

Role of Virtual C.T. Colonoscopy In Diagnosis of Colonic Diseases

An Essay

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Virtual Colonoscopy is a recently developed technique that uses a CT scanner and computer virtual reality software to look inside the body without having to insert a long tube (Conventional Colonoscopy) into the colon or without having to fill the colon with liquid barium (Barium Enema), CT colonography is a new Technique that uses data generated from CT imaging to create two-and three- dimensional scans of the colon,⁽¹⁾

An optical colonoscopy has been commonly used for accurate diagnosis, however it is often regarded as invasive , highly uncomfortable technique. Recently, considerable interest has arisen in developing a computer based Screening modality as an alternative to the optical colonoscopy, by employing advanced computer graphics and visualization techniques⁽²⁾ with increasing emphasis among the medical community on the early diagnosis and staging of colorectal cancer, interest has grown in CT colonography as a developing technique to challenge existing methods such as the barium enema and conventional colonoscopy.⁽³⁾

The aim of this study: is to evaluate the role of virtual colonoscopy based on three dimensional CT data, in diagnosis of colon diseases.

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References

1. **Sonnenberg A, Delco F and Bauerfeind P:** Is virtual colonoscopy a cost-effective option to screen for colorectal cancer. Am J Gastroenterology 1999 , Aug,(8):2268-74
2. **Sato M, Lakare S, Wan M, Kaufman A, Liang Z and Wax M:** “An automatic colon segmentation for 3D virtual colonoscopy” IEICE Trans. Information and systems, Vol.E84-D, No. 1.Jan.2001. PP201-208
3. **Bruzzi JF, Moss AC and Fenlon HM:** Clinical results of CT colonoscopy , Eur –Radiol.2001; 11(11): 2188-94

Introduction

Virtual Colonoscopy is a recently developed technique that uses a CT scanner and computer virtual reality software to look inside the body without having to insert a long tube (Conventional Colonoscopy) into the colon or without having to fill the colon with liquid barium (Barium Enema), CT colonography is a new Technique that uses data generated from CT imaging to create two-and three- dimensional scans of the colon.⁽¹⁾

An optical colonoscopy has been commonly used for accurate diagnosis; however it is often regarded as invasive, highly uncomfortable technique. Recently, considerable interest has arisen in developing a computer based Screening modality as an alternative to the optical colonoscopy, by employing advanced computer graphics and visualization techniques,⁽²⁾ with increasing emphasis among the medical community on the early diagnosis and staging of colorectal cancer, interest has grown in CT colonography as a developing technique to challenge existing methods such as the barium enema and conventional colonoscopy.⁽³⁾

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Anatomy of the Colon

Gross anatomy: (Fig. 1)

Large intestine extends from the caecum in the right iliac fossa to the anus in the perineum, and surrounds the centrally placed small intestine. It is much shorter (1.5 m) than the small intestine and decreases in diameter from the caecum to the descending colon. All parts of it are capable of considerable distension. The large intestine consists of the caecum, appendix vermiformis, the ascending, transverse, descending parts of the colon which meet at the right and left flexures, the sigmoid colon, the rectum and the anal canal.⁽⁴⁾

The caecum (Fig.2) is the blind end of the large intestine in the right iliac fossa. It is approximately 5-7 cm in length. Superiorly it joins the ascending colon and terminal ileum. It lies on the right iliacus and psoas muscles, and on the nerves (genitofemoral, femoral, and lateral cutaneous) and blood vessels (testicular or ovarian) anterior to them. It frequently overlaps the external iliac artery and being relatively mobile, may lie in the lesser pelvis. The caecum is almost surrounded by peritoneum, but is frequently attached by it to the iliac fossa laterally and medially. This produces a wide retrocecal peritoneal recess which may ascend posterior to the inferior part of the ascending colon. The appendix vermiform frequently lies in this recess. Rarely the caecum may lie at the level of the right colic flexure; the ascending colon is then absent.⁽⁴⁾

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The vermiform appendix is a narrow (approximately 5 mm) blind tube of very variable length (5-15cm). It is suspended by a small extension of the mesentery which descends posterior to the terminal ileum. The base of the appendix is attached to the posteromedial surface of the caecum 2-3 cm inferolateral to the ileocecal junction. The appendix is very variable in position.

Frequently it lies in the retrocecal recess, but may extend into the lesser pelvis to lie close to the ovary, uterine tube, and ureter. The appendix has the same peritoneal and muscle coats as the small intestine. At the base, the longitudinal muscle is continuous with the three taeniae of the caecum and colon. The caecum and appendix are supplied by the ileocolic artery.⁽⁴⁾

The ascending colon is about (13 cm) long and lies in the right lower quadrant. It extends upward from the caecum to the inferior surface of the right lobe of the liver, where it turns to the left, forming the right colic flexure, and becomes continuous with the transverse colon. The peritoneum covers the front and the sides of the ascending colon, binding it to the posterior abdominal wall. Anteriorly; the coils of the small intestine lie, as well the greater omentum and the anterior abdominal wall. Posteriorly; the iliacus, the iliac crest, the quadratus lumborum and the lower pole of the right kidney. The iliohypogastric and the ilioinguinal nerves cross behind it. It is supplied by the ileocolic and right colic branches of the superior mesenteric artery.⁽⁵⁾

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The right colic flexure is at the junction of the ascending and transverse colon; the later turns down, forward and to the left. Posterior is the inferolateral part of the anterior surface of the right kidney; above and anterolaterally is the right lobe of the liver; anteromedially is the descending part of the duodenum and fundus of gall bladder. Its posterior aspect is not covered by peritoneum and is in direct contact with renal fascia. It is not so acute as the left colic flexure.⁽⁶⁾

The transverse colon is usually the longest (40-50cm) and most mobile part of the colon. It extends between the right and left colic flexures and forms a dependant loop between them. The lowest part may reach well below the umbilicus in the erect position, but is usually just superior to it in the recumbent position. If the intestine is distended, the transverse colon may be pushed superiorly. Occasionally it passes anterior to the stomach. The transverse colon is suspended by the transverse mesocolon. The transverse mesocolon ascends from the colon to be attached to the descending part of the duodenum, the head and lower margin of the body of pancreas, and the anterior surface of the left kidney. The transverse colon begins anterior to the descending part of the duodenum and head of pancreas, and posterior to the liver and the fundus of the gall bladder. It then descends anterior to the coils of small intestine, and ascends on the left to the left flexure, immediately inferior to the spleen and posterior to the left margin of the greater omentum. The right colon flexure and proximal two thirds of the transverse colon are supplied by the middle colic

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artery, a branch of the superior mesenteric artery. The distal one third and the left colic flexure are supplied by the left colic artery, a branch of the inferior mesenteric artery.⁽⁴⁾

The left colic flexure is so acute that the end of the transverse colon usually overlaps the front of the descending colon. The left flexure is above and on a more posterior plane than the right flexure and is attached to the diaphragm with the tenth and eleventh ribs by the phrenicocolic ligament, which lies below the anterolateral pole of the spleen.

The descending colon passes from the left flexure to the margin of the superior aperture of the pelvis near the inguinal ligament. It is attached by peritoneum to the posterior abdominal wall in the left paravertebral gutter and iliac fossa. At first anterior to the lateral surface of the left kidney and medial to the diaphragm, it descends on transversus abdominis and quadratus lumborum to the iliac crest, anterior to the same nerves as the ascending colon here it turns medially, superior to the inguinal ligament, and lies on the femoral nerve, psoas, the testicular vessels, and the genitofemoral nerve, and joins the sigmoid colon anterior to the external iliac vessels. The blood supply is by the left colic artery and upper sigmoid branches of the inferior mesenteric artery.⁽⁴⁾

The sigmoid colon varies in length from 15 to 80 cm. it extends from the end of the descending colon to the pelvic surface of the third piece of the sacrum where it joins the rectum. The sigmoid mesocolon begins at the end of the

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descending colon and ascends on the external iliac vessels to the middle of the common iliac artery. Here it turns sharply downwards and to the right across the lesser pelvis to the third piece of the sacrum.⁽⁴⁾

The rectum is continuous with the sigmoid colon at the level of the third sacral vertebra, the junction being at the lower end of the sigmoid mesocolon. It descends along the sacrococcygeal concavity, with an anteroposterior curve, it then curves down and back, then downwards and finally down and forwards to joins the anal canal by passing through the pelvic diaphragm.

The anal canal begins where the rectal ampulla suddenly narrows, passing down and backwards to the anus. It is about 4 cm long in adult, its anterior wall being slightly shorter than its posterior. When empty its lumen is a sagittal or triradiate longitudinal slit. Posterior is a mass of fibromuscular tissue, the anococcygeal ligament, separating it from the lower vagina; laterally are the ischiorectal fossae. Over its whole length. It is surrounded by sphincters which normally keep it closed.⁽⁵⁾

Lymph drainage and nerve supply of the large intestine

Lymphatics: Some nodes lie near the marginal artery and along the arteries passing to it. The lymph drainage through these nodes on the branches of the superior mesenteric artery passes to the intestinal trunk in the root of the mesentery. That draining with the inferior mesenteric artery enters the lumbar lymph nodes beside the aorta. Both reach the cisterna chyli.

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Nerves: parasympathetic-vagus nerve to 2/3 along transverse colon then S2, S3, S4 to rest of bowel. And sympathetics T10 – L2 for vasoconstriction and pain.⁽⁷⁾

Microscopic anatomy: (Fig. 1)

The mucosa comprises parallel rows of epithelial tubules or crypts, surrounded by the connective tissue framework of the lamina propria. The crypts are lined by goblet cells, and have undifferentiated cells at the base; the surface epithelium between the crypts is mostly composed of columnar absorptive cells with occasional goblet cells. The goblet cells produce glycoproteins. The colonic muscularis mucosa and submucosa have fewer lymphatic channels than the small bowel – an important feature when considering the metastatic potential of neoplastic mucosal lesions.⁽⁷⁾

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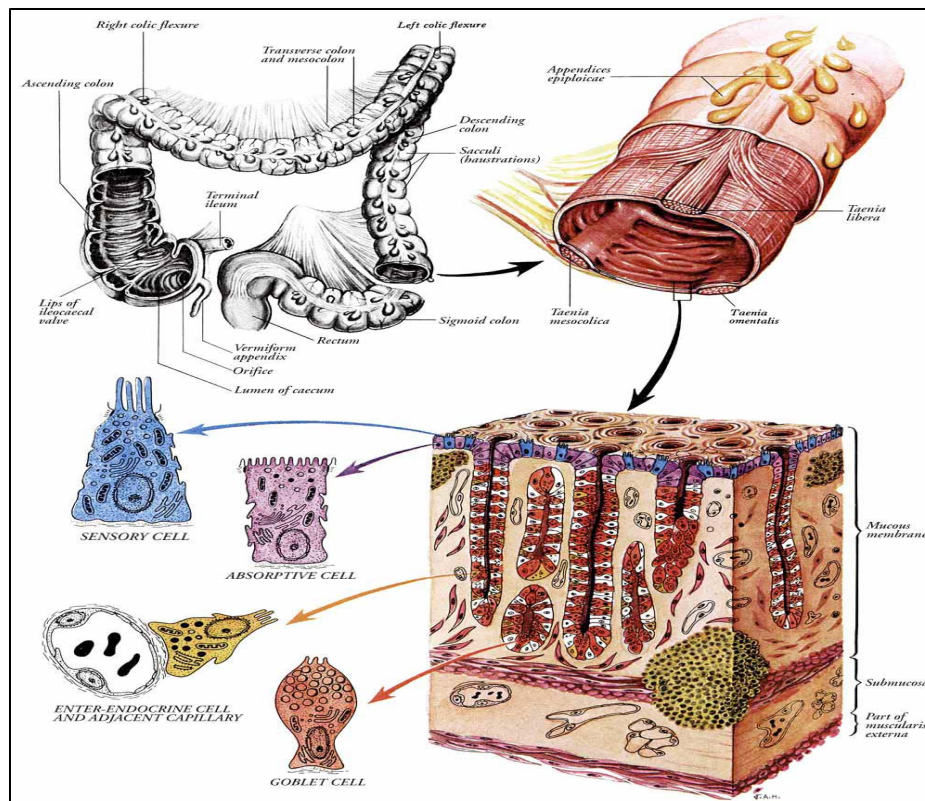


Figure (1): Diagrams of the disposition of the major regions of the large intestine, the microarchitecture and histology of the colonic wall and the ultrastructure of its epithelial cells (Quoted from Gray's Anatomy, 1999).⁽⁸⁾

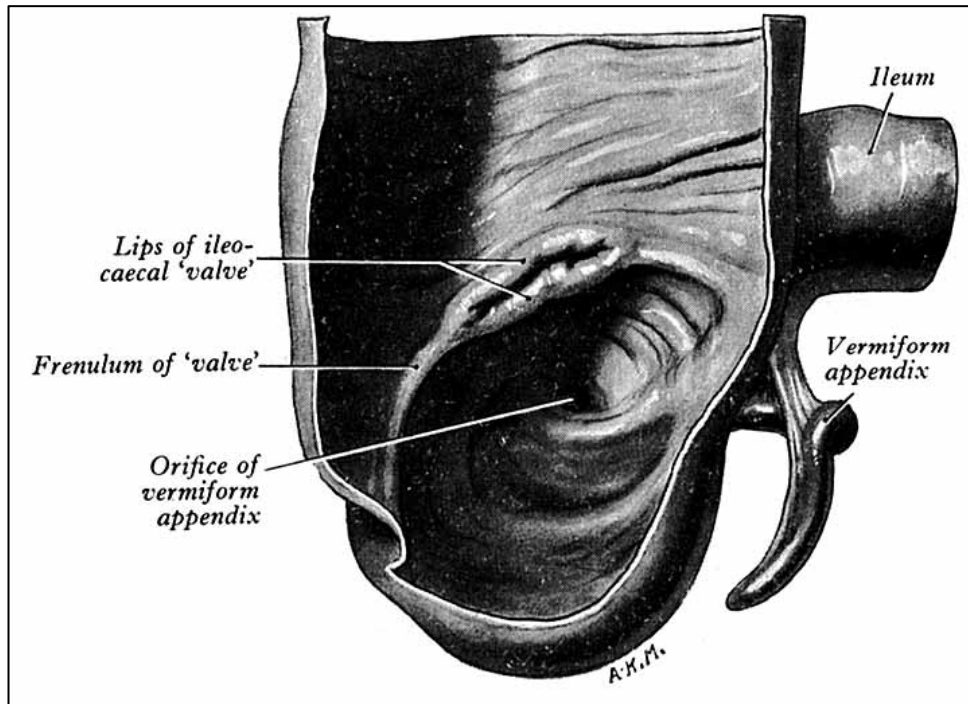


Figure (2): The interior of the caecum and commencement of the ascending colon, showing the ileocaecal valve (**Quoted from Gray's Anatomy, 1999**).⁽⁸⁾

Normal colon on CT: (Fig. 3)

The ascending and descending portions of the colon usually are well seen on CT images, being surrounded by extra-peritoneal fat in the pararenal space. The transverse colon lies anteriorly in the mid-abdomen and is distinguished from the small intestine by its haustrations and by bubbly appearance of its fecal contents.

The transverse mesocolon suspends the transverse colon from the retroperitoneum. The root of the transverse mesocolon

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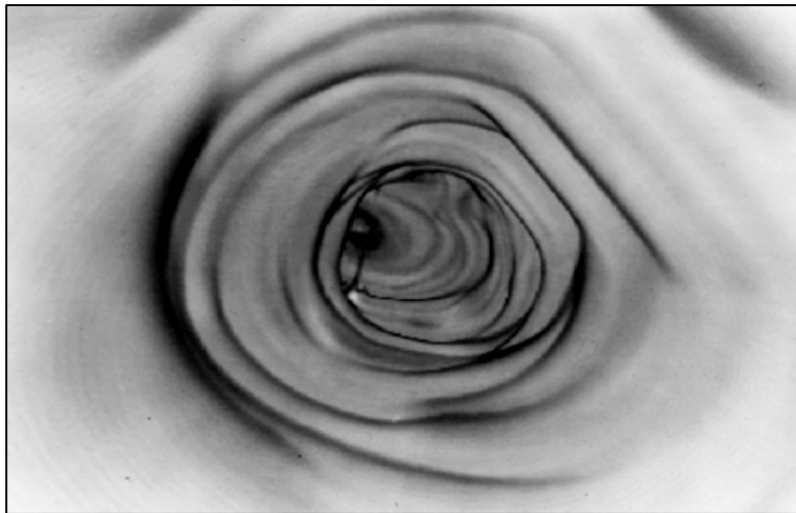
extends along the anterior surface of the pancreas from just inferior to the ampulla of Vater to a point superior to the ligament of Treitz. Normally, the transverse mesocolon is not visible on CT, but it may serve as a pathway along which pancreatic tumor or inflammatory disease can spread to the colon, in which case it appears a band-like horizontal structure posterior and superior to the transverse colon. The superior surface of the transverse colon is connected to the greater curvature of the stomach by the gastro-colic ligament, which also may act as a pathway for the spread of disease.⁽⁹⁾

Gas and fluid are normally present in the colon; however, colonic distension and air-fluid levels seen on CT hold the same significance as on plain abdominal radiographs. With sufficient fluid, or contrast material in the lumen, the thickness of the colonic wall can be evaluated and usually is less than 3 to 5 mm.⁽¹⁰⁾ Often it is helpful to opacify the colonic lumen with contrast material to avoid mistaking non-opacified large bowel, particularly the sigmoid colon, for a mass lesion. This is accomplished either by administering oral contrast material well in advance of the study or, preferably, by giving an enema of dilute contrast material just prior imaging. This is particularly important when the pelvis is the anatomic region of concern or when one suspects colonic disease.⁽¹¹⁾

The hepatic and splenic flexures of the colon are relatively constant in position and displacements are usually evidence of enlargement of the adjacent solid viscera. At the hepatic flexure displacements are usually from liver or gall bladder enlargement; the splenic flexure is displaced by an

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enlarged spleen or space occupying lesion of the tail of pancreas or kidney. The origin of the transverse colon may overlap the hepatic flexure whilst a redundant loop of descending colon may overlap the splenic flexure. This overlapping is important as growths of these portions of the colon may be hidden behind the barium filled loop. Certain areas of physiological narrowing, at times resembling (sphincters), may occur, they are all transient and show normal mucosal features which enable them to be differentiated from true strictures.⁽¹²⁾



(A)