definitive diagnostic tool. Various researches have been done on anatomical position of vermiform appendix on dissected bodies, during open appendectomy and postmortem but there is relative lack of data on MDCT which is innovative imaging modality on position wise frequency of vermiform appendix and its association with appendicitis in adult urban Karachi population. The purpose of this study is to enlighten the different anatomical variations of vermiform appendix and to determine its association with appendicitis, which aids clinicians and surgeons in performing safe appendicular surgeries.

**METHODOLOGY:**

The study was conducted in Department of Anatomy and Department of Radiology in a tertian care hospital Liaquat National Hospital and Medical College, Karachi. The duration of study was 6 months after getting approval from Ethical review committee (Ethical committee no: Ref: App#0633-2021LNH-ERC) from March 2021 till August 2021.Between the period of March 2021 till Aug 2021, all adult patients came to an emergency department with a clinical suspicion of appendicitis with typical presentation including complain of pain in right lower quadrant or right iliac fossa, nausea, vomiting, rebound tenderness and fever with elevated WBC count or atypical presentation that is absence of at least one of the classic findings of acute appendicitis and all women with normal gynecological examination who had MDCT examination performed were analyzed in our study as it was retrospective cross sectional study.[13]

A total of three hundred and six (306) patient medical records and CT images were identified and reviewed. One year MDCT scan (16 slice Toshiba) of both gender patients was included and were divided into three groups according to age values 18-25years, 26- 35 years =35 years of age. We excluded all patients in this study whose MDCT showed perforation of vermiform appendix, patients who had previous history of appendectomy and all pregnant females. The mandatory consent from patients for this study was ignored because of retrospective data collection from database on Proforma using Microsoft excel sheet. Field of view (FOV) for scanning was included from the area starts with level of diaphragm to pubic symphysis for all patients. The anatomical findings of vermiform appendix were interpreted retrospectively in collaboration with radiologist by evaluating CT axial images along with coronal of 1.5mm thickness and sagittal reconstruction.

Data was entered on a VITREA work station. All demographic data was entered on designated Proforma, Microsoft excel was used and results were analyzed on SPSS version 25. Tables were used for presentation of results. Frequencies and percentages were used to summarize all categorical variables. Association between position of vermiform appendix and appendicitis, association between age and appendicitis was analyzed by chi- square test. P-value of $< 0.05$ was considered statistically significant.

**RESULTS:**

Total 306 patients (159 males and 147 females) were subjected for MDCT in this research project. Position of vermiform appendix anatomically was noted on the basis of localization on MDCT. Age groups were divided into

three categories. Age: 18-25 years, 26- 35 years, =35 years. Most common position found in this study was subcecal 27.8% followed by postileal 25.5%, pelvic 19.9%, postcecal 11.8%, preileal 9.5%. Total 5.6% ectopic positions were recorded on MDCT. (Table 1)

The 26-35 year old age group followed by 15-25 year old urban adult population of Karachi presented most frequently to a tertiary care hospital for pelvic pain, lower abdominal pain, right iliac fossa pain and lumbar pain. No statistically significant association was found between anatomical variations of positions of vermiform appendix and patient's age p- value (0.559). (Table 2a). In our study overall, out of total 306 scans, 68 scans detected by MDCT showed appendicitis. Significant statistical association was found in this study between appendicitis and age of patient p- value (0.039). (Table 2b)

The most common position of vermiform appendix in males was subceacal n=48(56.5%) in this study followed by postileal n=36(46.2%) followed by pelvic n= 28(45.9%), postcecal n= 21(58.3%), preileal n=17(58.6%) and ectopic n=9(52.9%). In females it was observed on MDCT postileal n=42(53.8%) followed by subcecal n=37(43.5%), pelvic n=33(54.1%), postcecal n=15(41.7%), preileal n=12(41.4%) and ectopic n=8(47.1%). There was no significant association between gender and anatomical position of vermiform appendix p- value (0.586). (Table 3)

In this study a total of 306 patients were included, among them it was found on MDCT that 68 patients also had appendicitis diagnosed on the basis of diameter and wall thickness of vermiform appendix. Statistically significant association was found by chi-square between appendicitis and positions of vermiform appendix. (Table 4)

Table 1: Demographic characteristics, anatomical position of vermiform appendix among adult urban Karachi population

| | Variable | n, % |
|---|---|---|
| **Gender** | Male | 159,52% |
| | Female | 147,48% |
| **Age(years)** | =25 years | 62,20.3% |
| | 26- 35 years | 133,43.5% |
| | =35 years | 111,36.3% |
| **Anatomical Positions of vermiform appendix** | Postcecal | 36 ,11.8% |
| | Preileal | 29, 9.5% |
| | Post ileal | 78,25.5% |
| | Pelvic | 61,19.9% |
| | Sub cecal | 85,27.8% |
| | Ectopic | 17,5.6% |

n= number of patients
Anatomical variations of position of Vermiform Appendix

Table 2a: Association between Anatomical variations of position of Vermiform Appendix in relation to age

| Age -Group | Position | | | | | | | P-value |
|---|---|---|---|---|---|---|---|---|
| | Ectopic | Pelvic | Post cecal | Post ileal | preileal | subcecal | Total | |
| **18-25 years** | 2 11.8% | 15 24.6% | 6 16.7% | 15 19.2% | 8 27.6% | 16 18.8% | 62 20.3 | 0.559 |
| **26-35 years** | 9 52.9% | 24 39.3% | 16 44.4% | 41 52.6% | 12 41.4% | 31 36.5% | 133 43.5% | |
| **>35 years** | 6 35.3% | 22 36.1% | 14 38.9% | 22 28.2% | 9 31.% | 38 44.7% | 111 36.3% | |
| **Total** | 17 | 61 | 36 | 78 | 29 | 85 | 306 | |

Table 2b: Association of Appendicitis with Age groups in adult urban Karachi population

| Age Group | Appendicitis | | | P-Value |
|---|---|---|---|---|
| | Yes | No | Total | |
| **<25 years** | 15 22.1% | 47 19.7% | 62 20.3% | 0.039 |
| **26-35 years** | 37 54.4% | 96 40.3% | 133 43.5% | |
| **>35 years** | 16 23.5% | 95 39.9% | 111 36.3% | |
| **Total** | 68 | 238 | 306 | |

Table 3: Association between Anatomical variations of position of vermiform appendix in relation to Gender

| Age -Group | Position | | | | | | | P-value |
|---|---|---|---|---|---|---|---|---|
| | Ectopic | Pelvic | Post cecal | Post ileal | Preileal | Subcecal | Total | |
| **Male** | 9 52.9% | 28 45.9% | 21 58.3% | 36 46.2% | 17 58.6% | 48 56.5% | 159 52.0% | 0.586 |
| **Female** | 8 47.1% | 33 54.1% | 15 41.7% | 42 53.8% | 12 41.4% | 37 43.5% | 147 48.0% | |
| **Total** | 17 | 61 | 36 | 78 | 29 | 85 | 306 | |

Table 4: Association of Appendicitis with anatomical position of vermiform appendix in adult urban Karachi population

| Position of vermiform appendix | Appendicitis | | | P-Value |
|---|---|---|---|---|
| | Yes | No | Total | |
| Ectopic | 0 0.00% | 17 7.1% | 17 5.6% | 0.019 |
| Pelvic | 12 17.6% | 49 20.6% | 61 19.9% | |
| Post cecal | 8 11.8% | 28 11.8% | 36 11.8% | |
| Post ileal | 27 39.7% | 51 21.4% | 78 25.5% | |
| Preileal | 4 5.9% | 25 10.5% | 9.5 85% | |
| Sub cecal | 17 25.0% | 68 28.6% | 85 27.8% | |
| Total | **68** | **238** | **306** | |

**DISCUSSION:**

Anatomical position of vermiform appendix is of great concern not only due to its evolutionary significance but also because of its surgical & pathological importance. Many controversies are present among the authors in context to different anatomical positions of appendix and due to their diverse classifications in the literature. According to many authors the vermiform appendix is the only organ of human body which has multiple anatomical positions in abdomen and its position varies from individual to individual. Due to lot of developmental disturbances during the midgut rotation, leading to multiple atypical positions of caecum and appendix. The normal position of vermiform appendix can be visualized by various non invasive imaging modalities. The MDCT has proved to be an excellent imaging modality for evaluation of vermiform appendix because of its excellent spatial resolution.[14] According to Gladstone and Wakeley study criteria, a total five anatomical positions of vermiform appendix were evaluated on MDCT (Multidetector computed tomography) in our study and its association with acute appendicitis.[15] In this study, we discussed classification based on anatomical position of appendicular tip on MDCT.[16]

In present study it was detected on MDCT subcecal is the commonest accounts for 27.8% (n=85), followed by postileal accounts for 25.5% (n=78) and pelvic accounts for 19.9% (n=61). The results of this study did not coincide with the results of previous studies by Wakely et al., (1933) and Tahir Iqbal et al., (2012) in which it was reported that retrocecal is the commonest position. This statement was not in accordance with the statistics which have been written in majority of Textbooks of Anatomy. Our study had similar findings with studies conducted in Korea. According to the results of Su Lim Lee et al, subcecal, postileal and pelvic were most commonly encountered than retrocecal position.[17] In cadaveric and postmortem studies gravity would be responsible to change the position of vermiform appendix, however in living subjects many factors e.g. gravity, gender, inflammatory condition, bowel pressure and gut movement would be responsible for the changing the anatomical position of vermiform appendix. The present study data might help for general experience of surgeons, histopathologist and anatomists.[18]

Gender wise the most common anatomical position of vermiform appendix in males was subcecal n=48 followed by postileal n=36 followed by pelvic=28. In females most common position of vermiform appendix noted was postileal n=42, followed by subcecal n= 37 followed by pelvic n=33. This result was not in contrast to the study Mohammadi S et al., 2017 who observed retroceacal position commonest in both genders followed by pelvic position.[19] Anatomically pelvis is divided into greater pelvis (false pelvis) which is considered as a part of abdominal cavity and lesser pelvis (true pelvis) which includes pelvic cavity. Female pelvis is more shallow and wide as compared to male pelvis. Higher frequency of subcecal, postileal and pelvic positions of vermiform appendix in males would be due to deep greater pelvis. There is a difference in anatomical location of male and female vermiform appendix which could be due to descent of testes and ovaries in males in females respectively.[20]

In Kenyan population Hemed El –busaidy et al(2014) identified on cadavers with the mean values age of 40.46 ± 20.99 years retrocecal position was the most commonest followed by pelvic position.[21] In present study the findings were analyzed in three age groups 18-25, 26-35 years, = 35 years in adult urban Karachi population and it was found that subcecal is most common anatomical position of vermiform appendix in two age groups 18-25 and =35 years but not in 26 -35 years of age group. According to age groups in this study subcecal was the most common position n=16 in the age group 18-25 followed by pelvic n=15, postileal n=15, preileal n=8, postcecal n=6 and ectopic n=2 position of vermiform appendix. In the age group 26-35 years postileal was the most common position n=41 followed by subcecal n= 31, pelvic n= 24, post ceacal n= 16 and preileal n=12.In the age group =35 years subcecal was the most common position n= 38 followed by pelvic n=22, postileal n=22, postcecal n=14, preileal n=9 and ectopic n=6.

The present study showed statistically significant (p= 0.05) associations between patient's age and occurrence of appendicitis. Increased incidence of appendicitis in adult urban Karachi population occurs between age group 26 to 35 years followed by =35 years. This statement was in accordance with Ibrahim et al; 2012.

Due to emergence of latest modality MDCT coronal and axial images helps in demonstrating the whole anatomic configuration of caecum, ileocecal valve and appendicular base. Appendix is considered to be the only abdominal organ which is most variable in anatomical position as observed by Yashwant et al., in 2018.[22] MDCT gives 99% accuracy in discriminating normal and from infected appendix. By knowing common anatomical positions of vermiform appendix association with appendicitis on MDCT will help on time accurate diagnoses of acute abdomen. Accurate knowledge regarding the anatomical position of appendix can help to improve prognosis of disease.

As far as our knowledge no study has been conducted yet in relation to anatomical positions of vermiform appendix and its association with appendicitis on MDCT in adult urban population of Karachi. Our study determined significant association between position of vermiform appendix and appendicitis (P=0.05). Interestingly in this study we noticed that postileal position of vermiform appendix was found more frequent in the inflamed group, means post ileal position strongly associated with appendicitis.

Most of the studies which observed higher percentage of retroceacal appendix were done on cadavers whereas studies

carried out on live subjects revealed different percentage for anatomical position of vermiform appendix.[23]

The most common anatomical presentation of appendix is descending intraperitoneal. Total 17 ectopic positions of appendix were found in this study mostly sub hepatic and near to femoral canal location. Recent advancement in abdominal CT imaging (MDCT) is superior due to improved imaging and easily visualization of normal and inflamed appendix.[24] This advancement as discussed earlier helped a lot to identify normal and variants of appendix. In present study remarkable difference in anatomical position of vermiform appendix was noted on MDCT of patients with acute abdomen as compared to other cadaveric studies.[25]

Subcecal 27.8% position was most common in this study followed by postileal 25.5% followed by pelvic 19.9% as compared to pelvic position 41.83% followed by retrocecal 35.95% followed by postileal in Karachi population on cadaveric study done in 2017. In a study conducted by Usman Ali et al reported retrocecal position was commonly associated with appendicitis on ultra sonograms abdomen.

Limitations of this study were that the data was collected retrospectively, limited number of patient's MDCT identified and done in single institution. Although plain MDCT is an excellent diagnostic tool for appendicitis however radiation exposure limits its use particularly in pregnant women.

## CONCLUSION:

The results of this study highlighted that the subcecal was the most frequent anatomical position of vermiform appendix and the postileal position was the most frequent position in inflamed appendix on MDCT in Karachi based population. For preliminary and quick diagnosis our study has provided the gross data on anatomical position wise variation of vermiform appendix and its association with appendicitis which is necessary for appropriate diagnosis and treatment of acute appendicitis.

**Authors Contribution:**
**Lubna Faisal:** Substantial direct
**Rizwan Ajmal:** Substantial intellect
**Fatima Rehman:** Contribution to the conception
**Zia ul Islam:** design
**Sadia Abdul Qayyum:** analysis
**Saima Athar:** Interpretation of data

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