IBOM MEDICAL JOURNAL
Vol.19 No.1 | January - March 2026 | Pages 267-271
www.ibommedicaljournal.org

A Right-Sided Megasigmoid Colon with Elongated Rectum: Embryological Basis and Clinical Significance

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Abstract

Sigmoid colon and rectum represent the distal segments of the large intestine. Their associated anatomical variants usually identified incidentally during radiological or surgical interventions. The present report details right-sided mega sigmoid colon associated with elongated rectum (abdominal-pelvic rectum) observed in a 51-year-old formalin embalmed male cadaver. This existence highlights attention during planning and implementation of radiological and surgical procedures involving the lower abdomen and pelvic visceral.

Keywords: right-sided sigmoid colon; abdominal-pelvic rectum; variations

Introduction

The Sigmoid colon represents an inferior S-shaped portion of the colon that connecting descending colon to the rectum. Usually is located in the pelvis (pelvic colon) rising from the left iliac fossa looping into pelvic cavity and covered by sigmoid mesocolon that begins from its junction with descending colon (iliac colon) and disappears at the end of the loop connecting to the rectum. It is not fixed to the posterior abdominal wall compared to other segments of the large intestine, henceforth, represents the most mobile portion of the colon in the human being. Due to its gross anatomical morphology and mesocolic axis, the sigmoid colon has been frequently affected with volvulus (sigmoid volvulus) causing large bowel obstruction[1,2] and sigmoid vascular obstruction.

The rectum constitutes the most distal portion of the large intestine, originating at the junction with the sigmoid colon at the level of the third sacral vertebra (S3) and terminating at the anal canal.[3,4] It typically measures between 12 and 15 cm in length and is anatomically subdivided into two distinct regions: the superior segment, which conforms to the curvature of the sacrum, and the inferior segment (the rectal ampulla).

Different kind of anatomical variations involving the sigmoid colon[5,6] and rectum has been reported previously, however, the present study highlights the novel observation that were made during the routine dissection class of the postgraduate's medical students. It details a case of a mega right-sided positioned sigmoid colon associate with an abdominal-pelvic rectum. Knowledge on the existence of these morphological variations in our societies, highlights their clinical importance's.

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DOI: 10.61386/imj.v19i1.941

Case Report

During routine dissection of the peritoneal cavity of the abdominal region to observe the insitu gross anatomical positions and respective relations of the intraperitoneal visceral organs on a 51-year-old formalin embalmed male cadavers at the Department of Anatomy, School of Medicine and

Dentistry, University of Dodoma in 2023 for first year surgical residents, a unique right-sided mega sigmoid colon and an abdominal-pelvic rectum were observed on the abdomen. This cadaver has been used following all local and international ethical guidelines and laws on the use of human cadaveric specimen for medical education and research (hence, institutional ethical approval excluded).

The anterolateral abdominal wall was dissected and opened as per grants dissector manual to expose the underlying structures with intent to observe the insitu contents of the peritoneal and pelvic cavities. Insitu placement of small and large intestines and their peritoneal reflections were studied in detail before being separated (Figure 1). Quantitative assessment of external diameters and lengths were conducted across multiple segments of the sigmoid colon using a digital precision calliper and a standard ruler.

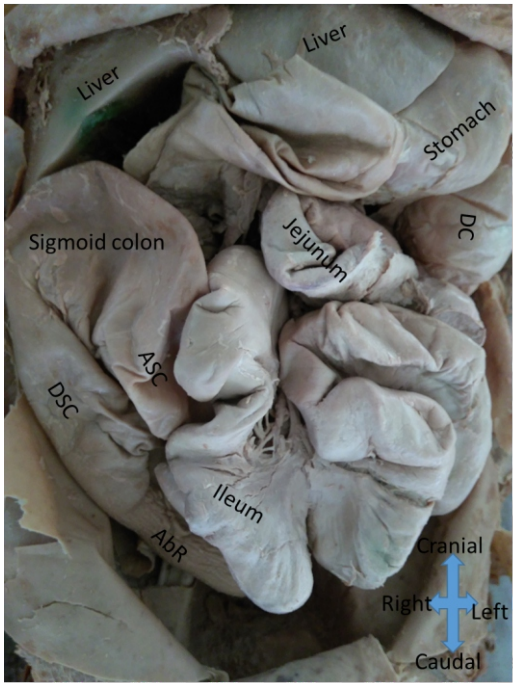

Figure 1: Abdominal contents after reflection of the anterolateral abdominal wall. Note the right position of the Sigmoid colon. Ascending (ASC) and Descending (DSC) limbs of Sigmoid colon. AbR: Abdominal Rectum, DC: Descending colon.

The descending colon (DC) measured 19.2 cm long with vertical, oblique and horizontal segments. The vertical segment of the descending colon extended from first lumbar (left hypochondriac region) to fourth lumbar (left lumbar region) vertebral level and then it turns Medio-inferiorly towards the midline forming a straight oblique segment of the DC measured 2.2 cm long into the left iliac region (fossa). It then forms the horizontal segment measured 3.5 cm long that extended from the superior part of left iliac to umbilical region, crossing the midline at 1 cm above the level of left pelvic brim towards the right side (Figure 2). All the way through this course, the DC remains retroperitoneal in position and covered by DC mesocolon. On its way from left to umbilical region, the DC crossed anterior (above) of the left gonadal vessels, left ureter, left genitofemoral nerve, left psoas muscles, and abdominal aorta, leading to compression of these anatomical structures. At the midline the DC enters the peritoneal cavity to become the sigmoid colon (Figure 2).

The sigmoid colon ascends superiorly from the umbilical region into the epigastric region and medial part of the right iliac region then turn to the left into the right hypochondriac region and occupies the right sub-hepatic region displacing the transverse colon aside (Figure 1). Here, at the level of hepatic flexure of the colon (junction between ascending and transverse colon) it formed a kink loop entering the right lumbar region compressing the ascending colon while displacing the small intestines to the left. It continues descending obliquely into the right iliac region compressing the ascending colon, caecum and ileum coils.

The sigmoid colon exhibited a total length of 52.6 cm, with notable variations in width (external diameter) along its course: Proximal segment (descending colon-sigmoid junction): 4.5 cm in external width (9 cm diameter); Midsegment (inverted U-portion): 8.4 cm in external width (16.8 cm diameter); Distal segment (rectosigmoid junction): 6.1 cm in external width (12 cm diameter).

The rectosigmoid junction was anatomically demarcated at the superomedial margin of the right iliac region, corresponding to the level of the fourth lumbar vertebra (L4). This transition was characterized by: Cessation of sigmoid morphological features (haustra, teniae coli, and omental appendices), and appearance of rectal columns (columns of Morgagni), indicating the

commencement of rectal mucosa (Figure 2).
Remarkably, the sigmoid colon maintained an exclusively intra-abdominal position, failing to descend into the pelvic cavity. Thus, it was classified as a complete abdominal sigmoid colon rather than a pelvic (or descending) sigmoid colon (Figure 2).
The rectum originated at this junction, measuring 18.6 cm in length with a uniform external width of 3 cm. Its trajectory followed an inferomedial descent into the pelvic cavity, where it expanded into the rectal ampulla before terminating as the anal canal. Consequently, the rectum was subdivided into two distinct anatomical segments: Abdominal rectum (suprapelvic portion) and Pelvic rectum (infrapelvic portion, inclusive of the ampulla) (Figure 2). Anteroinferiorly the abdominal rectum, was overlaid by the jejunum loops and coils of the ileum of which some of these coils filled the pelvic cavity compressing the rectum to the posterolateral pelvic position.

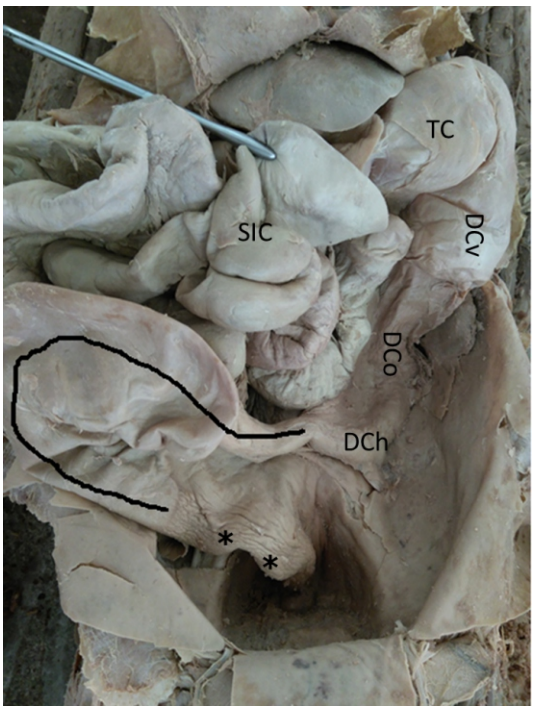

Figure 2: Display the descending colon, sigmoid colon (black line), and rectum (asterisks) after reflection of the small intestines coils (SIC). Note the origin and position of the sigmoid colon. Transverse colon (TC); Vertical (DCv), oblique (DCo), and horizontal (DCh) segments of the descending colon.

Discussion

Clinical conditions and complexity of embryological development of the colon may lead to anatomical variations in its length, width and position.
Sigmoid colon described to originate from descending colon at different levels: normal low-level below the left iliac crest; intermediate-level; and high-level above the rib cage.[7] In the present study, the sigmoid colon originates from the horizontal segment of the descending colon at the midline just above the pelvic brim.
Sigmoid colon usually characterized by having a S-shaped loop usually 45 cm long extending from left iliac fossa to the third sacral vertebra and joining the rectum within the pelvic cavity.[3,4,8] The present case is unique because the sigmoid colon started in the midline at fourth lumbar vertebra level within the abdomen then ascends through umbilical region into epigastric region superiorly to the right hepatic flexure then turns down forming an inverted U-shaped to join the rectum at fifth lumbar vertebrae, hence no pelvic segment. A study conducted in South Africa demonstrated the presence of an inverted V- and U-shaped sigmoid colon on the usual left iliac fossa.[5] The present case the inverted U-shaped sigmoid colon was found on the right hypochondriac and right lumbar region. Furthermore, the present study report for the first time the presence of the right positioned sigmoid colon at the sub-hepatic region (hepatic flexure) with gigantic diameters. Sigmoid colon has been described to have an average of 5.7 cm in diameter (4.7 cm to 7.5 cm),[9] however, this is contrary to the present case where it measured on average of 12 cm in diameter.
Madiba and Haffajee documented looping of the sigmoid colon towards the right side and its ascent within the pelvic cavity.[10] However, in the present study, the sigmoid colon originates at the midline (umbilical region), loops upwards into the epigastric region then into right sub-hepatic region, and does not extend into the pelvic cavity. Additionally, other studies have observed a long-loop, right-sided sigmoid colon.[11,12]
The rectum is traditionally described as originating at the third sacral vertebra and remaining within the pelvic cavity, characterized by two flexures.[3,4,13] However, in the present case, the rectum begins at

the L4 vertebra level in the lower abdomen and loops into the pelvic cavity, thereby forming distinct abdominal and pelvic rectal segments. Additionally, while previous studies report an average rectal length of 12–15 cm,[14,15] the current case presents a rectum measuring 18.6 cm in length.

Clinical and Embryological Correlations

Large intestine principally develops from caudal portion of midgut and the whole hind gut during the 3rd to 10th week of intrauterine life. Different signaling pathways, including Wnt and Notch, and transcription factors are involved in intestinal development, homeostasis and maintenance of the intestinal stem cell properties.[16] Mutations leading to derangement or dysregulation of these transcriptional factors may lead to grossly anatomical variations similar to what been observed in the present case.

Intestinal malrotation which usually grouped into syndromic and non-syndromic types, has been previously linked to mutations involving forkhead transcription factor FOXF1 and genes controlling Left-Right patterning.[17,18] This malrotation may results into disposition of the large intestine segments as in the current observation (caecum, sigmoid, and descending colon), which may compress the adjacent structures leading to clinical complications.

Major changes in environmental exposure occur right after birth, upon weaning, and during pubertal maturation into adulthood. Developmental timing, microbial colonization, and Toll/Interleukin-1 Receptor (TIR) signalling seem to play distinct and specific roles in regulation of gene-expression programs throughout postnatal development[19] which is crucial in shaping the gastrointestinal tract after birth, including smooth muscle development and cytoskeletal rearrangement, henceforth, indirectly affecting structural evolution. Derangement in these mechanisms, could resulted in anomaly growth of the sigmoid and rectum as observed in the present case, and might be exposed to clinical conditions such as intestinal obstruction, torsion and volvulus. Wnt signaling regulates hindgut elongation and differentiation,[20] while Retinoic acid signalling influences hindgut segmentation and rectal formation. Any alteration in these signalling pathway could result in the formation of the enlarged gastrointestinal segments originated from hindgut as observed in the present report.

Conclusion

This report underlines the significance of identifying a rare anatomical variant: a mega right-sided sigmoid colon associated with an elongated rectum (abdominal-pelvic rectum). This novel anatomical variant finding may result from intestinal malrotation caused by genetic mutations or disruptions in key signaling pathways during embryonic development or later maturation. Recognizing such anatomical variations is vital, as it necessitates thorough preoperative assessment to augment surgical planning, particularly for redundant colon segments.

Acknowledgements

The author sincerely thanks those who donated their bodies to science so that anatomical research could be performed. Results from such research can potentially increase mankind's overall knowledge which can then improve patient care. Therefore, these donors and their families deserve our highest gratitude."

The authors also sincerely thank Mr. Amani Japhet Mwambuluma of the Department of Anatomy and Histology, School of Medicine and Dentistry, for the management and preservation of the donated bodies, and assistance with administrative procedures.

Funding: Nil.

Authors' Contributions

GJM: Conducted the dissections, designed the study, Prepared the original draft of the manuscript, Reviewed and edited the manuscript.

Declarations:

Conflict of interest: There no conflicts of interest.
Consent to participate: Not applicable.
Consent for publication: Not applicable

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