

# Developmental Anomalies of the Midgut: Focus on Undescended Caecum and Its Surgical Importance

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## Abstract

**Background:** Congenital abnormalities of the caecum and colon are rare and result from malrotation of the midgut loop around the long axis of the superior mesenteric artery during fetal development. Normally, the caecum descends to the right iliac fossa by the 11th week of gestation. Failure of this descent results in a persistent subhepatic caecum, a rare congenital anomaly presents with significant clinical implications. **Material and Methods:** A descriptive observational study was conducted in the Department of Anatomy from 2023 to 2025 to observe and analyse morphological variations in caecum during routine dissection of 62 adult cadavers as apart of MBBS curriculum. **Results:** Among 62 cadavers (48 males, 14 females), the caecum was located in the right iliac fossa in 57 cases (91.9%). Positional anomalies attributable to midgut malrotation were observed in 5 cadavers (8.1%). These included subhepatic (3.2%), subhepatic without ascending colon (1.6%), and lumbar (3.2%) positions. Variations were commonly associated with a retrocecal appendix and abnormalities of the ascending colon. **Conclusion:** Atypical positioning of the caecum can complicate diagnosis, particularly in conditions such as appendicitis, which may present with atypical symptom localization. Awareness of the subhepatic caecum and its embryological development is essential for clinicians and surgeons to prevent misdiagnosis and avoid complications during abdominal surgery.

**Keywords:** Cecum abnormalities, Intestinal Malrotation, Intestinal Obstruction, Appendicitis.

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## INTRODUCTION

Midgut malrotation encompasses a series of congenital anomalies resulting from incomplete or abnormal rotation and fixation of the intestinal tract during fetal development. It is typically identified in neonates and infants with bilious vomiting or intestinal obstruction, but can also be an asymptomatic or later disease with inspecific abdominal symptoms and is therefore not always diagnosed in adults. [1,2]

Intestinal malrotation may be a hard diagnosis to make and treat because the condition is not an isolated congenital anomaly, but a continuum of abnormalities called by the arrangement and fixation of intestinal position and peritoneal. The great variety of anatomical variability forms a spectrum between minor variations (intestinal orientation) and total non- or even inverted rotation. This results in varied clinical complexity and varied patient presentation. [3]

An undescended caecum is one of the outstanding variants of the anatomy of patients with midgut malrotation. When inciting embryogenesis Under normal conditions, caecum after existing as a cecal bud forms on the post-arterial part of the abdominal loop of the midgut by the 11th gestational week. The descent is however incomplete or arrested, however, in malrotation cases resulting in an ectopic position of the caecum in the subhepatic area, or periumbilical area or even to the left side of the abdomen. [4,5]

Abnormal location can result in a difficult diagnosis especially in the case of appendicitis where the point of localization to the expected location may not be the same. The awareness of the usual embryological development and atypical location of the subhepatic caecum is what allows clinicians and surgeons to avoid mistakes in diagnoses and prevent complications intraoperative abdominal operations. [1,2]

The malpositioned caecum leads to the formation of bands (fibrous bands) which run along the duodenum to the right lateral peritoneum and they may compress it resulting in extrinsic obstruction.

The undescended caecum is therefore a developmental indicator of interrupted or incomplete midgut rotation and is a significant diagnostic indicator during the assessment of intestinal obstruction particularly in children. Besides, its occurrence in adults may confuse in the diagnosis of abdominal conditions as the localization of pain or pathology is not classical

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anatomically.<sup>[6]</sup>

Nevertheless, these implications do not diminish the fact that the undescended caecum spares little mention as far as midgut malrotation is concerned. This paper will close this gap by reporting adult cadavers who have the midgut malrotation with undescended caecum and ways it would be clinically relevant, diagnosis, and outcome of the surgery. The research offers meaningful information to clinicians, radiologists, and surgeons so that they can learn to improve knowledge of such a complicated condition and how to manage it.

## MATERIALS AND METHODS

**Study Design and Setting:** It is a descriptive observational study that will be conducted in 1st year MBBS students in authors institutes during gross anatomy dissection practical in 2023-2025 in accordance with National Medical Commission curriculum.

### Cadaver Selection

The number of embalmed adult cadavers (48 men, 14 women) comprised 62 cadavers.

### Inclusion criteria:

The inclusion criteria should be donated cadavers estimated aged 40-80 years at death, intact abdomen of cadaver, well-preserved without significant formalin artifacts.

### Exclusion criteria:

History of abdominal operations (e.g. appendectomy, colectomy), congenital defects (e.g. situs inversus), traumatic abdominal trauma, severe decomposition, or poor embalming.

**Dissection Procedure:** This was done by groups of 10-12

first year MBBS students who were actually supervised by the faculty of the Department of Anatomy. A typical laparotomy via the midline was taken:

- Vertical cut of the skin between xiphoid process and pubic symphysis.
- Anterior abdominal wall flap reflections.
- INCISION peritoneum in right paracolic gutter reaching right iliac fossa and ascending colon. The most essential anatomical landmarks were: ileocecal junction, convergence of taeniae coli, appendicular orifice, ileocecal valve, and psoas major muscle. The caecum was also mobilized completely by dissection of lateral peritoneal attachments, keeping the cadaver in the supine position.

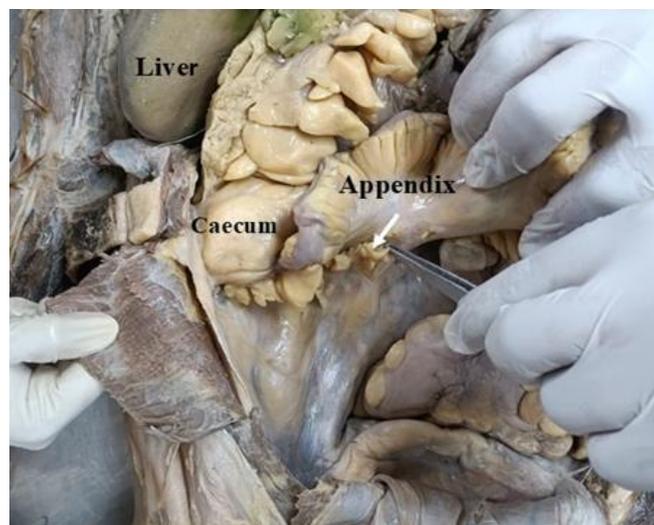
**Data Collection and Recording:** Location of caecum was categorized using its relation to right iliac fossa, pelvic brim, and adjoining structures into normal, pelvic, subhepatic, midline, or ectopic position according to descriptions in Gray Anatomy.<sup>[7]</sup> Observations were independently recorded by two anatomy faculty members, with inter-observer verification performed to resolve discrepancies. Standardized dissection steps, a predefined recording format, and photographic documentation were used to minimize observer bias. Variables recorded included sex of the cadaver and position of the caecum. Data were analysed using descriptive statistics (frequency and percentage) with Microsoft Excel and SPSS software.

## RESULTS

A total of 62 cadavers were examined in the present study, comprising 48 males and 14 females. The position of the caecum was assessed and categorized into subhepatic, hepatic, lumbar, and right iliac positions [Table 1].

**Table 1: Showing the different type of positions of the caecum.**

Sr. No	Position of Cecum	Number of Cases	Male Cadaver	Female Cadaver
1	Subhepatic	02 (3.2%)	02	00
2	Subhepatic without ascending colon	01 (1.6%)	00	01
3	Lumbar	02 (3.2%)	01	01
4	Right iliac	57 (91.9%)	45	12
	Total	62 (100%)	48	14

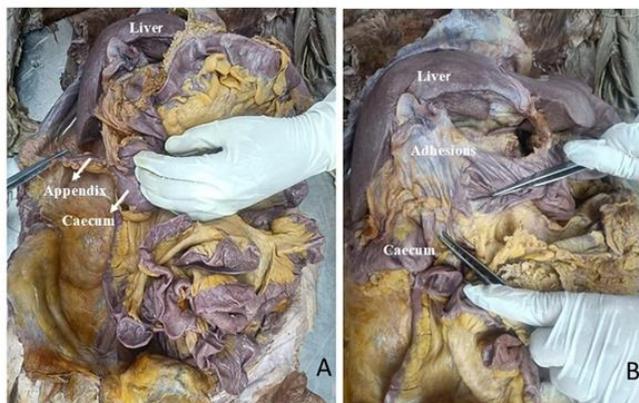


**Figure 1: Showing the subhepatic type of caecum with appendix at 3 o'clock position hidden behind the caecum and ilium.**

The right iliac position which was the most common observed in 57 out of 62 cadavers (91.9%), including 45 males and 12 females. It was representing the normal anatomical location.

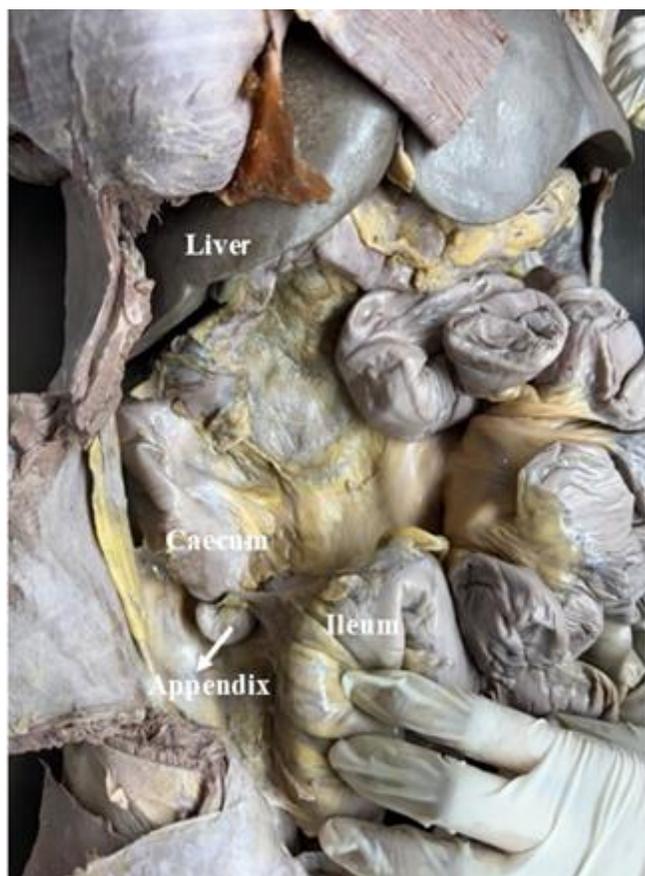
Positional anomalies of the caecum probably caused due to midgut malrotation were observed in 5 cadavers (8.1%). Among these, the subhepatic position was observed in 2 cases (3.2%), both of which in male cadavers. In these cases, the caecum was located in the right hypochondrium, immediately inferior to the liver, and the appendix was consistently found in a retrocecal position as shown in [Figure 1].

A subhepatic position of the caecum without ascending colon was observed in 1 cadaver (1.6%), occurring in a female cadaver. This case represented the most extensive anatomical variation. The caecum was located sub hepatically with a retrocecal appendix and was associated with complete absence of the ascending colon. Additional findings included adhesions between the liver, gallbladder, and transverse colon, along with an elongated descending colon and a dilated sigmoid colon shown in [Figure 2].



**Figure 2:** A- Showing the subhepatic type of caecum in which the ascending colon is absent so that it continues with transverse colon. Appendix is at 9 o'clock position. B- After reflecting transverse colon the adhesions between the liver, gallbladder, and transverse colon seen.

The lumbar position of the caecum was identified in 2 cadavers (3.2%), one male and one female. In both cases, the caecum was situated in the lumbar region and was associated with a short ascending colon. The appendix and ileocecal junction were found in retrocecal positions in these specimens as shown in [Figure 3].



**Figure 3:** Showing the lumbar variant caecum, situated in the lumbar region, associated with a short ascending colon and retrocecal positions of both the appendix and the ileocecal junction.

Overall, the study demonstrates that while the right iliac position of the caecum predominates, a small but clinically significant proportion of cadavers exhibit positional anomalies related to midgut malrotation.

## DISCUSSION

Failure of the descent can be caused by the malformation of lengthening of the ascending colon, the shortening of the right mesocolon, or fetal adhesions of the peritoneum. The most common, the retrocecal location of the appendix, observed in this case, is said to occur in 65-70% of people.<sup>[8]</sup> In the current research, both the cases of subhepatic caecum bore retrocecal appendix.

Such a position anomaly has clinical significance. Acute appendicitis in them can have the right upper quadrant pains that mimic cholecystitis, hepatic abscess or even peptic ulcer disease. The misinterpretation of radiological investigation is prevalent unless the clinical suspicion is high and the imaging (CT, USG) is detailed. Laparoscopic appendectomy may require repositioning of trocars due to the abnormal location of the caecum and appendix.

Subhepatic caecum with complex adhesions and absent ascending Colon likely represents a congenital malrotation with mesenteric malfixation, possibly compounded by perinatal peritoneal inflammation or developmental adhesion bands (Ladd's bands). These could have limited the descent and mobility of the colon, anchoring it in the upper abdomen.<sup>[4,5]</sup>

Chronic intermittent intestinal obstruction may occur due to volvulus or extrinsic compression by adhesion bands. Such case may create confusion in interpreting barium studies or colonoscopy findings. Further it increases the risk of complications during cholecystectomy or hepatic surgeries, due to adherence of bowel to the hepatobiliary structures.

Comparatively, a study by Applegate et al. (2006) noted that non-rotation and malrotation can manifest variably across patients and may remain asymptomatic or present acutely, depending on associated complications like volvulus or internal hernias.<sup>[9,10]</sup>

In the lumbar caecum, the caecum was observed in the lumbar region, with a short ascending colon and retrocecal position of both the appendix and the ileocecal junction. This variant may be attributed to partial rotation arrest with a limited cecal descent and shortened right mesocolon.

Difficulty in colonoscopic navigation due to shortened or abnormally angled ascending colon.

Increased risk of retroperitoneal misidentification during right-sided urological or orthopedic procedures. Higher chance of atypical symptoms in ileocecal tuberculosis or Crohn's disease localized to the terminal ileum. Few studies have similarly reported retrocecal and undescended caecum cases, highlighting the importance of awareness among Clinician.<sup>[11-13]</sup>

### Embryological Insight

All three variations reinforce the importance of understanding midgut embryogenesis. Between the 5th and 10th weeks of gestation, the midgut herniates and rotates around the Superior mesenteric artery. At the end of this rotation, the caecum is expected to reach the right lower quadrant by the 12th week. Arrest in this movement or improper fixation leads to these anomalies.<sup>[14]</sup> The absence of the ascending colon, as seen in one

case, may indicate a failure of post-rotational elongation. The clinical implications of undescended caecum are high. Anterior displacement of the caecum can result in a diagnosis error with diseases like appendicitis, in which right lower quadrant pain is non-classical. Also, the duodenal obstruction can be caused by the Ladd bands (fibrous peritoneal adhesions) which stretch all the way up to the posterior abdominal wall through the misplaced caecum. In addition, narrow mesenteric base exposes bowel to volvulus which is a life-threatening emergency in surgery.<sup>[8,9]</sup>

The findings of autopsy do reveal the existence of some sort of intestinal malrotation in the population, which may be about 0.5 to 1 percent. It is known that many people with such a condition admit to adulthood without being detected. But even the percentage of such patients that ultimately come up with gastrointestinal symptoms of malrotation is uncertain.<sup>[3]</sup> King in 1955 was the first to describe subhepatic appendicitis, but other reports have been few since then and include reports of missed diagnosis resulting in perforation. Interestingly, there is a relative scarcity in literature related to treatment of subhepatic caecum in case of its presence alongside appendicitis. In earlier years, Lockwood in 1892 and Treves in 1885 had reported cases at the autopsy table, and Robinson had described two out of 130 necropsies. A study by Smith in 1911 involving 1050 infant autopsies (most of them less than three months old) found that cecal descent had failed in 6 percent. Cases have been occasionally reported by surgeons when found during a surgical procedure; Jonas gave 11 examples of arrested development of intestines with three having the appendix in the gallbladder area. However, in case the appendix is located excessively high, acute appendicitis can confuse with acute cholecystitis, making it difficult to diagnose and treat.<sup>[15]</sup>

Patients who have intestinal malrotation can be characterized by an extended background of unspecific gastrointestinal symptoms, such as frequent abdominal pain, vomiting, and diarrhea. These symptoms are often mistaken to milk allergy or gastroenteritis. Positive diagnosis is made usually with the help of upper gastrointestinal contrast studies which demonstrate malrotation. This puts into perspective the diagnostic difficulties in the chronic malrotation and the paramount importance of early diagnosis and prompt intervention.<sup>[16]</sup>

**Radiological and Surgical Significance:** The use of modern imaging studies like MDCT, MRI and ultrasound has enhanced preoperative detection of such anomalies. but unless particularly mentioned, subhepatic caecum may pass Unnoticed.<sup>[12]</sup>

To avoid needless harm or even open surgery, surgeons doing surgeries like Laparoscopic appendectomy, Right hemicolectomy, Retroperitoneal surgeries have to expect these changes.

A strange positioning may also complicate the intervention of obstetric surgeries or renal surgeries in which the cecal positioning in the back may make a retroperitoneal approach difficult.

**Incidence and Comparison with Literature:** Although prevalence-based research on undescended caecum existing in large-scale has been scarce, cadaveric data reports

incidence ranging between 2 and 8 with our result keeping in line with this finding of 9.3. Although, however, variation 2 is merely a compound variation, which is seldom recorded in books, or in atlases, and this shows the originality of our Observations.<sup>[7,8]</sup>

#### Limitations of the Study

There are restrictions to the current study. The sample was also quite small consisting of 62 cadavers potentially limiting its future applicability to the rest of the population. Since the observations were conducted entirely on cadaveric observations only, radiological correlation and clinical records were not available and therefore interpretation of clinical relevance and whether the observed abnormalities were symptomatic in life was not possible. Moreover, histopathology of the adhesion was not possible and, therefore, it was challenging to differentiate between the original variations in anatomy and adhesions due to inflammatory or fibrotic events acquired.

**Implication of Teaching and Training:** Such anatomical differences ought to be highlighted in the process of undergraduate dissection, radiology, and surgical training. In practice-based clinical situations, anatomical awareness can be an important factor in low morbidity because of a false diagnosis or surgery error.

#### CONCLUSION

This is an influencing series that establishes undescended caecum as a progressive and underreported manifestation of midgut malrotation, which adds to delays in diagnosis and diversity of clinical manifestations. An in-depth knowledge of embryology and anatomy variations play an important role in the treatment of such cases. Histopathological examination is a helpful supplementary method in the confirmation of ischemic alterations and the rejection of other types of diagnoses. The important aspect of contributing good results in such patients has been the early diagnosis, proper imaging and prompt surgical intervention.

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#### Conflicts of interest

There are no conflicts of interest.

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