

# A Case Series on Variations in Location of Vermiform Appendix: Revisited with Computed Tomography

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## ABSTRACT

The appendix is known to have varying locations and extents in relation to the cecum, to which it is attached in the main gastrointestinal tract. These variations have significant implications in terms of the varying clinical presentation of appendicitis, which may deviate from the classical presentation in the right iliac fossa and thus delay diagnosis. Knowledge of the different positions of the appendix helps in identifying the relatively common pathology of appendicitis, which may occur even beyond the confines of the right iliac fossa. This imaging case series depicts the spectrum of variations in the locations of the appendix as seen on Computed Tomography (CT) in a comprehensive though simpler way. The types of appendix illustrated in this imaging case series include the medial appendix with its subtypes (postileal-3, pelvic-2), subcecal (3), retrocecal (2), paracecal (1), and prececal appendix (1). In cases of the acute abdomen where appendicitis is suspected and if the appendix is not identified or only partly traced in the right iliac fossa, attempts should be made to trace the entire appendix in unconventional locations in the abdomen-pelvis. Such a scenario might be more likely if the patient is only experiencing distal appendicitis.

**Keywords:** Paracecal, Pelvic appendix, Prececal, Retrocecal, Subcecal

## INTRODUCTION

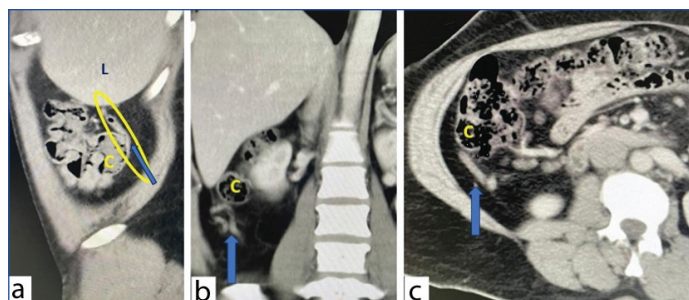
The appendix is variable both in its location as well as length. Variations in locations are described in anatomical as well as radiological literature [1-4]. These variations are important as there might be clinical implications, and certain variations may make it difficult for the appendix to be localised on ultrasound. Knowledge of the different positions of the appendix in different individuals helps in identifying a diseased appendix even in uncommon locations and avoids misdiagnosis or may obviate the need for some other investigations. It is important to know about these because of varied clinical presentations resulting from inflammation of the appendix in differing locations [3]. According to locations, the appendix has been traditionally classified as postileal, preileal, pelvic, subcecal, retrocecal, paracecal, pelvic, and others, including ectopic appendix [1-4].

## CASE SERIES

In this imaging case series, the focus is on variations in the location of the appendix as seen on CT. All cases illustrated here are in the adult age group, and none had a history of surgery in a relevant anatomical area. For the sake of simpler as well as a comprehensive understanding, cases under this series were discussed under the following broad categories: 1) Posterior (Retrocecal); 2) Anterior Pericecal (prececal); 3) Medial (further subclassified into preileal, postileal, pelvic, and promontory type); 4) Lateral-paracecal; 5) Inferior-subcecal appendix.

**Posterior (Retrocecal) appendix:** A retrocecal appendix, after its origin from the cecum, turns posteriorly to lie behind the cecum and may ascend superiorly to the ascending colon or even to the inferior surface of the liver. Among the two cases illustrated here, in one case, the retrocecal appendix extended to the inferior surface of the right lobe of the liver, with the tip of the appendix closely abutting the liver surface [Table/Fig-1a]. In another case, it extended to the mid-ascending colon level, with the distal segment having a looped configuration [Table/Fig-1b,c].

**Inferior-subcecal appendix:** The appendix extends inferiorly below the cecum, lying on the iliacus muscle with intervening



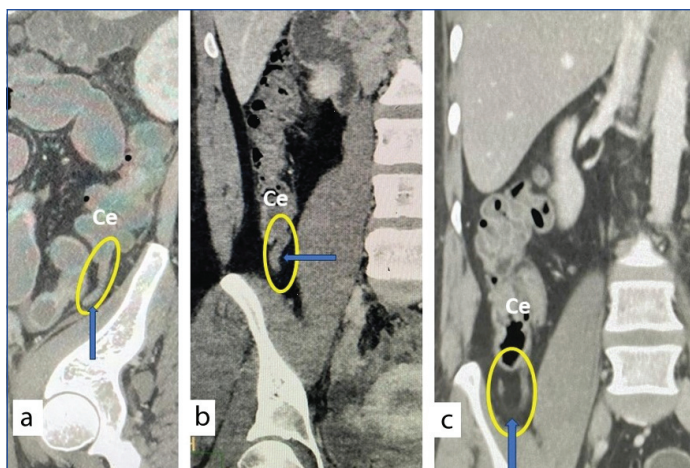
**[Table/Fig-1]:** Retrocecal appendix in two cases. Sagittal reformatted CT image: a) Showing appendiceal tip till inferior surface of the liver (encircled and blue arrow); Coronal and axial CT images; b,c) Showing appendix till mid-ascending colon level with looped configuration (blue arrow). C: Cecum

peritoneal lining. In the three cases illustrated here in this group, two had short, almost straight appendices extending from the cecum to the ilio-psoas groove [Table/Fig-2a,b], while in one case, the subcecal appendix made a lateral U-turn towards the cecal base [Table/Fig-2c].

**Medial appendix:** In this case series, among the five medial appendices, the appendix was elongated, measuring 6 to 15 cm in length. In one case, a long appendix was seen having a serpiginous course and extending to the right paramedian location [Table/Fig-3a-d], and another was having an almost horizontal course extending to the right paramedian location of the mid abdomen [Table/Fig-3e]. These both were postileal appendices. In another case, the postileal appendix was descending vertically down to a level just above the iliac crest level. In this case, the cecum was also a high-lying type in the mid-flank region without any obvious pathology [Table/Fig-3f,g]. Two cases were of pelvic appendices. In one case, the appendiceal tip was noted along the right iliac vessels [Table/Fig-4a,b]. In the other case, the appendix extended to the deep pelvis, coursing anterior to the iliac vessels and descending along the lateral pelvic wall [Table/Fig-4c,d]. In both cases, the appendix was closely abutted to the external iliac vessels.

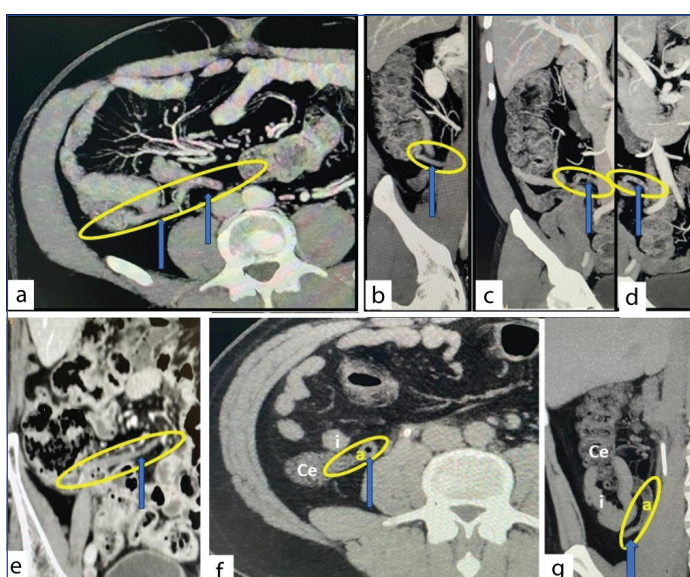
**Lateral-paracecal:** The paracecal appendix, after its origin from the cecum, turns laterally and courses towards the right flank along the





**[Table/Fig-2]:** Subcecal appendix in three cases (a-c). In two cases, sagittal (a) and coronal (b) Reformatted CT images showing short appendices extending from cecum to ilio-psoas groove; in another case coronal CT image (c) Showing lateral U turn towards cecal base.

All appendices are encircled and indicated with blue arrow; Ce: Cecum



**[Table/Fig-3]:** Medial Appendix. Oblique axial (a) and coronal; (b-d) CT images showing medial long postileal appendix with serpiginous course; (e) Oblique coronal CT image showing almost horizontal medial appendix, it was also postileal; (f,g) Oblique axial and coronal CT image showing postileal appendix having vertical downwards course along lateral margin of psoas muscle.

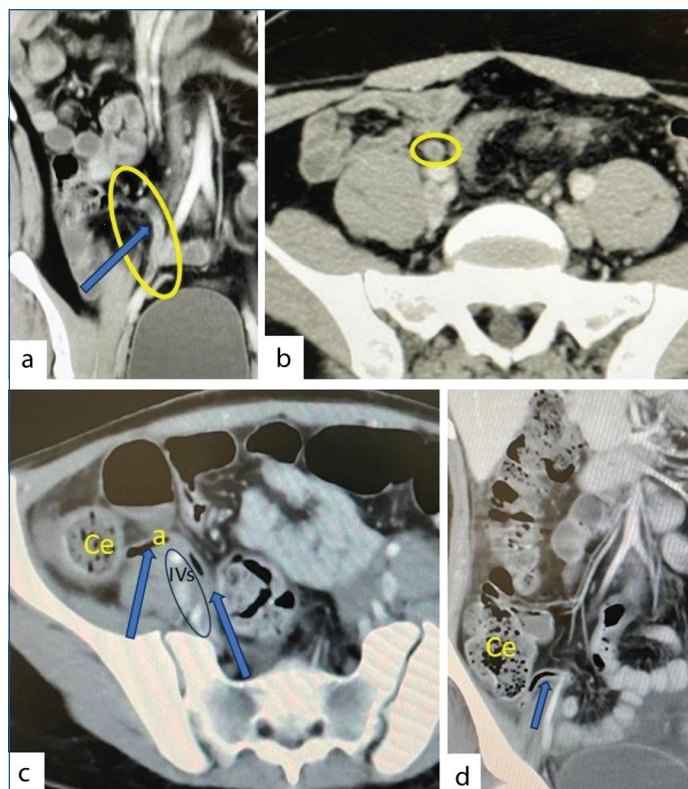
a: Appendix, Ce: Cecum, i: Ileum; appendix encircled in yellow; blue arrows pointing at appendix

lateral margin of the cecum. In the case shown here, the appendix, after coursing downward for a short distance, turned laterally with its tip close to the lateral wall of the cecum [Table/Fig-5].

**Anterior-prececal:** It is also an uncommon type of appendix. The appendix courses anteriorly to lie along the anterior aspect of the cecum. An anterior prececal appendix is relatively easier for surgical access [5]. In the case illustrated here, the appendix was found to be turned anteriorly and lying as a looped tubular structure on the anterior wall of the cecum, and beneath a laterally placed ileal segment [Table/Fig-6].

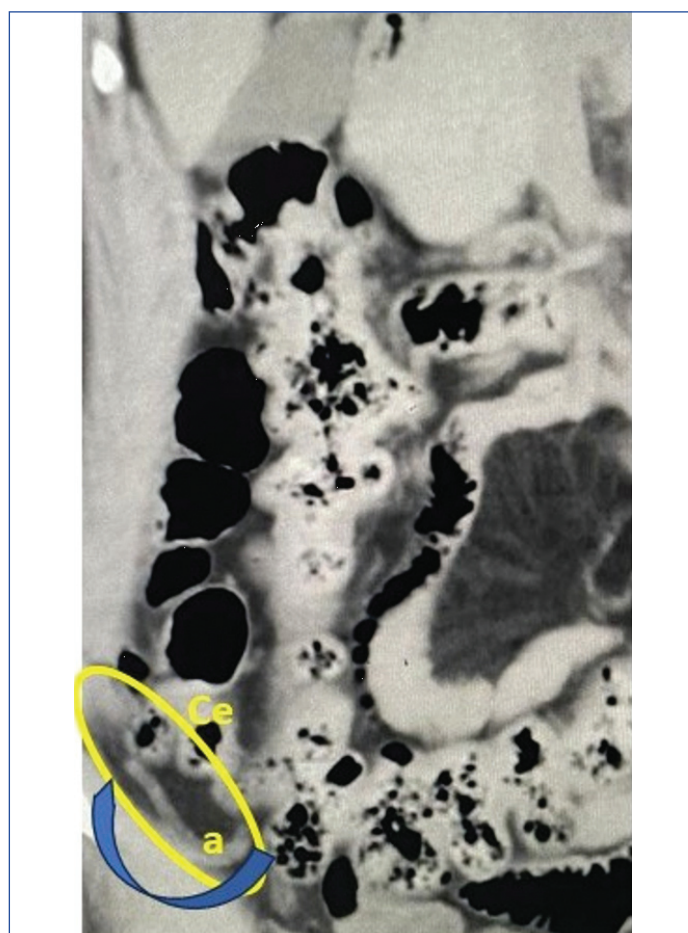
## DISCUSSION

In imaging studies, the appendix is usually visualised as a thin, blind-ending tubular structure of a smooth outline and varying length, arising from the lower posteromedial aspect of the cecum and coursing variably from the right iliac fossa to adjoining abdominopelvic locations [6]. In the majority of individuals, a normal appendix measures 6 to 7 mm in the outer wall-to-wall diameter; however, a normal appendix with a diameter up to 10 mm has also been reported. A larger diameter in a normal appendix may be due to intraluminal contents such as air or fluid, with single-wall appendiceal thickness usually <3.0 mm [6-8]. Ultrasound and CT



**[Table/Fig-4]:** Pelvic appendix in two cases. Oblique coronal and axial CT images (a,b) in one case showing appendiceal tip lying over iliac vessels (encircled in yellow). In other case axial and coronal CT images (c,d) Showing long air filled appendix (blue arrows) coursing anterior to right iliac vessels and lateral pelvic wall.

Ce: Cecum, a: Appendix; IVs: Iliac vessels

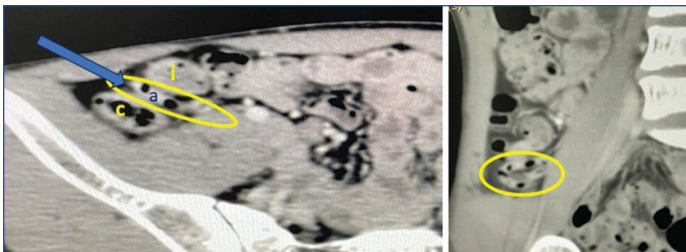


**[Table/Fig-5]:** Subcecal/Paracecal Appendix: coronal CT image showing appendiceal tip reaching till lateral margin of cecum.

a: appendix, Ce: Cecum; curved blue arrow indicating course of appendix

are the two most common imaging modalities used in the evaluation of suspected appendicitis, with the sensitivity of CT being higher than that of ultrasound. The lower sensitivity of ultrasound in the





**[Table/Fig-6]:** Anterior Prececal Appendix: Axial and coronal CT images showing appendix lying along anterior wall of cecum (encircled in yellow).  
Ce: Cecum, a: Appendix; i: Ileal segment

visualisation of the appendix is multifactorial, including variations in the location of the appendix and dependency on the operator. Also, CT is the first-line recommended imaging modality if appendicitis is suspected in adult patients [9-11].

In a large study by Wakeley CP (10,000 cases), the appendix was retrocecal in 65.28% of cases followed by pelvic (31.01%), subcecal (2.26%), preileal (1%), and postileal (0.4%) position [1]. In a study by de Souza SC et al., the retrocecal appendix was seen in 43.5% of cases, followed by other types including subcecal: 24.4%, postileal: 14.3%, pelvic: 9.3%, paracecal: 5.8%, preileal: 2.4%, and other positions: 0.27% [2]. In a cadaver-based study by Patra A et al., the retrocaecal appendix was found in 48.9% followed by pelvic in 27.7%, with three cases each of preileal, postileal, and promontoric (6.4%), one case (2.1%) each of paracaecal and subcaecal. However, the study had a small sample size (n=47) [3]. In another study by Ojeifo JO et al., involving the Nigerian population, the retrocecal appendix was seen in 45.07% of cases, with others being pelvic (25%), postileal (14.78%), paracecal (6.39%), subcecal (2.37%), preileal (1.82%), and ectopic (4.74%) [12]. Contrary to this, in a recent study on the South Korean population by Lee SL et al., the retrocecal appendix was found to be a less common type. The positions of the appendix reported in this study were as follows: type 1 (antececal): 3.5%; type 2 (preileal): 1.7%; type 3 (postileal): 9.0%; type 4 (subileal): 12.9%; type 5 (subcecal): 42.3%; type 6 (deep pelvic): 16.2%; type 7 (retrocecal): 10.9%; and type 8 (paracecal): 3.0% [4].

In a CT-based study by Altunkas A et al., the pelvic appendix was the most common (32%), followed by subcecal (23%), retrocecal (18%), postileal (18%), preileal (6%), and paracaecal (3%) appendices [7]. In a study by Keyzer C et al., using CT, the locations of the appendix with respect to the cecum were reported as anterior (3.1%), lateral (10.2%), medial (54.1%), or posterior (32.6%) [8]. In another study by Suval et al., in the Nepalese population, the pelvic appendix was the most common type followed by the retrocecal appendix [13].

In a large surgical Indian study by Chidambaram B et al, the retrocecal appendix was the most common (86%), followed by pelvic (11%), postileal (10%), preileal (10%), subhepatic (0.8%), paracolic, and subcecal (0.1%) [14]. In another Indian CT-based study by Singh N et al., the retrocecal location was the most common (25.3%) for the appendix, followed by other types including subcecal (20.3%), postileal (18.7%), pelvic (16.5%), preileal (7.9%), promontory (7.9%), and paracecal (3.1%) locations [15]. Ectopic appendix is a rare entity and may be a challenging entity. It has been reported as part of a malrotation with an appendix on the left side [16] and as a right-sided appendix in a very unusual location such as the deep gluteal region [17].

As far as the clinical implications of these variations are concerned, they may also vary according to the locations of the appendix. Apart from the extension of infective-inflammatory changes in adjacent small and large bowel loops in all types of appendices, there might be involvement of other structures according to the locations of the appendix. High retrocecal appendicitis may be complicated

by liver abscesses or renal infections. Similarly, it may mimic acute abdomen due to hepatic abscesses or renal infections [18-20]. Pelvic appendicitis, in fact, may mimic other causes of acute pelvic pain such as ureteric colic, cystitis, or in females, tubo-ovarian infections and pelvic inflammatory diseases [21,22]. Retrocecal and subcecal appendicitis may also be complicated by ilio-psoas abscesses [23]. Vice versa may also happen. Subcecal, paracecal, retrocecal, and prececal appendices, due to relatively close relation to abdominal walls, if inflamed, may be complicated by abdominal wall abscesses [24]. Variations in the locations of the appendix are wide-ranging with varying frequencies, and clinical presentation, at least initially, will largely depend on the location of the appendix, and it may mimic other pathologies in that location.

## CONCLUSION(S)

The vermiform appendix is known to have wide-ranging variations in its locations in relation to the cecum, and a pre-existing knowledge of these variations is important for radiologists as well as surgeons to suspect and evaluate a common pathology such as appendicitis, sometimes even in uncommon locations.

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