DIAGNOSTIC ACCURACY OF COMPUTED TOMOGRAPHY OF COLON "VIRTUAL COLONOSCOPY" IN COLORECTAL PATHOLOGIES

By

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In partial fulfillment of the requirements for the degree of

DOCTOR OF MEDICINE

IN

RADIODIAGNOSIS

Under the Guidance of

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MAY 2015

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I hereby declare that this dissertation/thesis entitled **DIAGNOSTIC ACCURACY OF COMPUTED TOMOGRAPHY OF COLON "VIRTUAL COLONOSCOPY" IN COLORECTAL PATHOLOGIES** is a bonafide and genuine research work carried out by me under the guidance of **Dr.PURNIMA HEGDE** M.D (R.D), Professor & Head, Department of Radiodiagnosis, and co-guidance of **Dr. K. NISCHAL** Professor Dept of Surgery Sri Devaraj Urs Medical College Tamaka, Kolar.

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Dr. AADITYA KUMAR SINGH

LIST OF ABBREVIATIONS

CC	Conventional colonoscopy
CE	Capsule endoscopy
CRC	Colorectal Cancer
CT	Computed tomography
DCBE	Double-contrast barium enema
GI	Gastro intestinal
GISTs	Gastrointestinal stromal tumors
ICC	Intestinal cell of Cajal
MDCT	Multidetector computed tomography
VC	Virtual colonoscopy

ABSTRACT

Background: Colorectal cancer (CRC) is a major health issue receiving much attention in recent years. Conventional colonoscopy is the gold standard for screening and early diagnosis of CRC. However it has its disadvantages in the form of pain, discomfort and rarely perforation of colon. Virtual colonoscopy is a recent radiological technique to evaluate the colon without causing much pain and discomfort to the patient with virtually no risk of perforation.

Aims and Objectives: To evaluate the sensitivity and specificity of computed tomography "virtual" colonoscopy in detection and diagnosis of colorectal pathologies in comparison with conventional colonoscopy which is presently the gold standard.

Methodology: The study was conducted on 30 patients who underwent conventional colonoscopy during the period of January, 2013 to June, 2014. Patients were taken up for virtual colonoscopy immediately after conventional colonoscopy procedure by inflating the colon with room air using a catheter introduced through the anus and non-contrast CT scan was taken. Two-dimensional images were obtained after which three-dimensional images were generated on the workstation using flythrough technique. Virtual colonoscopic findings were recorded and compared with conventional colonoscopic findings.

Results: Similar intraluminal findings were obtained on both conventional and virtual colonoscopy. Additional findings such as fat stranding and enlarged lymphnodes were seen in virtual colonoscopy and not in conventional colonoscopy. In 16 patients there was incomplete evaluation of colon by conventional colonoscopy due to either obstructive intraluminal growth or patient compliance. In these cases entire colon was evaluated by virtual colonoscopy.

Conclusion: Virtual colonoscopy is as sensitive as conventional colonoscopy in detection of colonic lesions and can be used as an initial tool in screening or in evaluation of patients suspected to have colonic pathology.

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INTRODUCTION

Colorectal cancer (CRC) is a major public health issue that has received much attention in recent years. It is the third most common cancer in men and women worldwide.[1,2] Incidence rates of CRC vary 10-fold in both sexes worldwide, the highest rates being estimated in Australia/New Zealand and Western Europe, the lowest in Africa (except Southern Africa) and South-Central Asia. Within Asia, the incidence rates of CRC vary widely and are uniformly low in all south Asian countries and high in all developed Asian countries. The burden of CRC has risen rapidly in some economically developed Asian countries like Japan, South Korea and Singapore.[3]

It is known that in over 90% of cases the progression of colon cancer is from local (polyp adenomas) to advanced stages (CRC)[4], it is critical that major efforts be devoted to screening of colon cancer and removal of lesions (polyps) when still in an early stage of the disease. As evidence of the impact of removing lesions, a study on 1693 patients, followed over a 10- year period, demonstrated that colonoscopic polypectomy substantially reduced the incidence of CRC in the cohort compared with that expected in the general population.[5] While there is wide consensus that screening patients is effective in decreasing advanced disease, only 44% of the eligible population undergoes any type of CRC screening. Many reasons have been identified for non-compliance, the key ones being patient comfort, bowel preparation and cost.

ANATOMY

The colon or large intestine is a six feet long structure and has four parts namely the ascending colon, transverse colon, the descending colon, and the sigmoid colon. Beyond the sigmoid colon are the rectum and the anus.

The ascending colon, on the right side of the abdomen, is about 12.5 cm long. It is the part of the colon from the cecum to the hepatic flexure (hepatic means liver). The transverse colon extends from the hepatic flexure to the splenic flexure (near the spleen). The descending colon extends from the splenic flexure to the beginning of the sigmoid colon. The sigmoid colon starts after the descending colon and ends before the rectum. The name sigmoid means S-shaped.

The rectum is about eight inches and connects the sigmoid colon with the anal canal. The anal canal is 2.5 - 4 centimeters long. It's situated between the rectum and anus.

The superior mesenteric artery supplies ascending colon and proximal 1/3rd transverse colon. Lower mesenteric artery supplies rest of the transverse colon, descending, sigmoid colon and rectum.

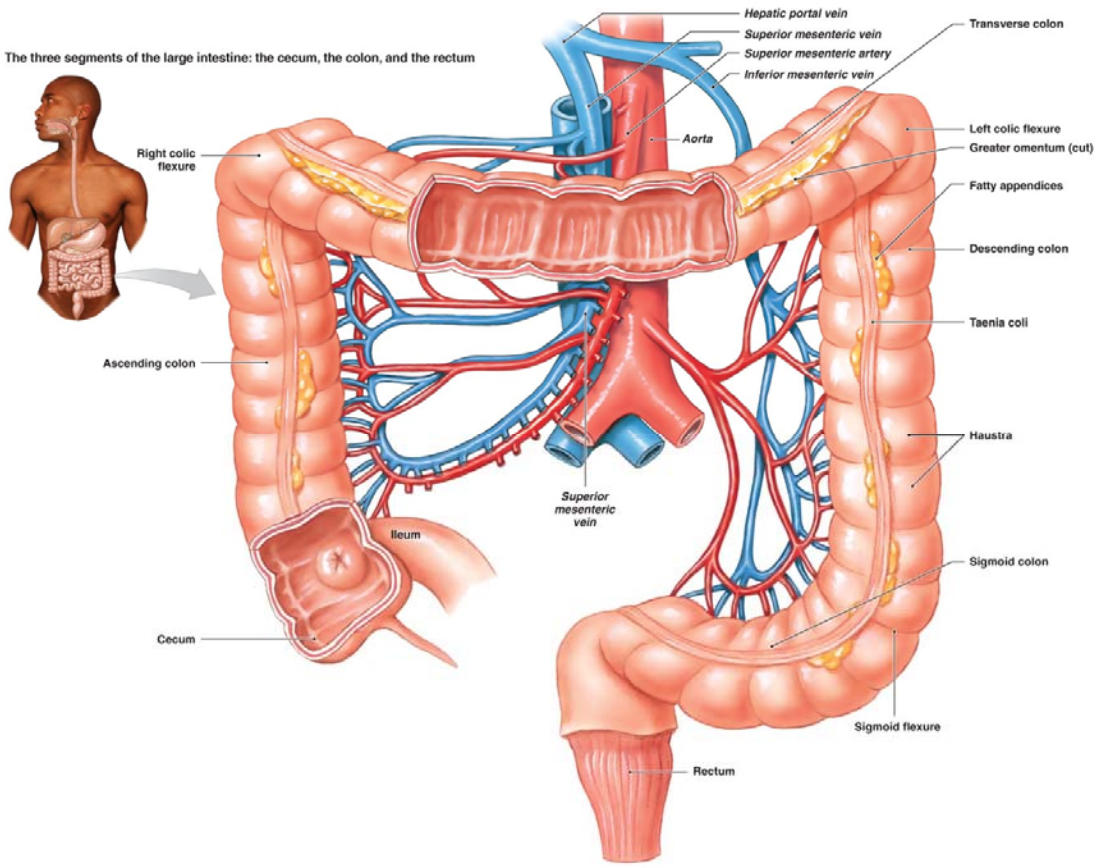


Figure 1: Anatomy of colon

PHYSIOLOGY

The functions of the Colon are absorption of water and minerals and the formation and elimination of feces. The small intestine absorbs the nutrients from the food and pours the leftover sludge into the cecum. This sludgy waste then moves from the cecum to the colon for further processing. The colon absorbs water from the sludge while transporting it toward the rectum.

The colon stores the waste material until it is time for it to be evacuated. The colon moves the waste material through by involuntary wavelike contractions, made possible by smooth muscles within the colon wall, a process which is referred to as peristalsis.

The urge to defecate is signaled by the propulsion of feces from the sigmoid colon to rectum. Distention of the rectum causes relaxation of the internal anal sphincter (involuntary sphincter). For defecation to proceed, the external anal sphincter must voluntarily relax. Defecation is facilitated by squatting or sitting and by increasing intra-abdominal pressure.

COLORECTAL DISEASES

COLON CANCER: It is a common type of the malignant tumor that is located on the colon wall. Like most other cancers, it occurs when some cells in the body begin to divide and multiply in an uncontrolled manner. Normally after a long period of development, the group of abnormal cells gets bigger and bigger. Finally, it forms a mass (also called a tumor) that invades into the colon wall, where normal cells are replaced and destroyed. Colon cancer can lead to a change of colon behavior, a feeling of incomplete defecation and a reduction of stool diameter. A large tumor can obstruct the colon and even cause bleeding inside. In some cases, cancer cells can also spread to other areas of the human body and damage organic functionalities there.

Several types of cancer can start in the colon or rectum.

Adenocarcinomas: More than 95% of colorectal cancers are a type of cancer known as adenocarcinomas. These cancers start in cells that form glands that make mucus to lubricate the inside of the colon and rectum.[6]

Other, less common types of tumors may also start in the colon and rectum. These include:

Carcinoid tumors: These tumors start from specialized hormone-producing cells in the intestine. Neuroendocrine tumors and cancers act like the cells they come from, often releasing certain hormone-like substances into the bloodstream. In most people with

carcinoid tumors, the levels of these hormones are not high enough to cause symptoms. But in about 1 person out of 10 with carcinoid tumors, the tumor spreads and grows enough to release high amounts of these hormones. This can cause a set of symptoms known as the carcinoid syndrome. Some symptoms of the carcinoid syndrome include flushing (redness of the skin with a feeling of warmth), wheezing, diarrhea, and a fast heartbeat.[6]

Gastrointestinal stromal tumors (GISTs): These tumors start from specialized cells in the wall of the colon called the interstitial cells of Cajal (ICC). ICCs are cells of the autonomic nervous system, the part of the nervous system that regulates body processes such as digesting food. ICCs are sometimes called the "pacemakers" of the gastro intestinal (GI) tract because they signal the muscles in the digestive system to contract to move food and liquid through the GI tract. Some GISTs are benign (non-cancerous); others are malignant (cancerous). These tumors can be found anywhere in the digestive tract, but they are unusual in the colon.[6]

Lymphomas: These are cancers of immune system cells that typically start in lymph nodes, but they may also start in the colon, rectum, or other organs.[6]

Sarcomas: These tumors can start in blood vessels as well as in muscle and connective tissue in the wall of the colon and rectum. Sarcomas of the colon or rectum are rare.[6]

Factors that increase a person's risk of developing colon cancer include:[7-10]

- **Age**: Older people are at a higher risk of developing colon cancer. More than 90% of people diagnosed with colon cancer are older than 50 years. Younger cases are uncommon.

- **Heredity**: Members of a family that has a history of colon cancer are at a higher risk of developing colon cancer.

- **Diet and living habits**: Studies show that diets high in red and processed meat and lacking in fresh fruits, vegetables, poultry and fishes increase the risk of colon cancer. Certain living habits, e.g. smoking, drinking alcohol and physical inactivity, also increase the colon cancer risk.

- **Other factors** are, for instance, viruses, having inflammatory bowel disease and environmental impacts.

COLONIC POLYPS: Most cases of CRC develop from previously benign neoplastic polyps. Colonic polyps have been extensively studied. It is normally a benign growth of tissue projecting from the mucous membrane of the interior colonic surface. In terms of their shapes, colon polyps can be categorized into two types:

- The pedunculated polyp is attached to the colon wall by a narrow elongated stalk. It typically presents as a protrusion shaped like a mushroom.
- The sessile polyp grows directly into the inner wall of the colon and is similar in appearance to a drop of spilled paint.

Depending on their severities, polyps can also be classified as:

- Hyperplastic polyps: small polyps (normally less than 5mm in diameter).
- Adenomatous polyps: bigger polyps (larger than 10mm in diameter).

Hyperplastic polyps are usually considered to be harmless and usually don't turn malignant. They are not always distinguishable from adenomatous polyps.

Adenomatous polyps are really pre-cancerous and have a greater malignancy potential.[11]They account for approximately two-thirds of all colonic polyps, although only a minority will develop into colon cancer over years. The risk of malignancy increases with both the size of the polyp and the degree of villous component.[12-14]

Colonic polyps commonly occur in about 30% to 50% of adults. The development from an adenoma to colon cancer usually takes about 10 years. Although not all polyps will become cancerous, almost all colon cancer incidences are developed from colonic polyps. Therefore, early detection of colonic polyps is important. The endoscopic removals of polyps plus post-polypectomy surveillance are associated with a substantial reduction of incidence and thus mortality from CRC.

METHODS OF EVALUATION OF COLON

There are various means to detect early CRC and adenomatous polyps.

a. Conventional Colonoscopy (CC)

CC is considered the "gold standard", although not infallible, as it has a very high sensitivity and specificity for detection of CRC and polyps, and also allows visual inspection of inflammatory changes. During CC it is also possible to perform biopsies and resect polyps. However, CC is an invasive procedure that often requires the use of sedative and/or analgesic medication in order to reduce patient pain and discomfort. Half of all severe adverse events during CC are reported to be cardiopulmonary events such as hypotension, oxygen desaturation and cardiac arrhythmias, some of which are related to sedation.[15]CCis associated with low risk of perforation, approximately 0.1%.[16] In addition, it has been reported that CC fails to depict the whole colon in approximately 3-23% of patients, due to e.g. pain and discomfort, or technical problems like colon tortuosity, strictures or fecal material.[17-19] Although CC is the most accurate diagnostic test to screen for CRC and polyps, the compliance of individuals to endoscopic screening has been reported to be low.[20]

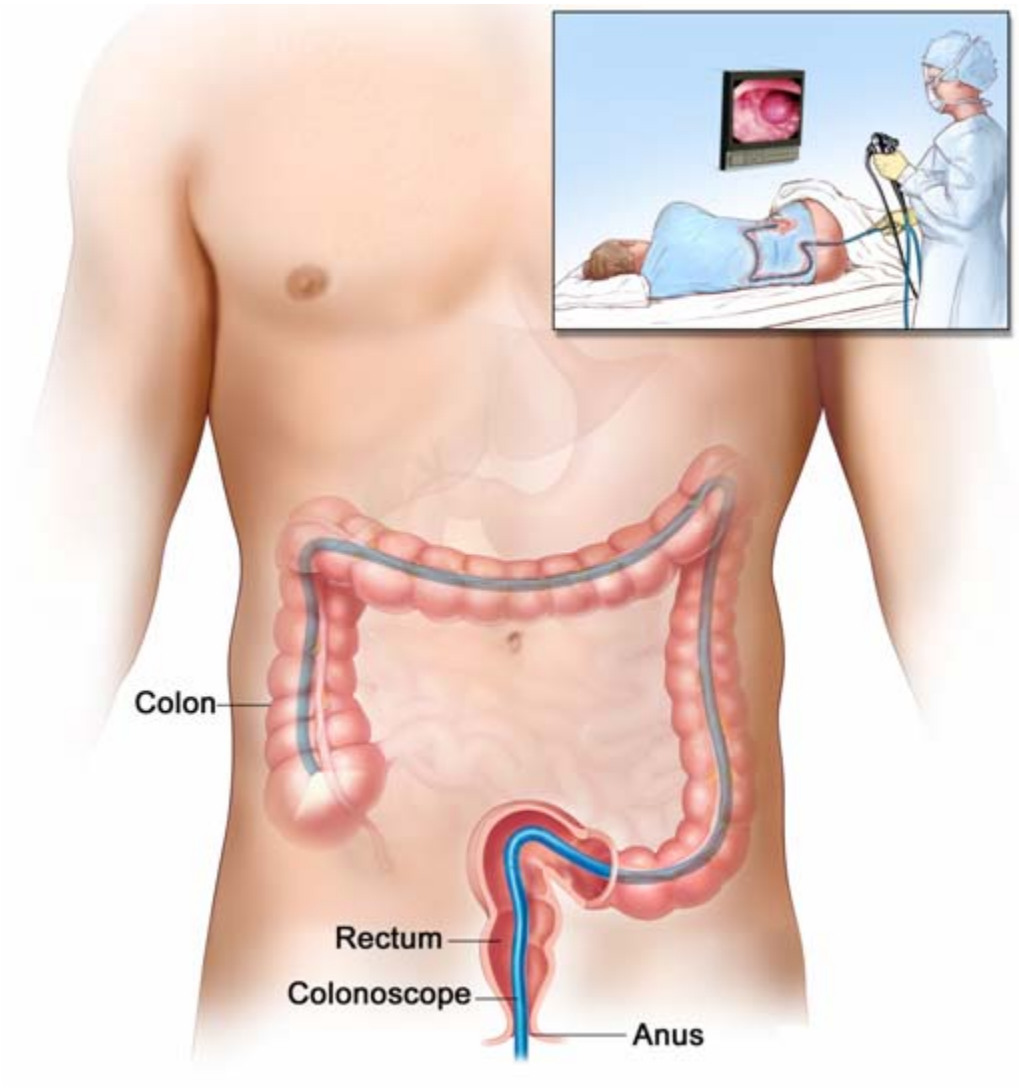


Figure 2: Graphicrepresentation of colonoscopy

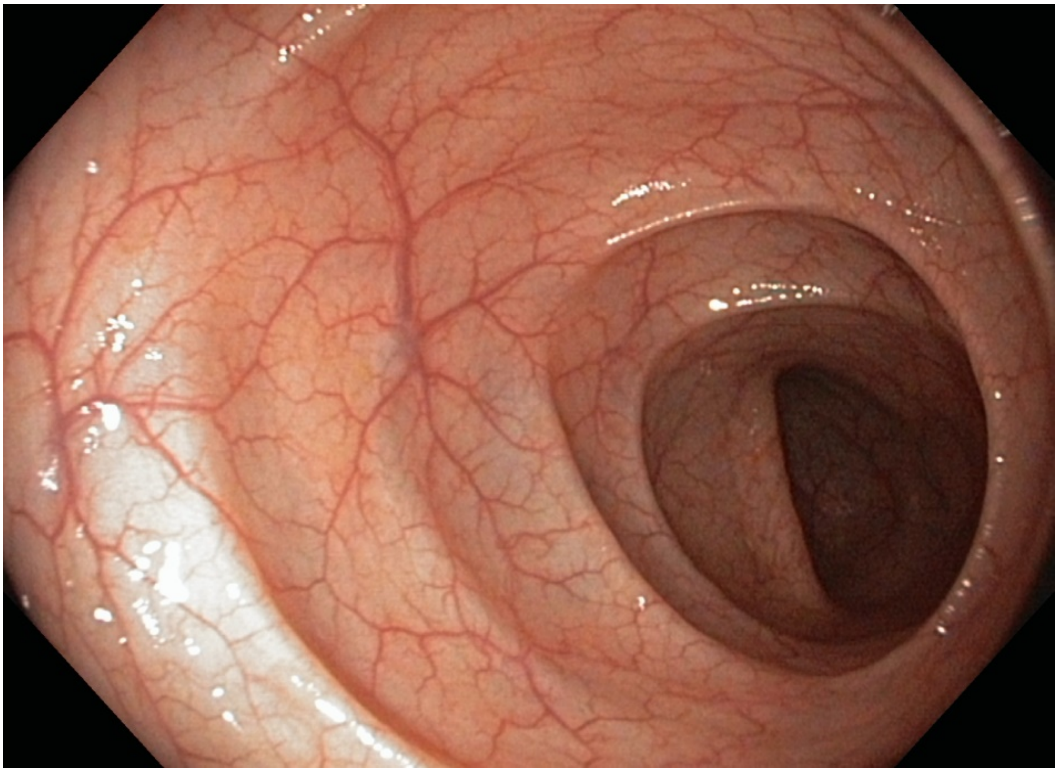


Figure 3: Normal sigmoid colon on colonoscopy

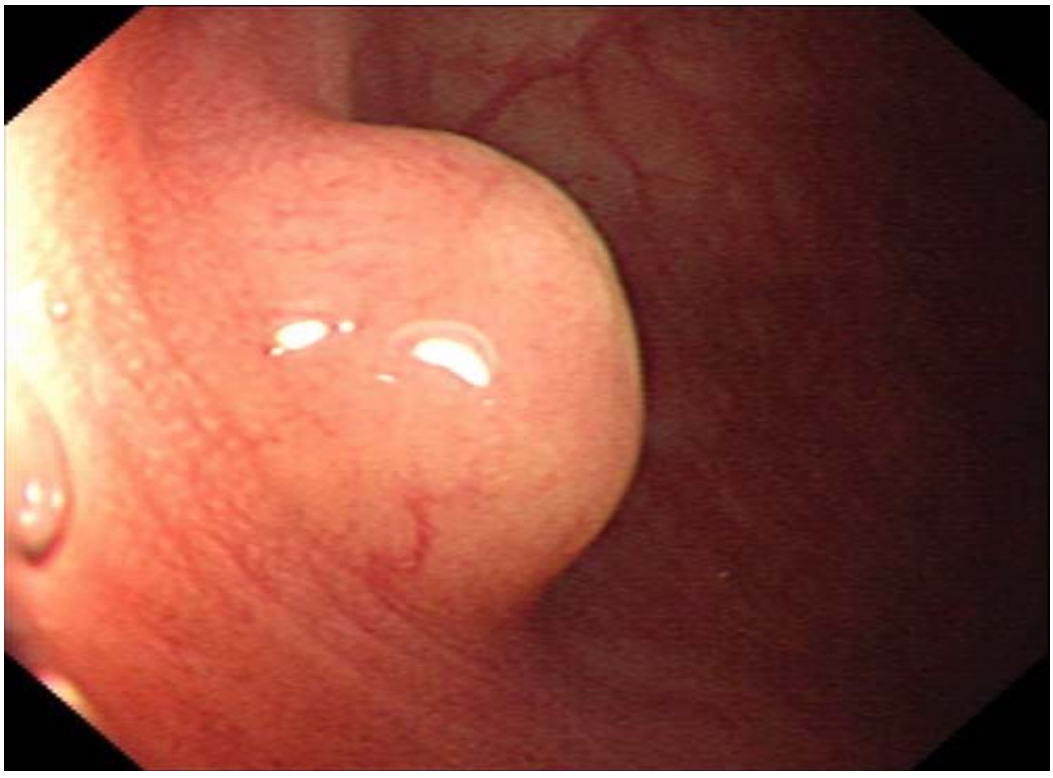


Figure 4: A sessile polyp on colonoscopy

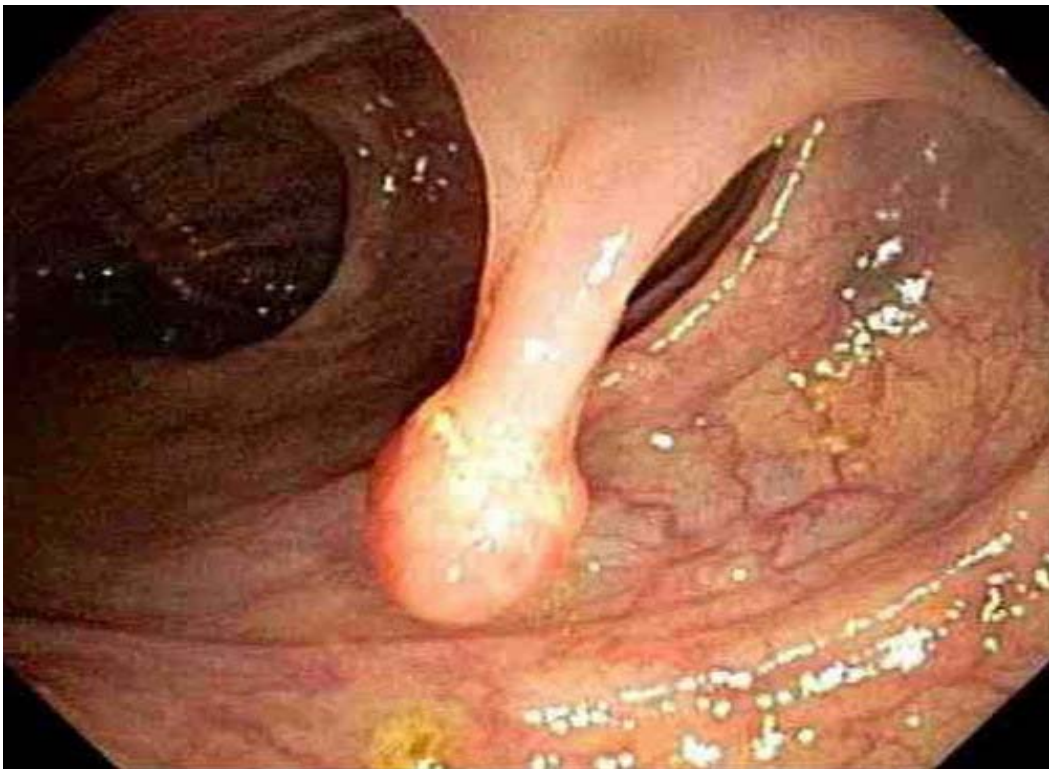


Figure 5: A pedunculated polyp on colonoscopy

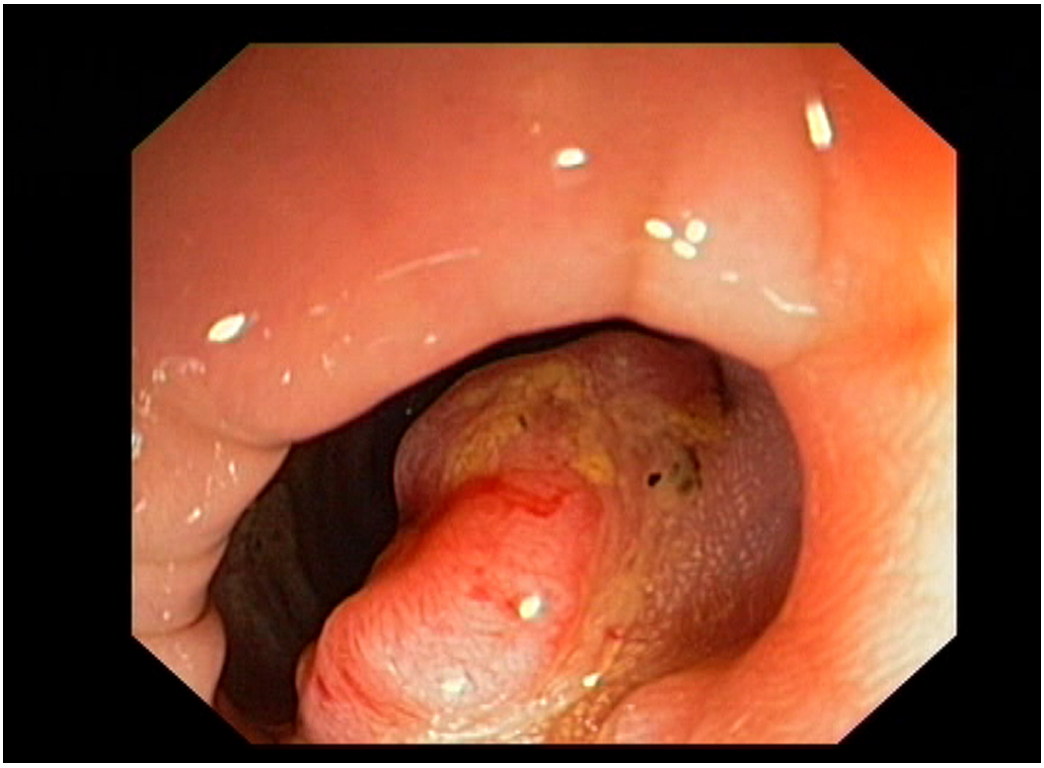


Figure 6: Carcinoma Rectum on colonoscopy

b. **Fecal occult blood tests (FOBT)**

FOBT detect the presence of blood in the stool, which might be caused by a bleeding CRC or large polyps. Large trials have shown that screening with FOBT, followed by colonoscopy with removal of detected polyps, reduces CRC mortality by 15-33% and reduces CRC incidence by 20%.[21-23] However, FOBT have highly variable sensitivity and specificity, depending on the type of test (low-sensitivity or high-sensitivity FOBT).[24] For CRC and advanced adenomas, the high-sensitivity FOBT have a reported sensitivity of 64-80% and 41%, respectively, and a specificity of about 87%.[25,26] FOBT should be repeated every year or every 2 years as CRC or large polyps can bleed only intermittently. Subjects with positive FOBT need to undergo colonoscopy.

c. Sigmoidoscopy

Sigmoidoscopy is an endoscopic procedure where only the distal part of the colon and the rectum is examined. No sedation is required. As at least one third of polyps are located in more proximal parts of the colon[27], it cannot be considered a complete diagnostic test. However, it may have some predictive value regarding the proximal colon, as patients with an adenoma in the distal colon or rectum have a higher risk of advanced neoplasia in the proximal colon compared with patients with no adenomatous polyps in the distal colon or rectum. It is therefore recommended that patients with adenomas found at sigmoidoscopy undergo complete colonoscopy.

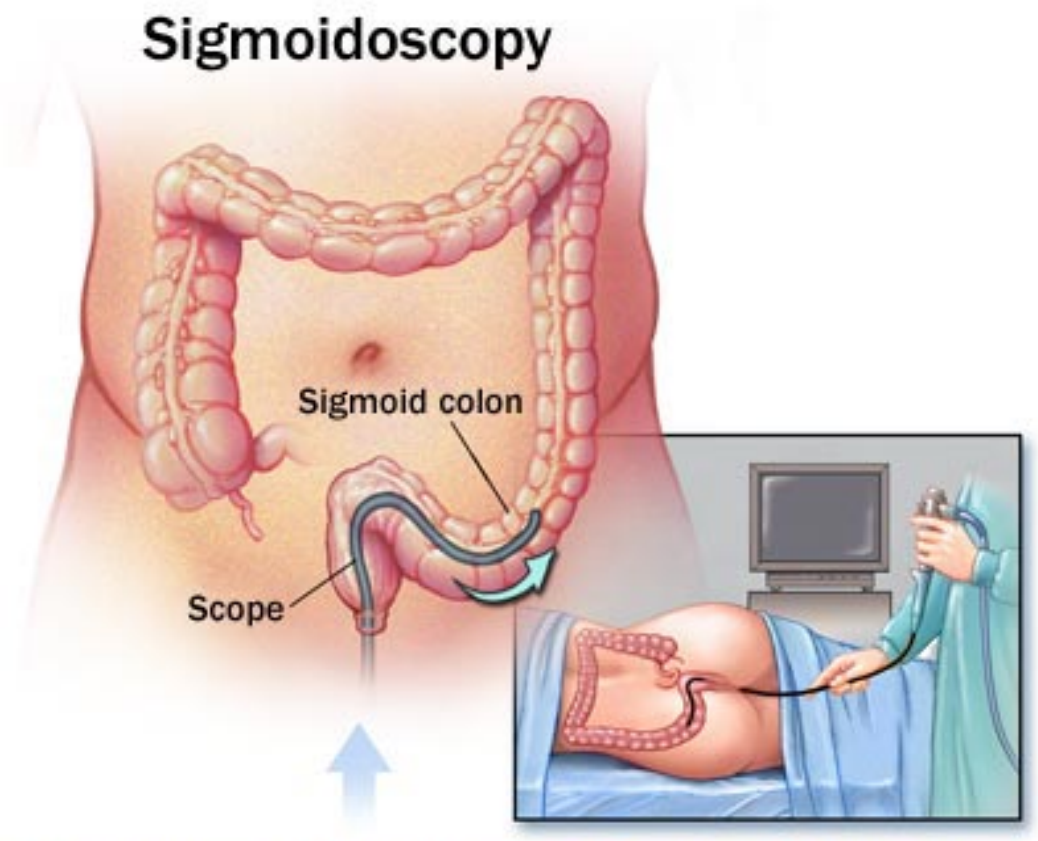


Figure 7: Graphic rendering of sigmoidoscopy

d. Double-contrast barium enema (DCBE)

DCBE is a radiological procedure performed after rectal administration of a radiopaque contrast medium (barium sulphate) and air. The barium coats the colorectal mucosa while air distends the lumen. Multiple radiographs are taken with the patient turning in several positions under fluoroscopy. No sedation is required. DCBE has a relatively high sensitivity and specificity of about 85% [28-30]for CRC, but quite low sensitivity for polyps. However, there is risk of radiation exposure to the patient.

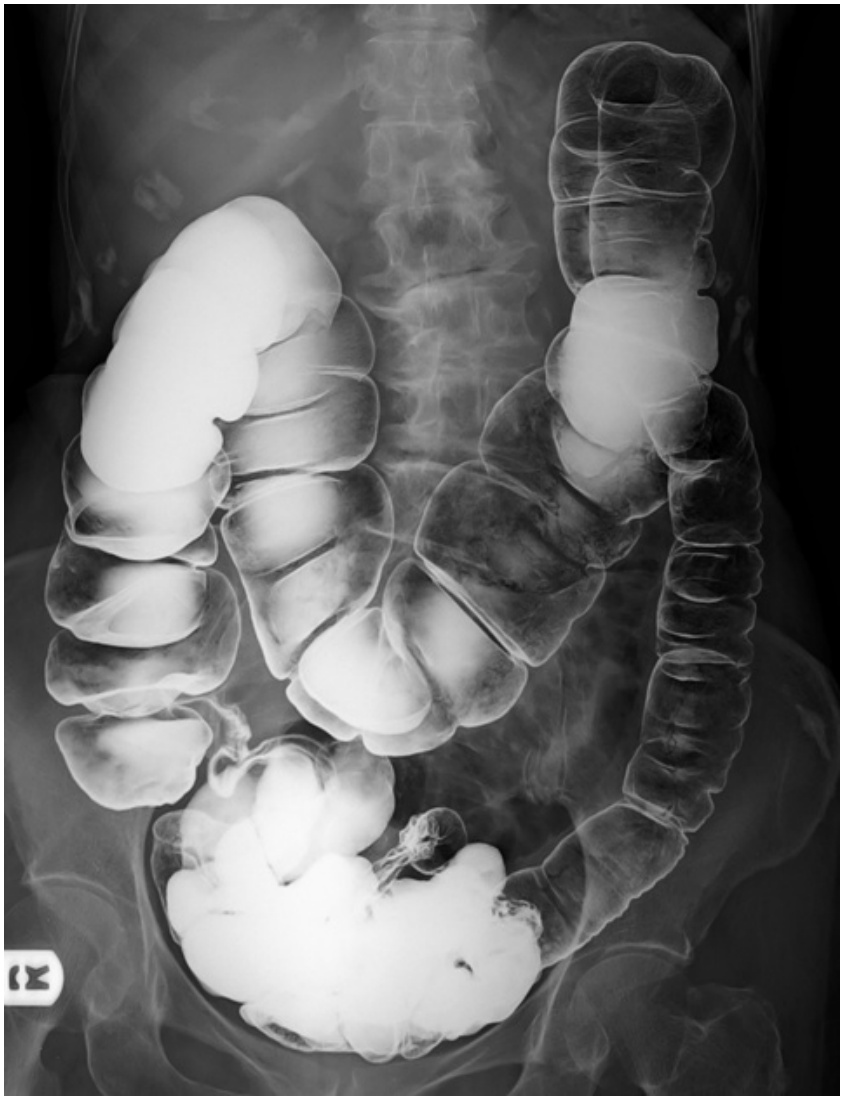


Figure 8: Normal study on double-contrast barium enema

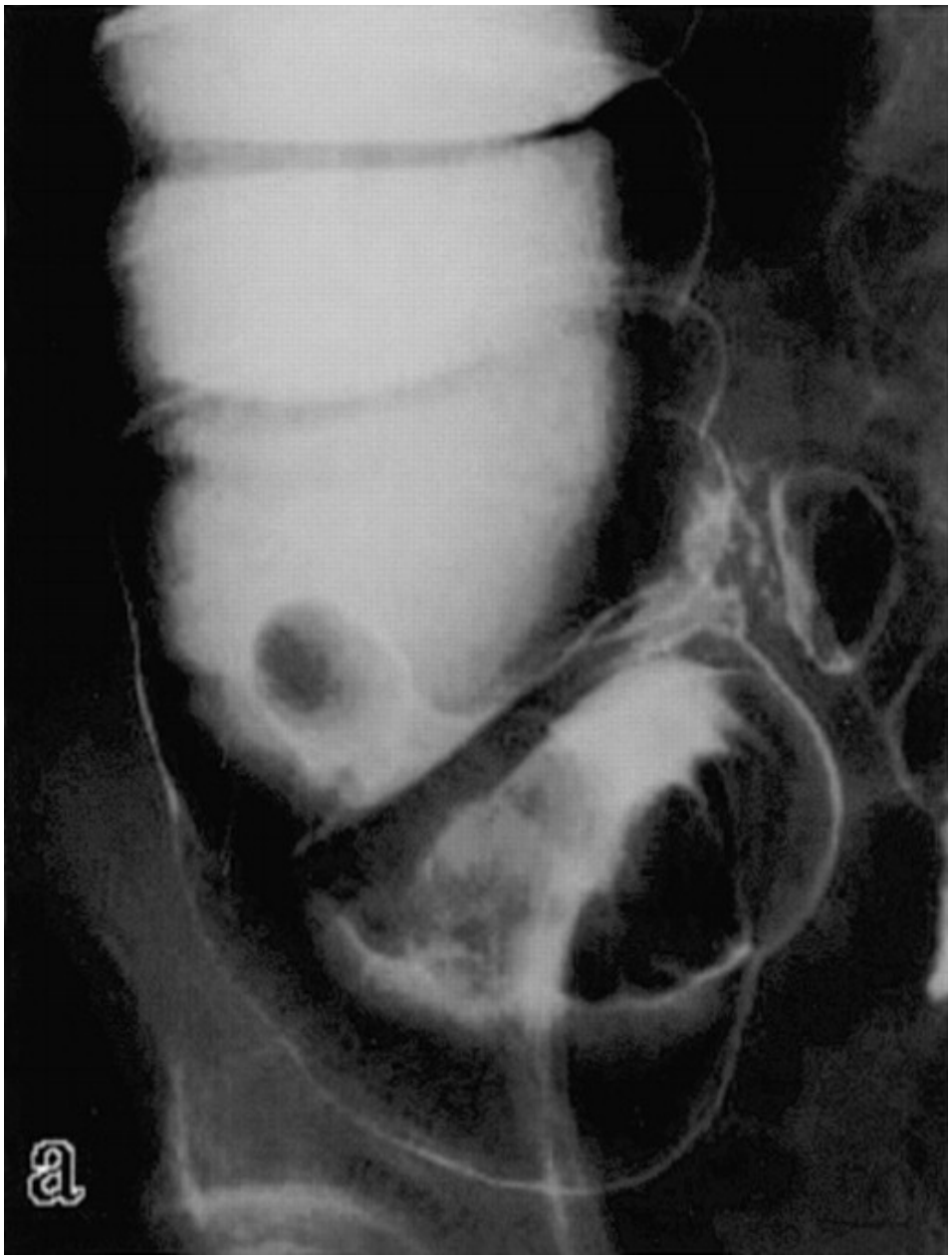


Figure 9: Double-contrast barium enema showing a tumor causing irregular filling defect in the cecum

e. Contrast enhanced computed tomography of abdomen

Allan MacLeod Cormack and Godfrey Newbold Hounsfield (awarded the Nobel Prize for Physiology or Medicine in 1979) are generally credited with inventing computed tomography. Although the Norwegian Abel conceived the idea of tomography significantly earlier (in 1826), and then the Austrian Radon developed it further, it was only the solution proposed by Cormack and Hounsfield that fully deserves the name computed tomography.[31]

The first experiments to produce CT images were carried out on a human brain prepared in formalin, the brain of a living calf and the kidneys of a pig and it was difficult to differentiate the healthy tissues from the unhealthy. Nevertheless, after about 2.5 hours of reconstruction process and about 28 thousand measurements, an image was obtained with enough contrast to enable the observation of the differences between the tissues of the brain. The resolution of the image was 80 X 80 pixels. Hounsfield finally patented his device in 1968. [31]

The first tomographic examination was of a woman with a suspected brain tumour took place on 1 October 1971. On the image obtained, it was possible to differentiate clearly between the physiological areas of the brain and the round, darker pathological area where a cyst was developing. [31]

In an extremely short time span there has been much progress in their design and manufacture. Contemporary computed tomography (CT) scanners today can scan in a few hundred milliseconds and reconstruct an image of 2048 X 2048 pixels. [31]

CT with refinements of intravenous and enteral contrast application has revolutionized imaging of peritoneal and extra peritoneal spaces, abdominal parenchymal organs and bowel wall diseases. Multidetector CT (MDCT) has the advantage of sagittal and coronal reconstructions of similar quality as axial imaging.

In cases of colonic pathologies, it help us in much better evaluation of perilesional spread, enlarged lymphnodes and the liver, etc. But it requires intravenous, oral and/or rectal contrast for much better delineation of the lesion than plain scans which can lead to contrast reactions in few cases.

MDCT has created unparalleled increase in spatial and temporal resolution combining narrow scan collimation with rapid data acquisition. MDCT has the advantage of sagittal and coronal reconstructions of similar quality as axial imaging.

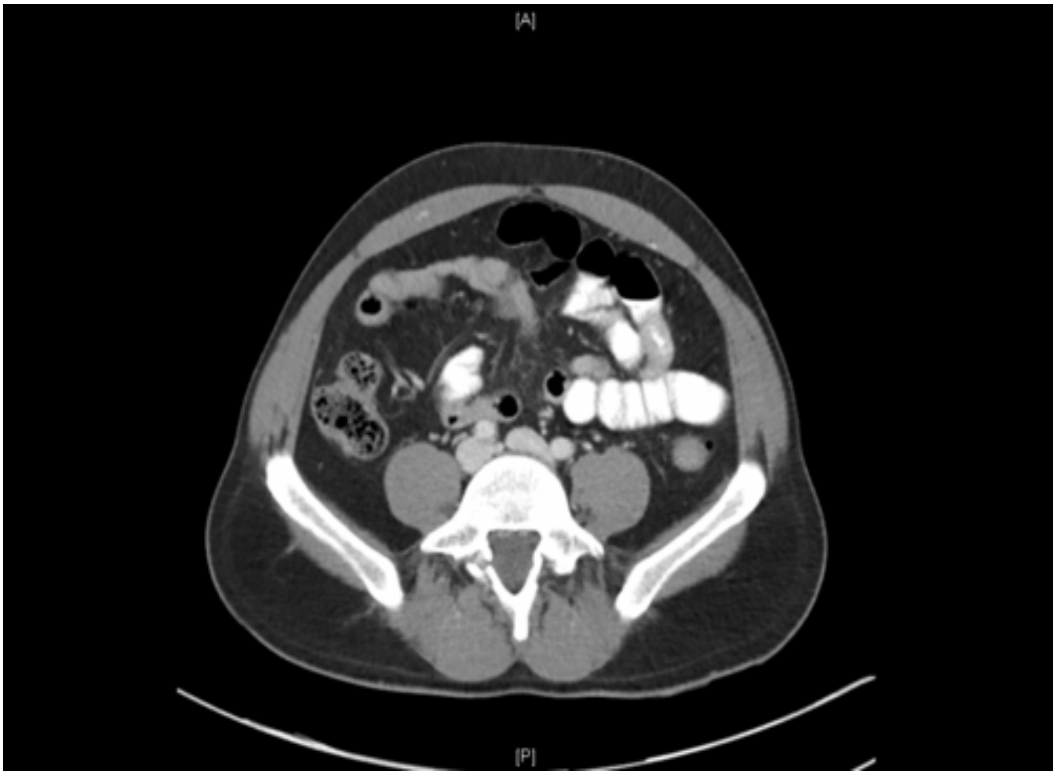


Figure 10: Normal post IV and oral contrast CT axial image of abdomen

f. Computed tomographic "virtual" colonoscopy

Computed tomographic "virtual" colonoscopy (VC) is a relatively recent radiological examination that uses CT technique and dedicated interactive three-dimensional (3D) and two-dimensional (2D) imaging software to evaluate the colon.

Drs. Vining and Gelfand presented the first VC fly-through video in February 1994.[32] Since then there has been ongoing research in the field of virtual colonoscopy which lead to clinical trials, software development, stool opacification, electronic subtraction, MR imaging virtual colonoscopy, optimization of CT technique, the study of interpretation visualization methods, radiation dose evaluation, the study of extracolonic findings, and computer aided design (CAD). The Navigator (GE Medical Systems, Milwakee, WI), introduced at the annual meeting of the Radiological Society of North America in November 1995, was the first commercial VC product to appear on the market. More than 20 virtual endoscopy products are available today.[32]

The colon is distended by insufflation of air or carbon dioxide, via a small plastic rectal tube. Antispasmodic agents (Buscopan or Glucagon) are often used to relax the bowel for adequate distention which in turn aids in proper evaluation of colon. Contrast media may be administered intravenously before the CT scan. Recently, the use of oral contrast agents (such as barium, water-soluble low-osmolar iodine or gastrografin) has been introduced. The oral contrast medium opacifies residual stool or fluid, thus allowing

discrimination from polyps, resulting in so called “fecal” or “fluid tagging”. Additionally, it is possible to perform an “electronic cleansing”, i.e. the CTC software recognizes areas with high density (corresponding to oral contrast mixed with stool or fluid) and subtracts it from the images. The CT scan may be performed in supine and prone positions during breath-holding. No sedation or analgesics are required.

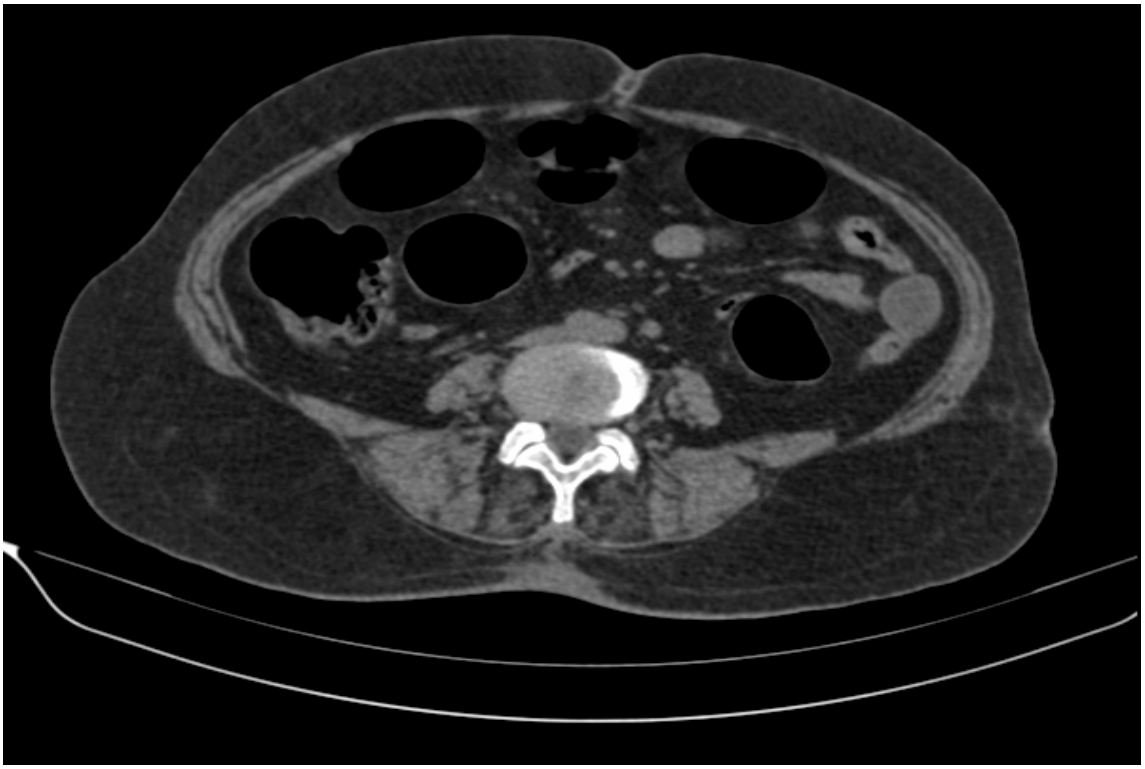


Figure 11: Axial plain CT image of abdomen at the level of umbilicus after rectal insufflation of colon

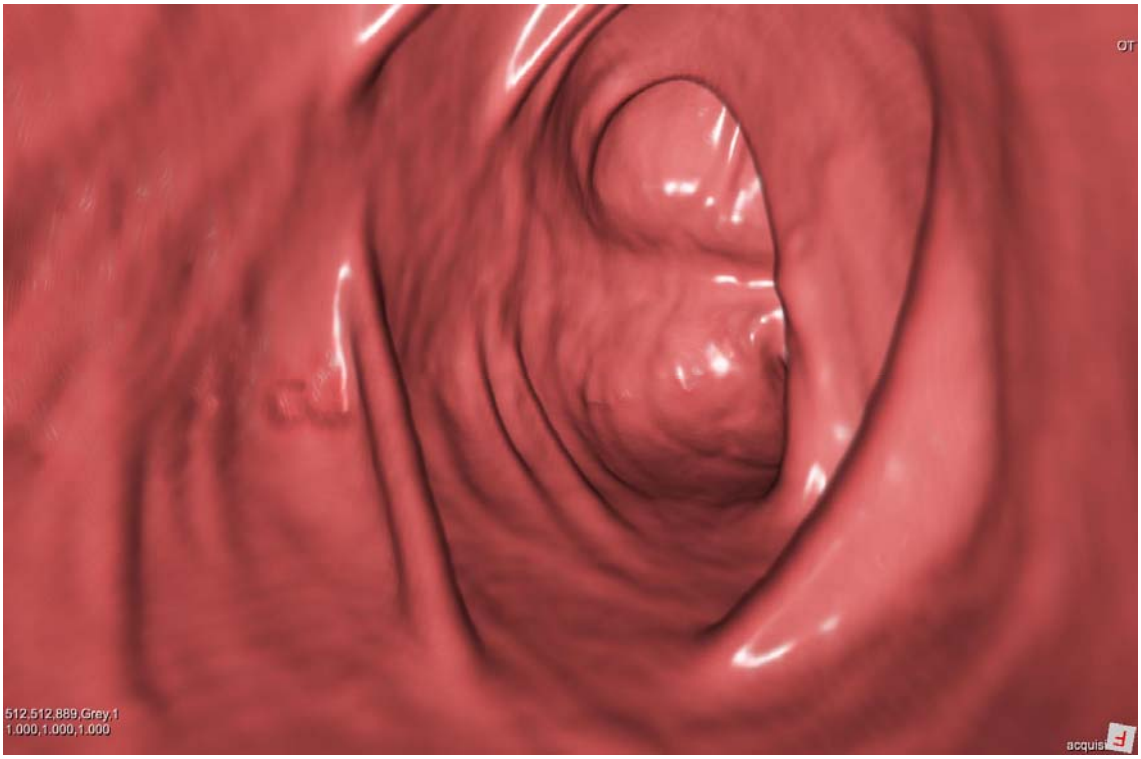


Figure 12: Normal virtual colonoscopy image of colon

g. Virtual magnetic resonance (MR) imaging colonoscopy

MR imaging has been employed to avoid the use of ionizing radiation, particularly in a healthy screening population. Liquid gadolinium enema is used in most protocols, which must be retained by the patient during the period of MR scanning, to distend the colon and provide a high-contrast interface with the colonic mucosa. Distending the colon with air or carbon dioxide has met with limited success due to artifacts. Although sensitivity and specificity rates have been good in the hands of experts, widespread use of MR imaging virtual colonoscopy is limited by the lower resolution of MR imaging as compared with CT, and by the concern for contamination of the MR table with gadolinium if the patient cannot retain the liquid enema for the duration of the entire examination. Research efforts are under way to study MR virtual colonoscopy in larger cohorts and to develop new protocols that would permit a good-quality examination while using gaseous distension of the colon. [32]

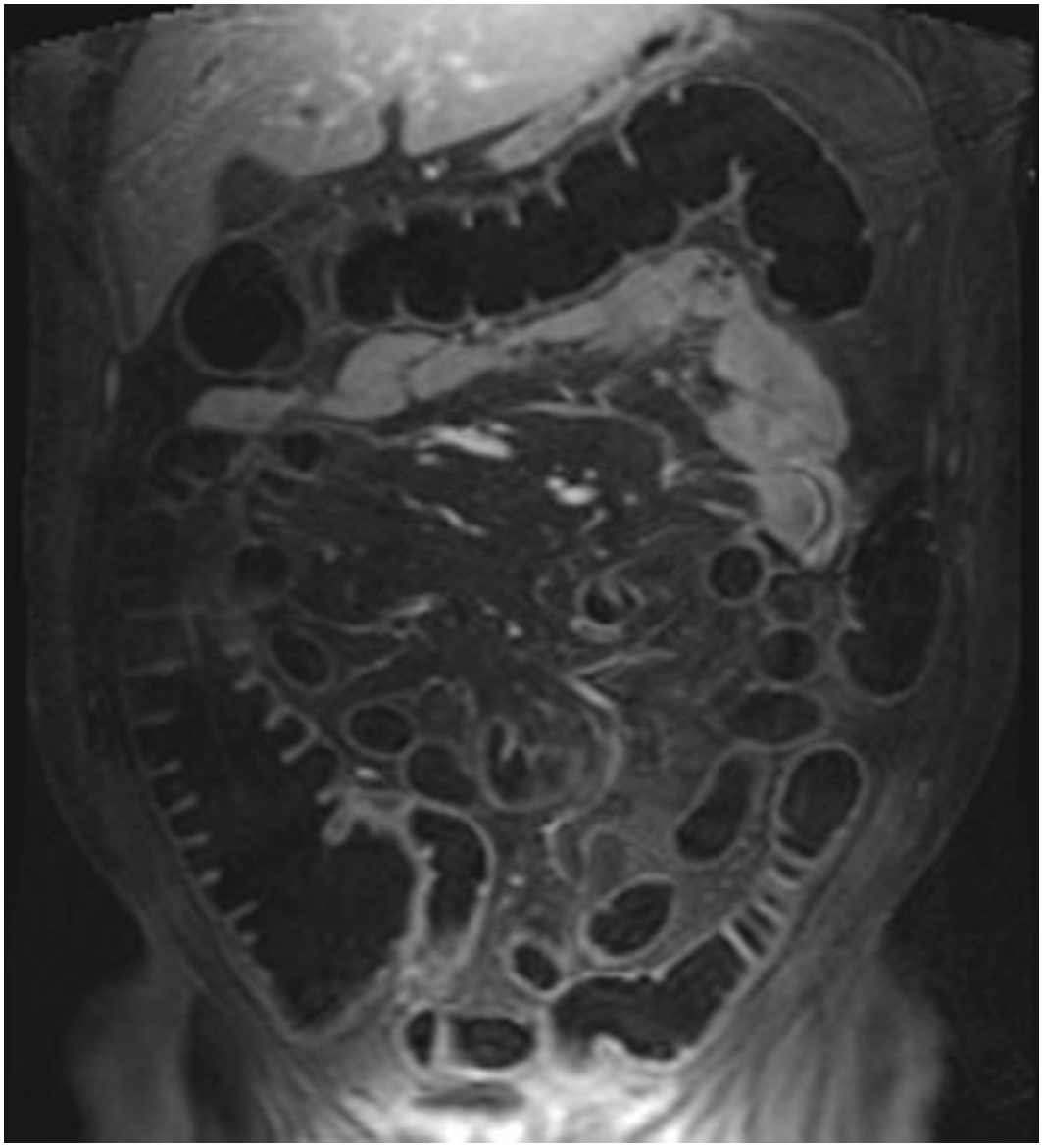


Figure 13: T1-weighted gradient echo magnetic resonance (GRE MR) colonography image

h. Capsule endoscopy

Capsule endoscopy (CE) is a simple, safe, non-invasive, reliable technique, well accepted and tolerated by the patients, which allows complete exploration of the small intestine. Lately this technique has also been used for esophageal and colonic diseases as well.[33]

The capsule endoscope is a disposable, small, swallowable, wireless, miniature camera which allows us to get a direct visualization of the gastrointestinal mucosa.[34]

The capsule which measures only 11 mm × 26 mm and weighs 3.7 gm holds a metal oxide semiconductor imaging chip video camera, 6 white light-emitting diode illumination sources, 2 silver-oxide batteries and a radio telemetry transmitter. The image filed is 140 degrees, magnification is 8x and the depth of view is 1 to 30mm. [35, 36]

Before the capsule is swallowed, 8 skin antennas are taped to the patient's anterior abdominal wall and connected to the hard drive. After an overnight fast, the patient swallows the capsule with a few sips of water and then the capsule is passively moved along by peristalsis. Two hours after ingestion, the patient is allowed to drink, while eating is allowed after 4 h. During the procedure the patient may carry on with his daily activities. [37]

The camera takes 2 images per second and transmits these by means of radio frequency to 8 skin antennas placed on the patient's abdomen and from here to the hard drive in a belt that the patient wears for the duration of the battery life (8 h). The capsule is excreted with the feces, usually within 24 to 48 hours. CE is usually performed as an outpatient procedure. [37]

The presence of intestinal contents or a motility disorder may cause the incomplete visualization of the intestinal mucosa. The main contraindication to performing CE is the suspicion or knowledge of an obstruction in the gastrointestinal tract. The retention of the device is the main complication of the procedure and is defined when CE remains in the digestive tract for a minimum of 2 weeks. [38] CE has also some clinical limitations which are problems in sizing and locating small bowel lesions, a possible false-negative CE result, due to the fact that the global miss rate is about 11%, ranging from 0.5% for ulcerative lesions to 18.9% for neoplastic disease and the fact that sometimes we can get findings of uncertain relevance in healthy subjects. [34]In almost 20% of procedures the capsule does not reach the cecum while it is active. Another drawback is that thousands of images are generated and these need to be studied in order to pick up a lesion, hence the study is time consuming and prone to errors, viz, missing the lesion. [37]

Figure 14: Capsule endoscope

Figure 15: Parts of capsule endoscope

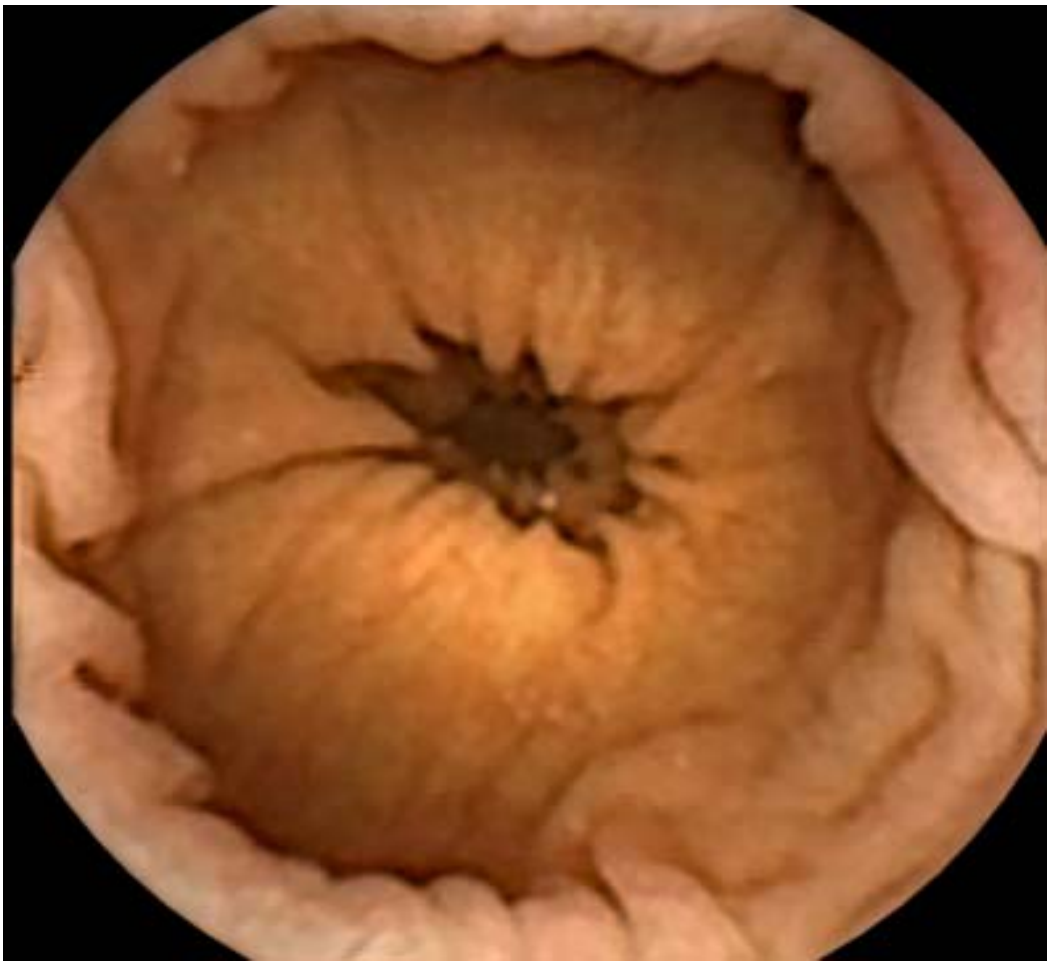


Figure 16: Image of the colon acquired by capsule endoscopy

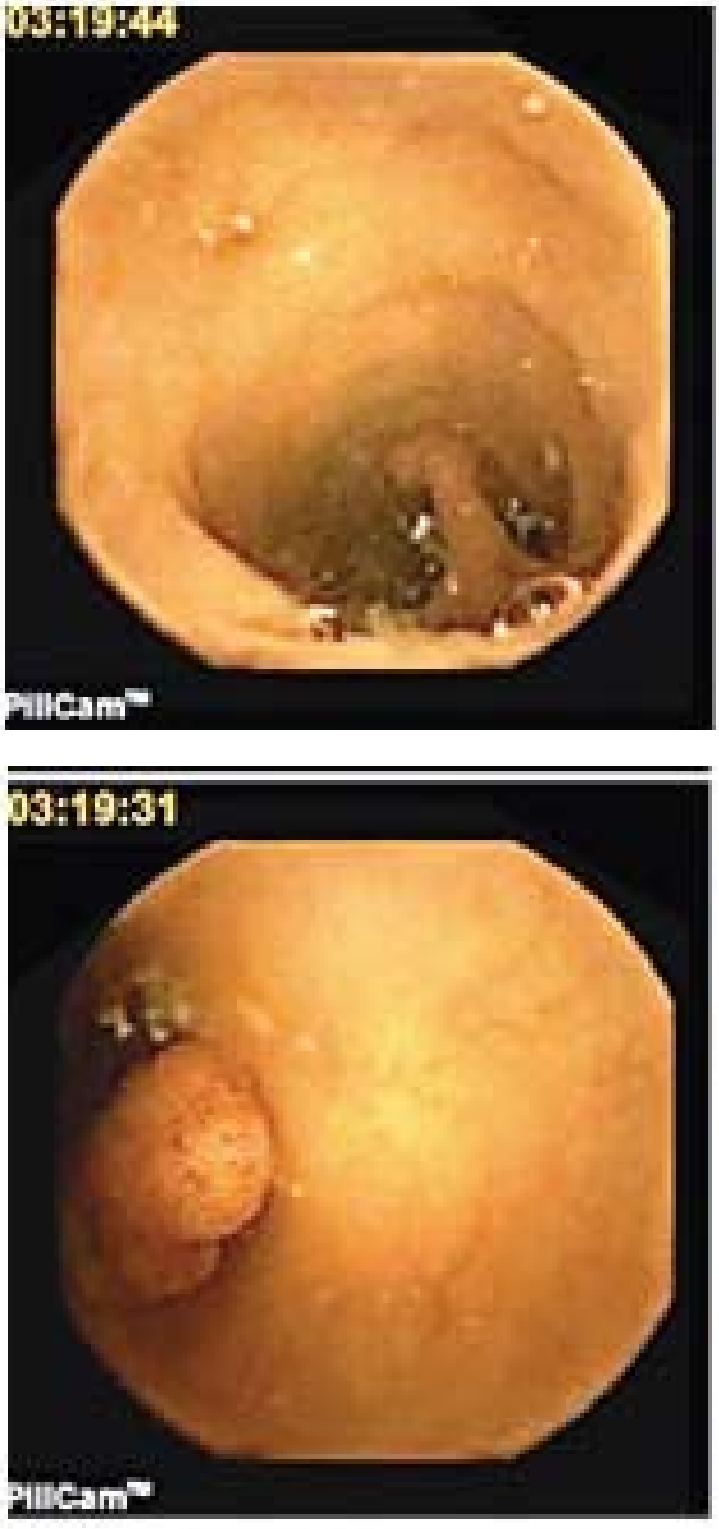


Figure 17:a & b: Pedunculated polyp in sigmoid colon

AIMS AND OBJECTIVES

- To evaluate the sensitivity and specificity of computed tomography "virtual" colonoscopy (VC) in detection and diagnosis of colorectal pathologies.
- Computed tomography "virtual" colonoscopy (VC) is compared with conventional colonoscopy (CC) which is presently the gold standard.

REVIEW OF LITERATURE

The need for CRC screening has been well documented. The current recommendations for screening by the American Cancer Society for the average-risk population consist of a yearly fecal occult blood test with sigmoidoscopy every 5 years, or colonoscopy every 10 years, or double-contrast barium enema every 5-10 years beginning at age 50. CC has been considered to be the most effective screening test. The information provided by CC is not available when using contrast radiography such as colonic mucosa, surface details like presence of blood, pus or mucus in the lumen, etc. Unfortunately, it is relatively uncomfortable, invasive, time-consuming, and expensive. Also, the entire colon cannot be examined with colonoscopy in approximately 15% of patients.[39,40]

In recent times, VC has emerged as a promising tool in colorectal evaluation of patients with proven carcinoma of colon and in patients with colorectal polyps. It is being evaluated as a potential new screening tool for CRC and polyps.

VC technique uses standard helical CT images of the colon and advanced imaging software to produce reformatted two- and three-dimensional views of the entire colon. Computer-rendered three-dimensional images simulate the endoluminal image seen at CC.

In various studies VC showed several advantages over CC, which are:

- High patient acceptance
- Simple and reliable
- Better patient compliance as it is less painful.
- No risks due to sedation as sedation is not required.
- No risk of perforation.
- Complete evaluation of colon in cases where entire colon could not be evaluated due to narrowed lumen by carcinoma colon.
- Staging can be accomplished as entire abdomino-pelvic is evaluated.

The main disadvantages are:

- Low sensitivity for detection of polyps less than 5 mm
- Not able to obtain information about the histopathology, so patient has to undergo conventional colonoscopy with biopsy.
- Requires adequate bowel preparation as residual fluid may obscure the lumen and residual fecal matter may give false positive results.
- Residual fecal matter or mucus cannot be removed during examination.
- Does not provide information about the mucosa or early surface inflammatory changes or small ulcerations.
- Ionizing radiation to the patients.
- Time consuming.

Studies on VC Performance

VC has emerged as a potential alternative or complement to CC and DCBE in the detection of CRC and polyps.VC is more sensitive and more specific than DCBE concerning polyps ≥6 mm.[41-44] Concerning comparison of VC versus CC, several meta-analyses suggest that VC has excellent average sensitivity concerning identification of patients with CRC (96%, range 80-100%) and very good average sensitivity (82-93%, range 48-100%) and specificity (97%) concerning patients with largeadenomas.[42,45,46] Accuracy of VC diminishes with decreasing polyp size, with an average sensitivity for polyps <5 mm of only 50%.Some conflicting results on VC performance have, however, been published. In one of the studies, the authors had excellent results on 1233 screening individuals with asensitivity of 94% for VC concerning patients with large adenomas, even higher than for CC (87.5%).[47] Two subsequent large studies had, however, disappointing results with VC sensitivity for patients with large polyps ranging from 55% to 64%.[43,48] A retrospective analysis of the data from one of the studies[43] showed that most of the polyps missed were perceptual errors, i.e. observer-related.[49] A criticism toward those two studies was raised concerning the lack of experience and inadequate training of the readers. Further multicenter trials have recently been performed in order to assess the potential of VC. In the ACRIN (American College of Radiology Imaging Network) trial[50] on 2531 screening individuals, the radiologists who read the VC datasets had an experience of at least 500 CTC or were trained and had to pass a test of their diagnostic ability before participating the trial. More than half of the readers had to

undergo additional training in order to pass the test. The newly published IMPACT trial (Italian Multicenter Polyp Accuracy Computed Tomography Colonoscopy)was performed on 937 individuals including asymptomatic individuals at higher than average risk and individuals with positive FOBT.[51] Radiologists with experience of at least 50 VC could participate. The ACRIN and IMPACT trials reported per-patient sensitivity of 90% and 85%, respectively, for large polyps and per-patient specificities over 85%. These results suggest that VC is an accurate test for detection of CRC and large polyps when performed by trained readers.

VC Indications

VC is currently performed in symptomatic patients in cases of failed or incomplete CC[52], which may be due to an obstructing colorectal cancer, diverticular disease, redundant colon, adhesions, residual colonic content and patient intolerance to CC because of excessive pain or discomfort. VC can visualize the colon proximal to a stenosing cancer and can thus evaluate any synchronous colonic lesions and at the same time evaluate the abdomen for local tumor spread, and liver or lymph node metastases for staging. VC can preferably be performed the same day as the failed CC in order to avoid a second bowel preparation. VC is preferred also in patients where CC is contraindicated (patients with cardio-pulmonary disease, bleeding disorders or anticoagulant therapy, elderly frail patients) or who refuse CC.

VC has less complications compared with CC, with a reported perforation rate between 0.03% and 0.009%.[53] Most of the studies on patient discomfort show either better acceptance of VC than of CC[54-56], or no difference between the two methods.[57,58] However, this issue is complex and depends not only on the actual experience of pain and discomfort during the examination but also on factors such as the use and effects of analgesics and sedatives at CC, and how patients are informed beforehand about the procedures and the potential need for follow-up examinations.

There is a general consensus that VC should replace DCBE as the radiological investigation of choice for the diagnosis of CRC and polyps.[59,60] Unlike DCBE, VC does

not require turning the patient in different positions and is better tolerated by the patients.[56,57,61,62]

VC is not indicated in inflammatory bowel disease (Crohn, ulcerative colitis) because it cannot give information on superficial ulcerations. Furthermore, patients with inflammatory bowel disease are at higher risk of developing CRC ex novo, i.e. which does not follow the adenoma-carcinoma sequence.

VC can however, be considered in such cases where CC is incomplete due to severe stricture of a colonic segment. In the USA, VC has recently been suggested by the American Cancer Society as alternative imaging method for CRC screening.[24] In Europe, VC is increasingly used in symptomatic patients. A survey in the United Kingdom showed that VC is performed especially in cases of failed whole colon examinations and as an alternative to DCBE in frail patients.[63]VChas attracted attention primarily for detecting symptomatic CRC.

Implementation of new technologies is complex, since interpretation of e.g. scientific evidence, local traditions, individual preferences, costs, vendor marketing and multitudes of technical solutions influence the process. The introduction of VC as a replacement for DCBE or as a complement to CC may affect costs for the referring clinic, as well as investments for the radiology departments.

MATERIALS AND METHODS

Source of data:

Study was conducted on 30 patients who underwent conventional colonoscopy at R.L.Jalappa, Hospital and Research Center, Kolar attached to Sri Devaraj Urs Medical College, Kolar during the period of January, 2013 to June, 2014.

Method of collection of data:

- Patients were taken up for VC immediately after CC procedure.
- After taking informed consent, VC was performed using SIEMENS SOMATOM Emotion 16-SLICE SPIRAL CT by inflating the colon with room air using a catheter introduced through the anus and non-contrast scans were taken in supine position. Scan was subsequently taken in prone position in some patients when residual fluid in the lumen interfered with image interpretation.
- CT parameters used were:-
    - The detector configuration of 16 × 0.625 mm
    - Pitch - 1.7
    - Rotation time - 0.5 sec.
    - 25 mAs and 130 kVs
    - Axial reconstruction with a slice thickness of 0.6 mm
    - Two-dimensional images were obtained. Then three-dimensional images were generated on the Siemens workstation using flythrough technique.

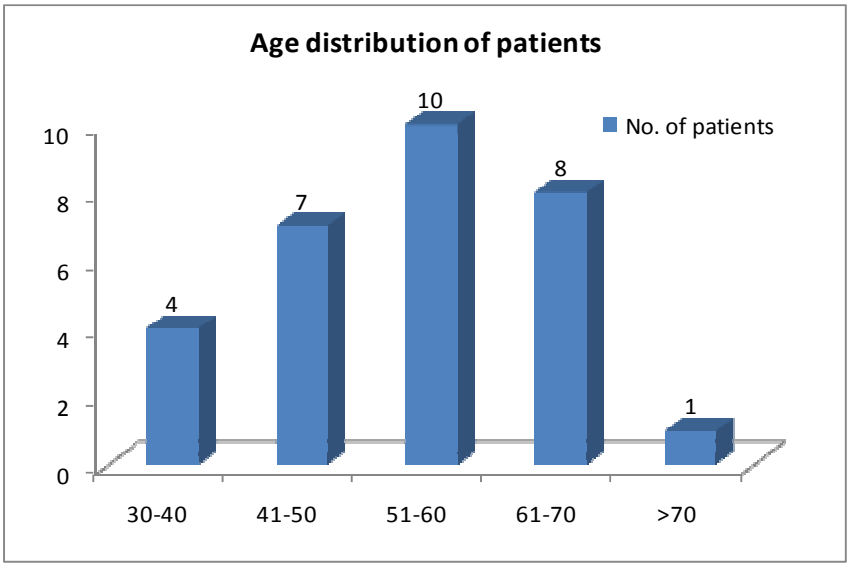
- Virtual colonoscopic findings were recorded and then compared with conventional colonoscopic findings.

RESULTS

The study was done on 30 patients comprised of 18 females and 12 males (mean age 56 +/- 12 years). Table 1 shows the age distribution and table 2 shows the gender distribution.

Age in years	**No. of patients**	**%**
30-40	4	**13.3**
41-50	7	**23.3**
51-60	10	**33.3**
61-70	8	**26.7**
>70	1	**3.3**
Total	**30**	**100.0**

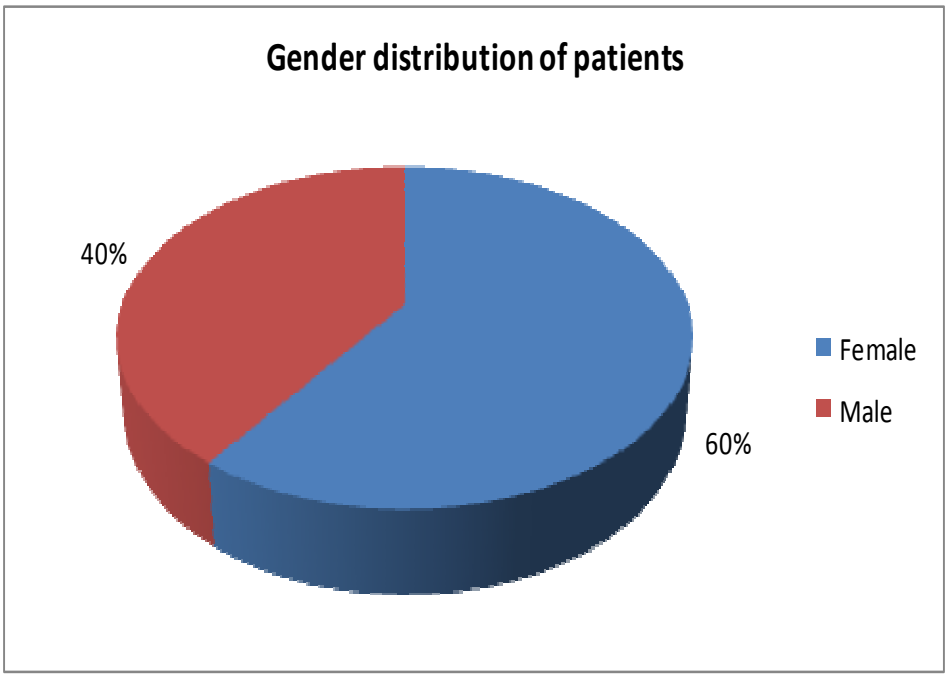
Table 1: Age distribution of patients studied



Graph 1: Age distribution of patients studied

Gender	No. of patients	%
Female	18	**60.0**
Male	12	**40.0**
Total	**30**	**100.0**

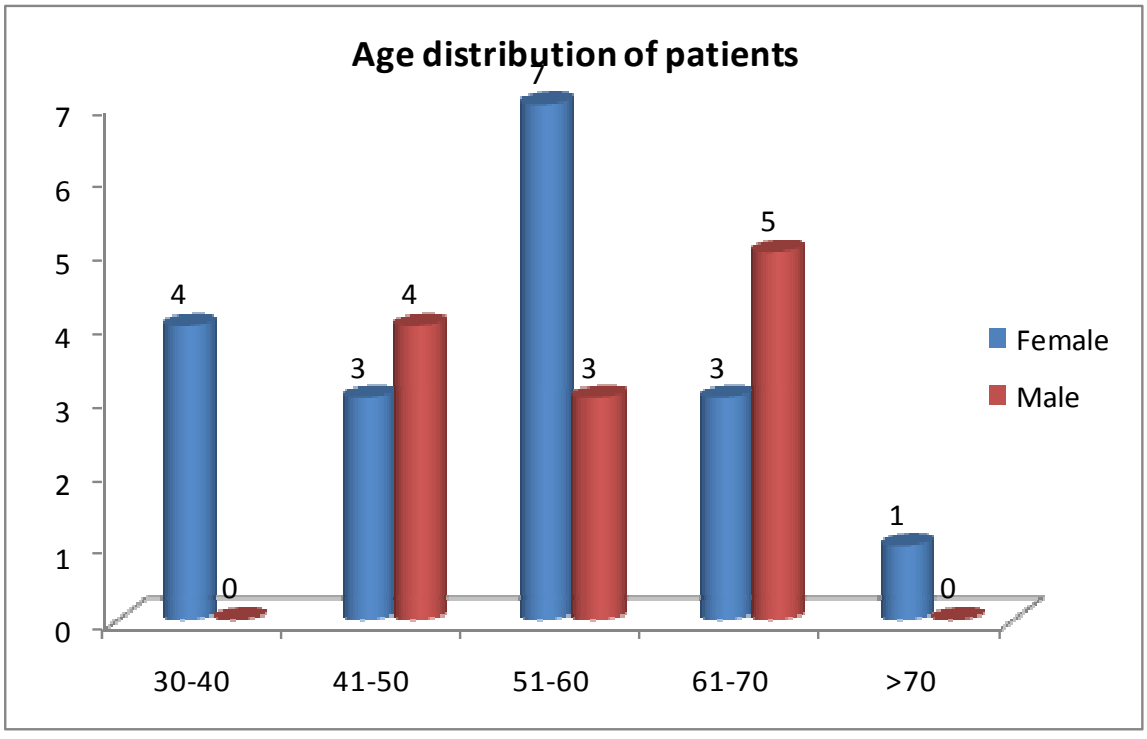
Table 2: Gender distribution of patients studied



Graph 2: Gender distribution of patients studied

Age in years	Gender		Total
	Female	Male	
30-40	4(22.2%)	0(0%)	**4(13.3%)**
41-50	3(16.7%)	4(33.3%)	**7(23.3%)**
51-60	7(38.9%)	3(25%)	**10(33.3%)**
61-70	3(16.7%)	5(41.7%)	**8(26.7%)**
>70	1(5.6%)	0(0%)	**1(3.3%)**
Total	**18(100%)**	**12(100%)**	**30(100%)**

Table 3: Age distribution of patients studied based on gender



Graph 3: Age distribution of patients studied based on gender

Lesions were more commonly found in rectum (n = 21; 70%) in both sexes with females being more affected.

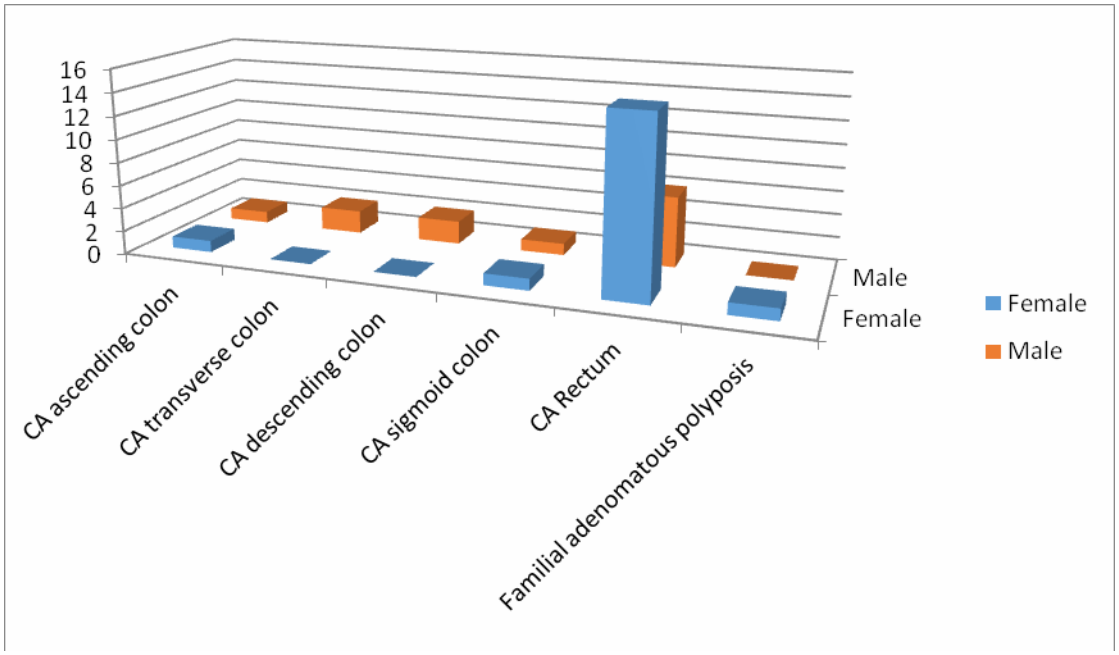
Lesions in ascending colon was seen in 2 cases, in descending colon was seen in 2 cases, in sigmoid colon was seen in 2 cases and in transverse colon was seen in 2 cases.

In 1 case of multiple adenomatous polyposis, multiple polyps were seen on CC up to the sigmoid colon. Beyond sigmoid colon, the colon was not evaluated as patient was not cooperating. In this case entire colon was evaluated by VC which showed multiple polyps involving the entire colon.

The intraluminal findings were similar in all cases on both VC and CC. In addition to that 20 cases showed fat stranding adjacent to the lesion and 20 cases showed regional lymphadenopathy on VC.

Conventional colonoscopy diagnosis	Gender		Total
	Female	Male	
Suspicious for CA ascending colon	1(5.6%)	1(8.3%)	**2(6.7%)**
Suspicious for CA transverse colon	0(0%)	2(16.7%)	**2(6.7%)**
Suspicious for CA descending colon	0(0%)	2(16.7%)	**2(6.7%)**
Suspicious for CA sigmoid colon	1(5.6%)	1(8.3%)	**2(6.7%)**
Suspicious for CA Rectum	15(83.3%)	6(50%)	**21(70%)**
Familial adenomatous polyposis	1(5.6%)	0(0%)	**1(3.3%)**
Total	**18(100%)**	**12(100%)**	**30(100%)**

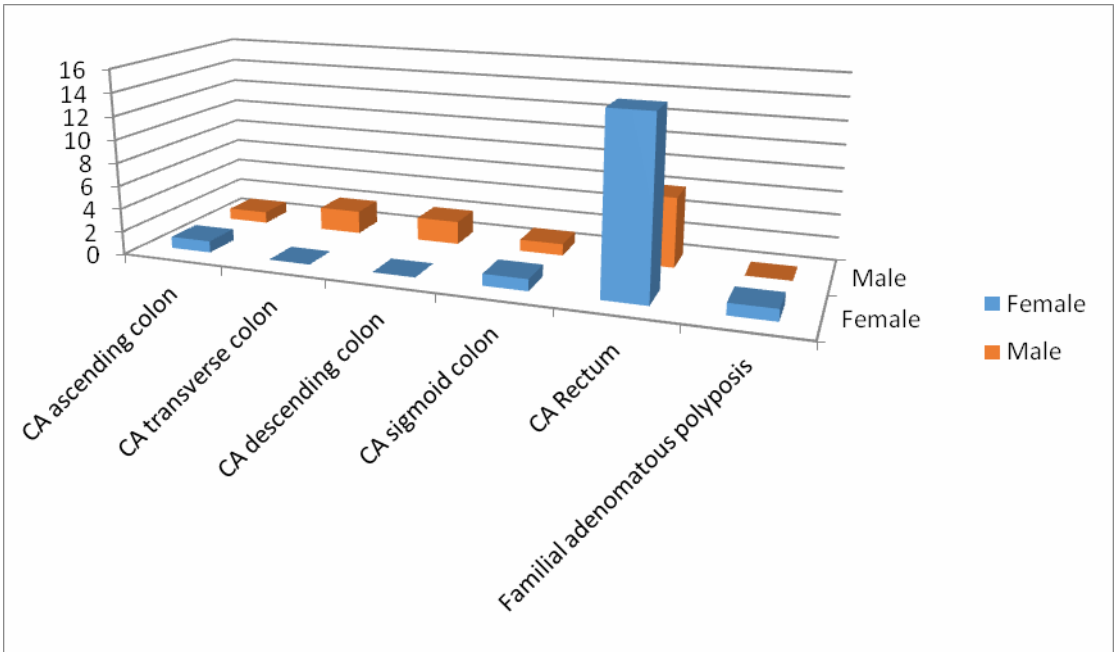
Table 4: Conventional colonoscopy diagnosis



Graph 4: Conventional Colonoscopy Diagnosis

Virtual Colonoscopy diagnosis	Gender		Total
	Female	Male	
Suggestive of CA ascending colon	1(5.6%)	1(8.3%)	**2(6.7%)**
Suggestive of CA transverse colon	0(0%)	2(16.7%)	**2(6.7%)**
Suggestive of CA descending colon	0(0%)	2(16.7%)	**2(6.7%)**
Suggestive of CA sigmoid colon	1(5.6%)	1(8.3%)	**2(6.7%)**
Suggestive of CA Rectum	15(83.3%)	6(50%)	**21(70%)**
Suggestive of Familial adenomatous polyposis	1(5.6%)	0(0%)	**1(3.3%)**
Total	**18(100%)**	**12(100%)**	**30(100%)**

Table 5: Virtual colonoscopy diagnosis



Graph 5: Virtual colonoscopy Diagnosis

In 16 patients complete evaluation of colon by CC was not possible due to luminal narrowing in 13 patients, 2 uncooperative patients and mucosal edema in 1 patient. In these patients, we were able to evaluate the entire colon by VC as we were able to visualize the colon beyond the obstructive lesion and there was better patient tolerance to VC.

In the patient of familial adenomatous polyposis complete evaluation of colon by CC was not possible since the patient was uncooperative and there was insufficient distention of colon for evaluation. However, on VC it was found that patient had perforation and therefore insufficient distention of colon. But on VC the entire colon was evaluated.

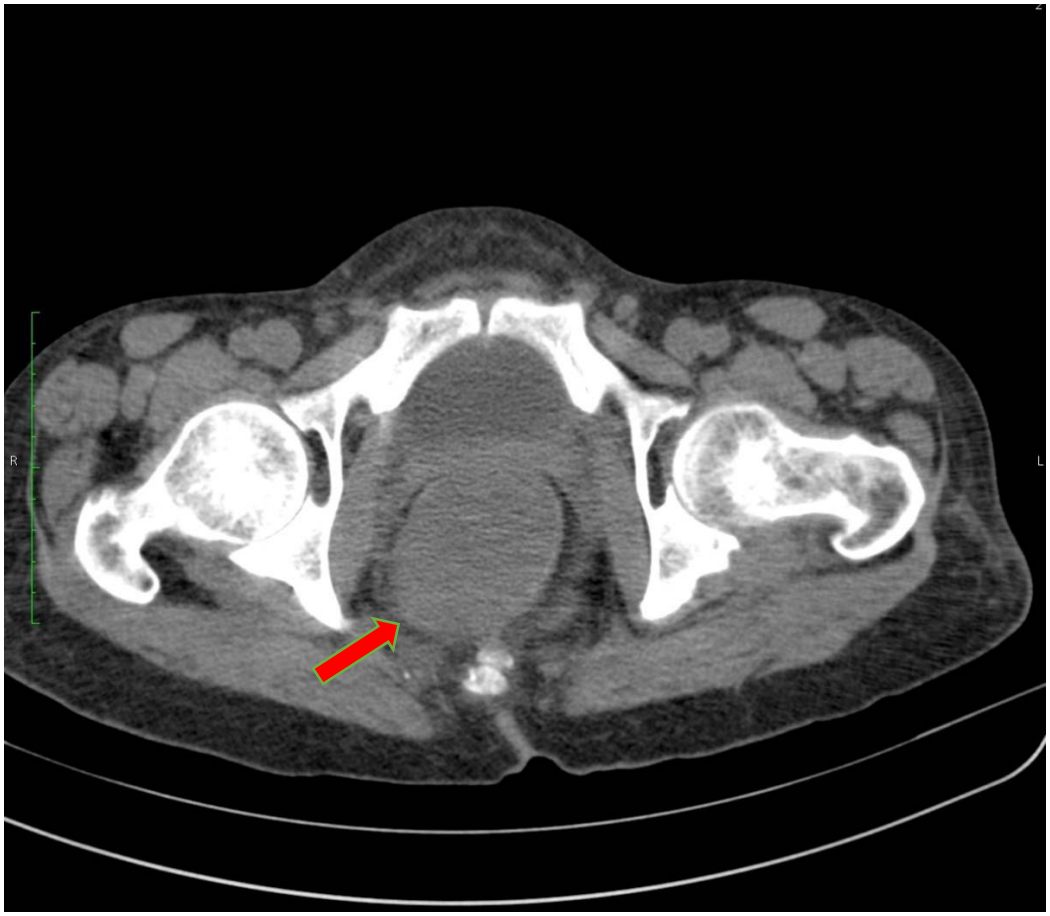


Figure 18: Large intra luminal mass in rectum causing near complete occlusion of lumen

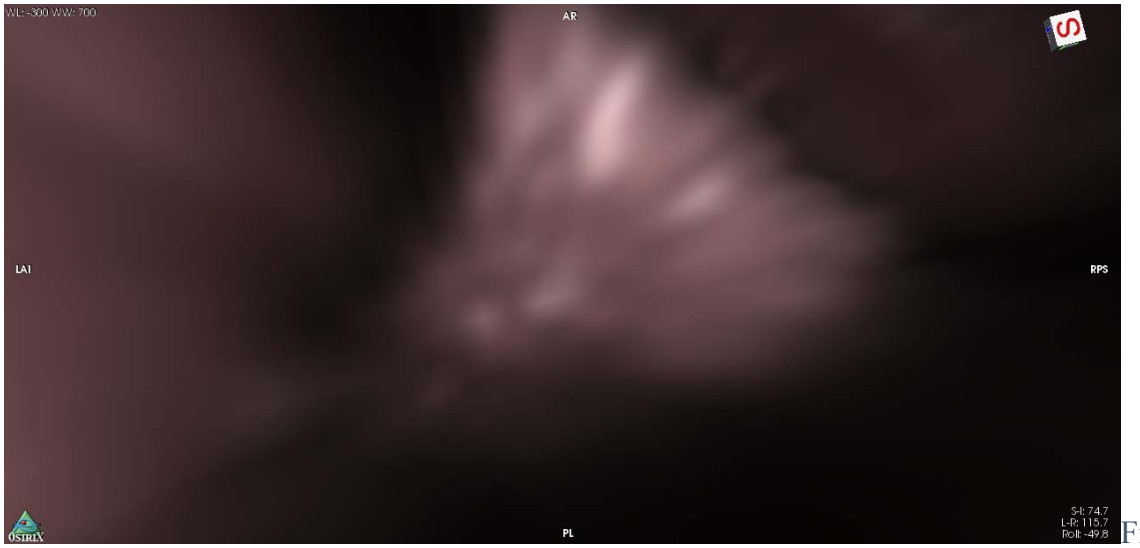


Figure 19: 3D reconstructed image of the same case showing near complete occlusion of rectal lumen

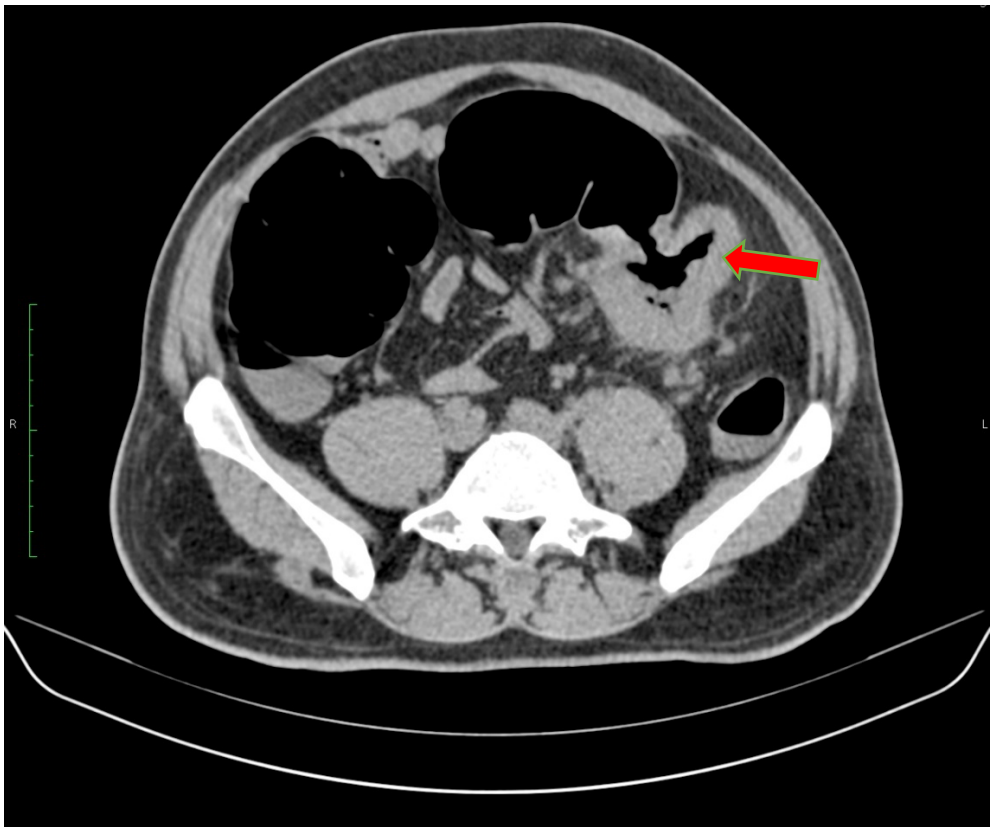


Figure 20: Circumferential mass lesion in descending colon causing luminal narrowing

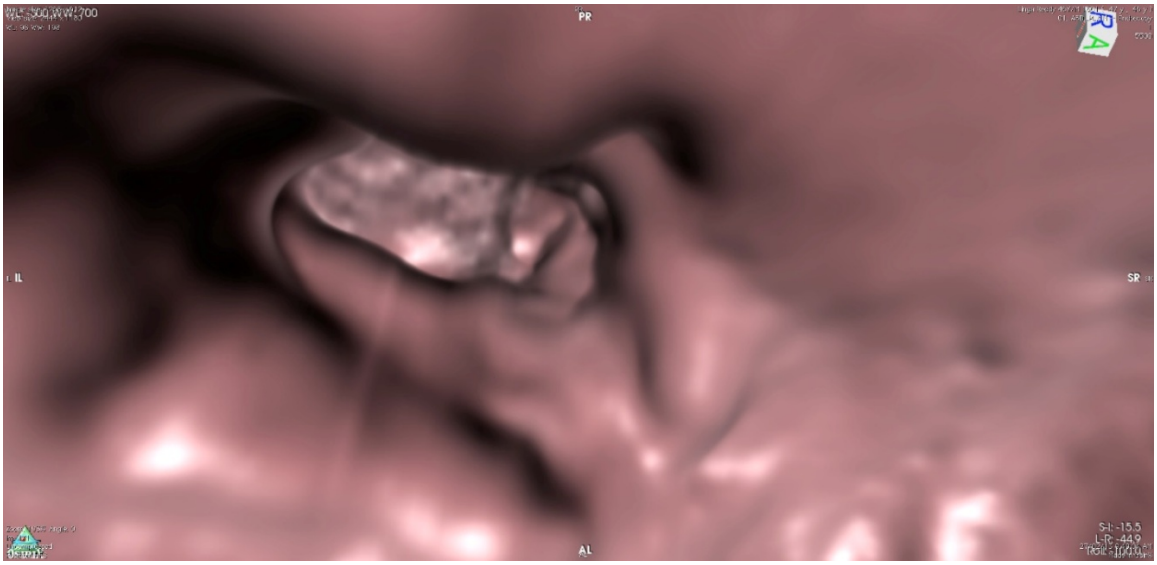


Figure 21: 3D reconstructed image of the same case showing narrowing of the lumen of colon

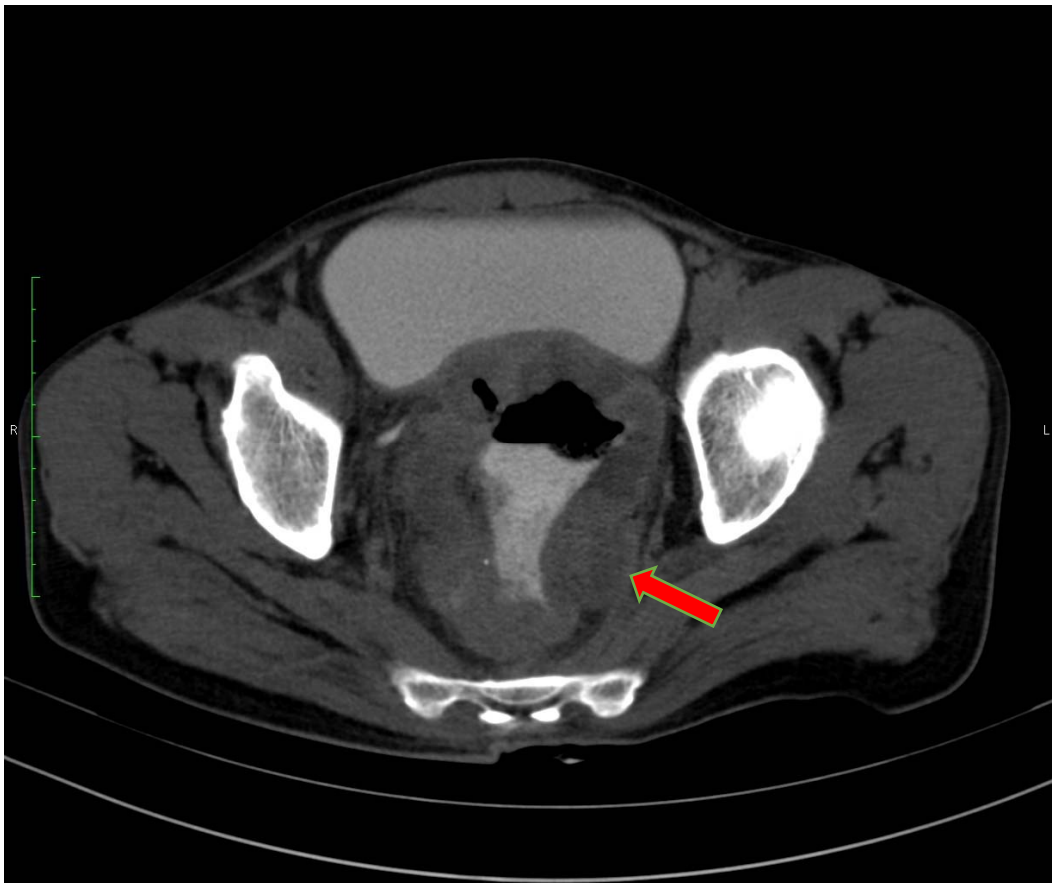


Figure 22: Case of diffuse circumferential rectal wall thickening with multiple intraluminal projections

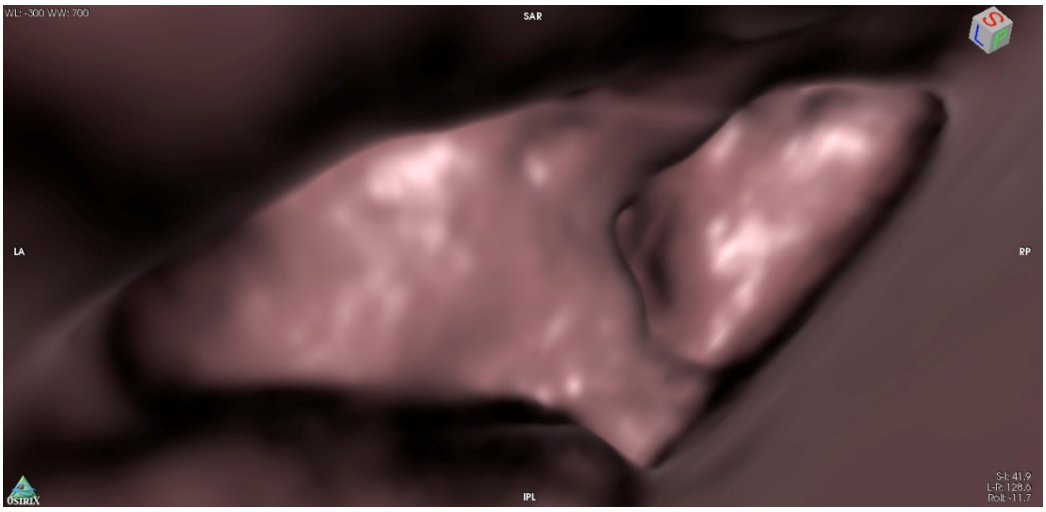


Figure 23: 3D reconstructed image of the same case showing luminal narrowing

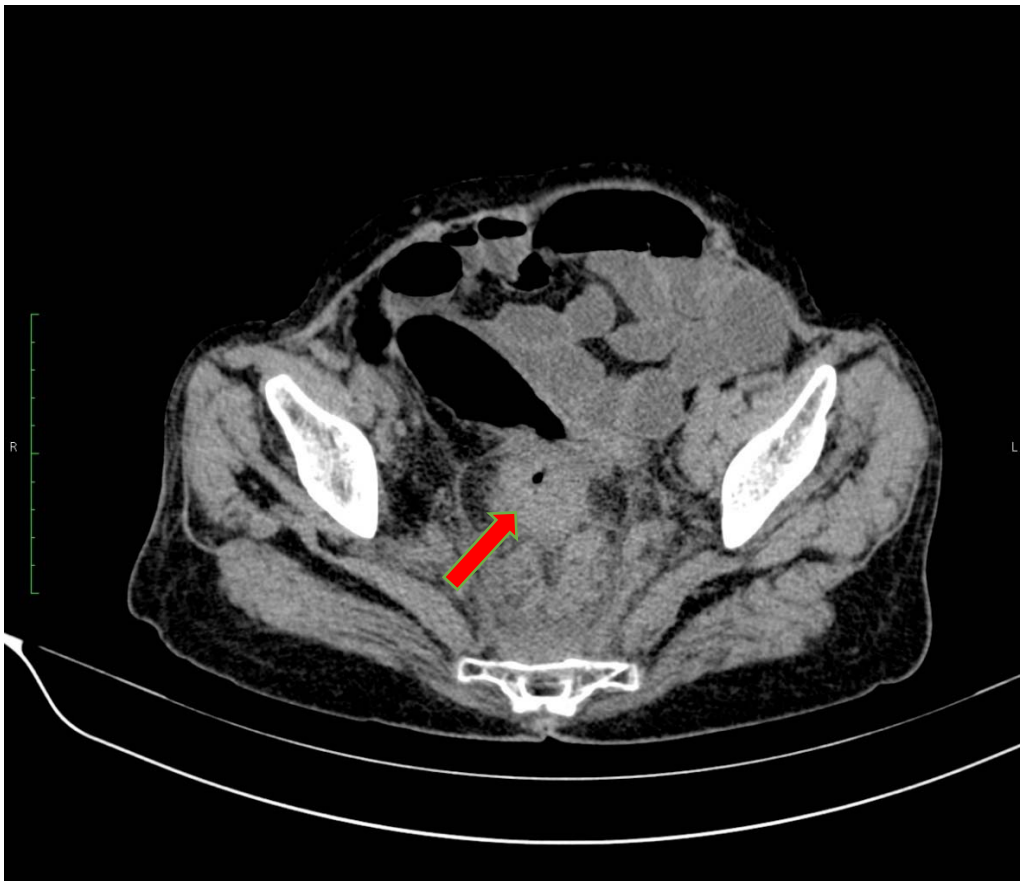


Figure 24: Case of circumferential rectal wall thickening causing luminal narrowing with perirectal fat

stranding

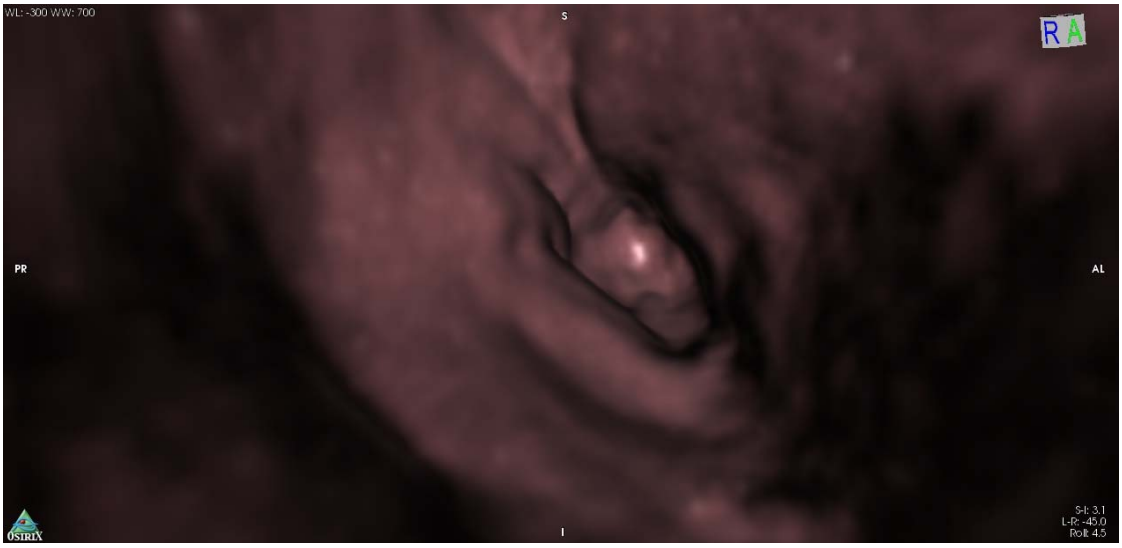


Figure 25: 3D reconstructed image of the same case showing luminal narrowing

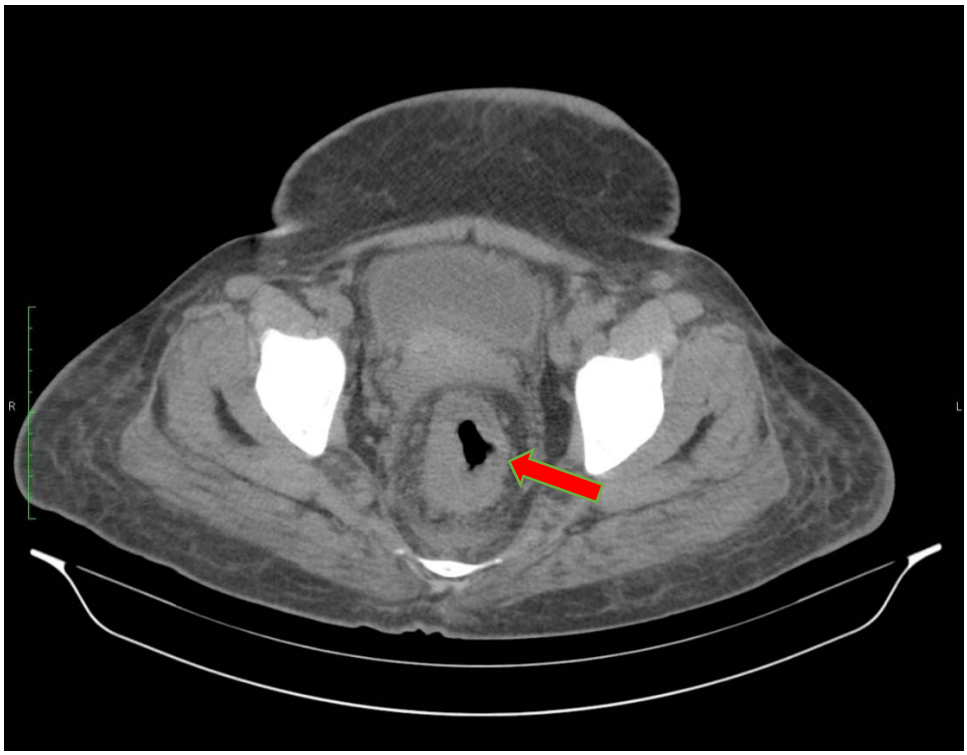


Figure 26: Case rectal of circumferential wall thickening

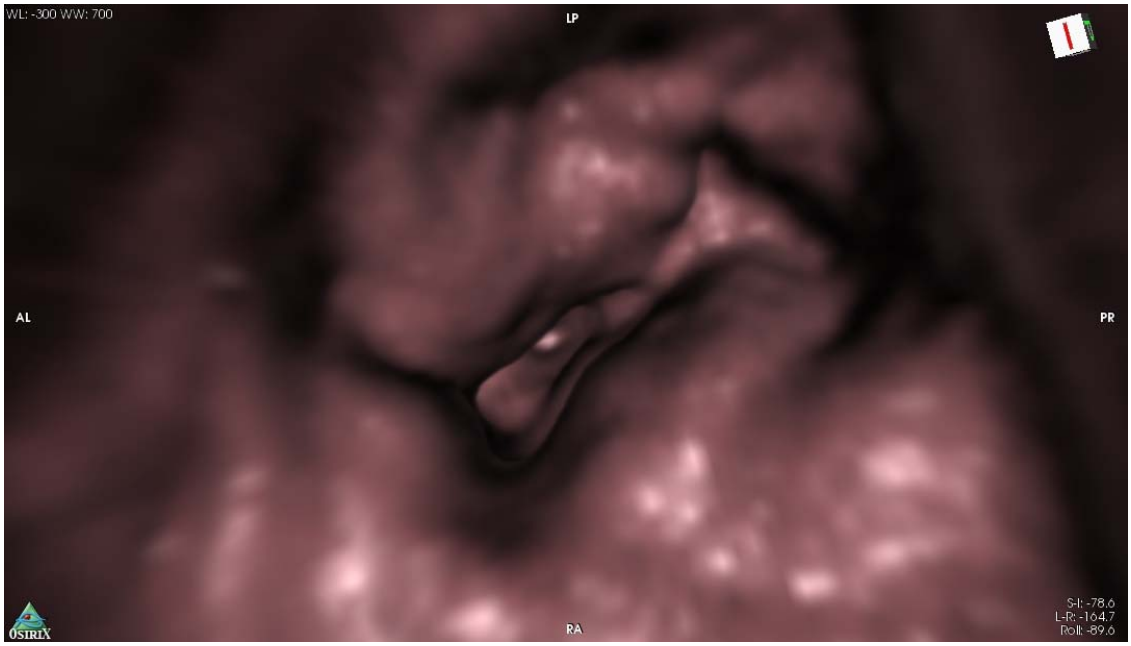


Figure 27: 3D reconstructed image of the same showing luminal narrowing

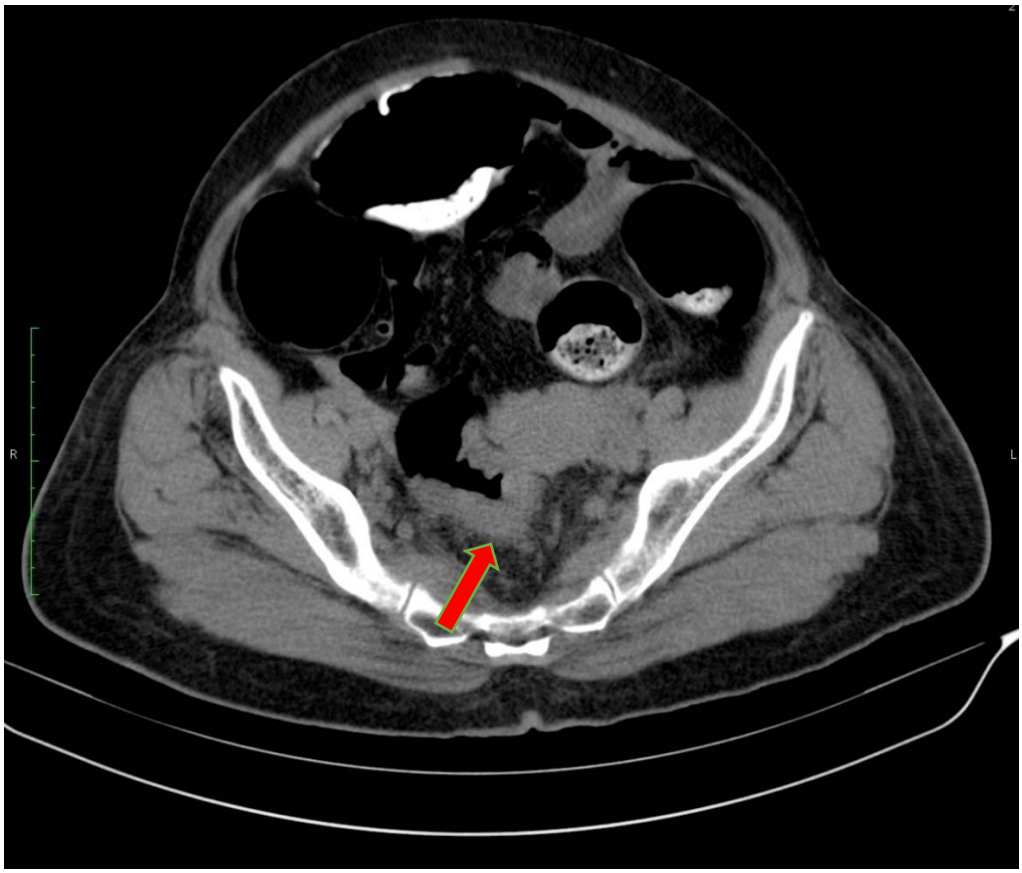


Figure 28: Case of irregular wall thickening of rectum with perirectal fat stranding

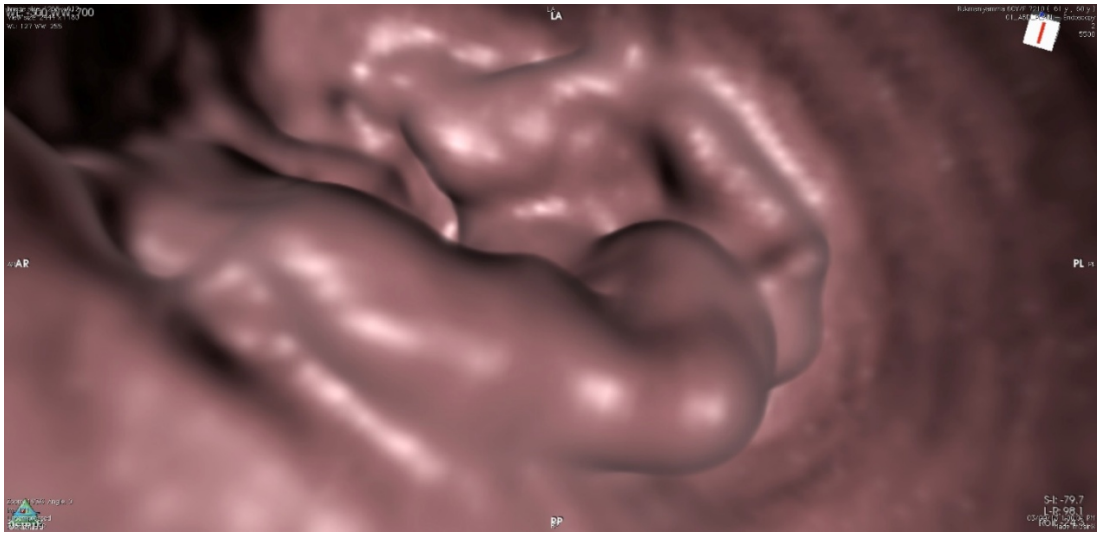


Figure 29: 3D reconstructed image of the same case showing luminal narrowing due to irregular intraluminal growth

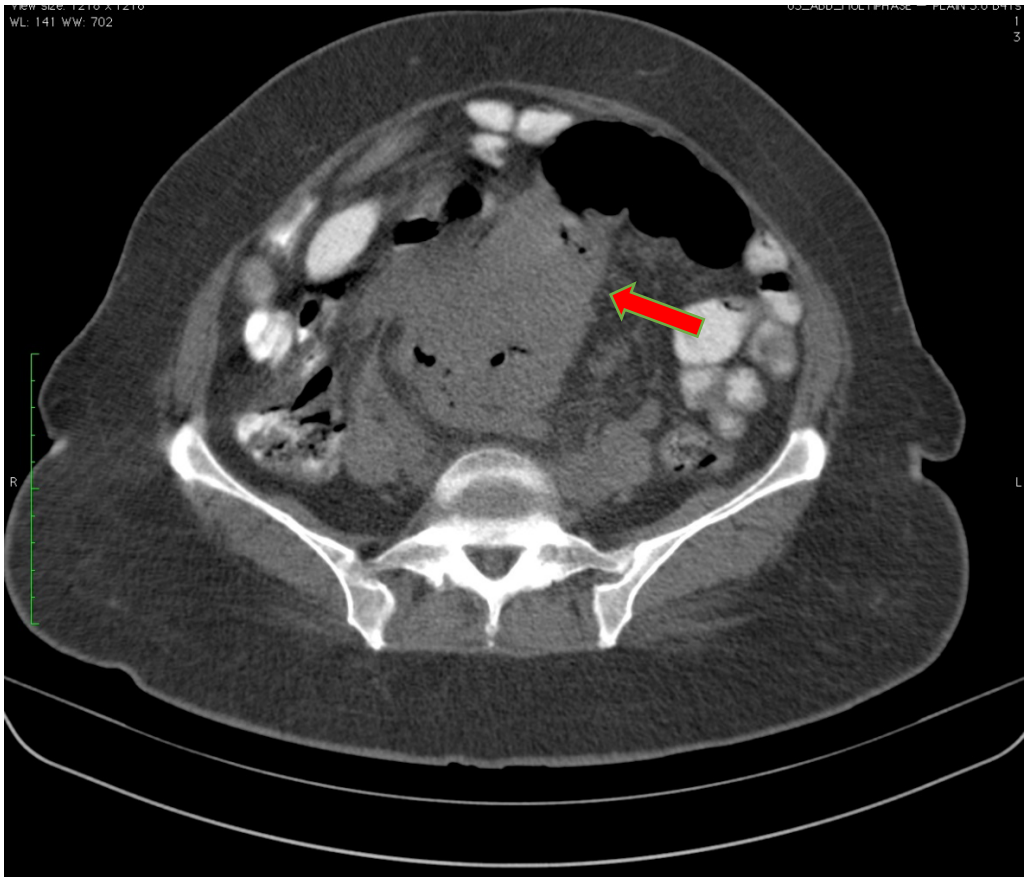


Figure 30: Case of asymmetrical circumferential wall thickening of sigmoid colon

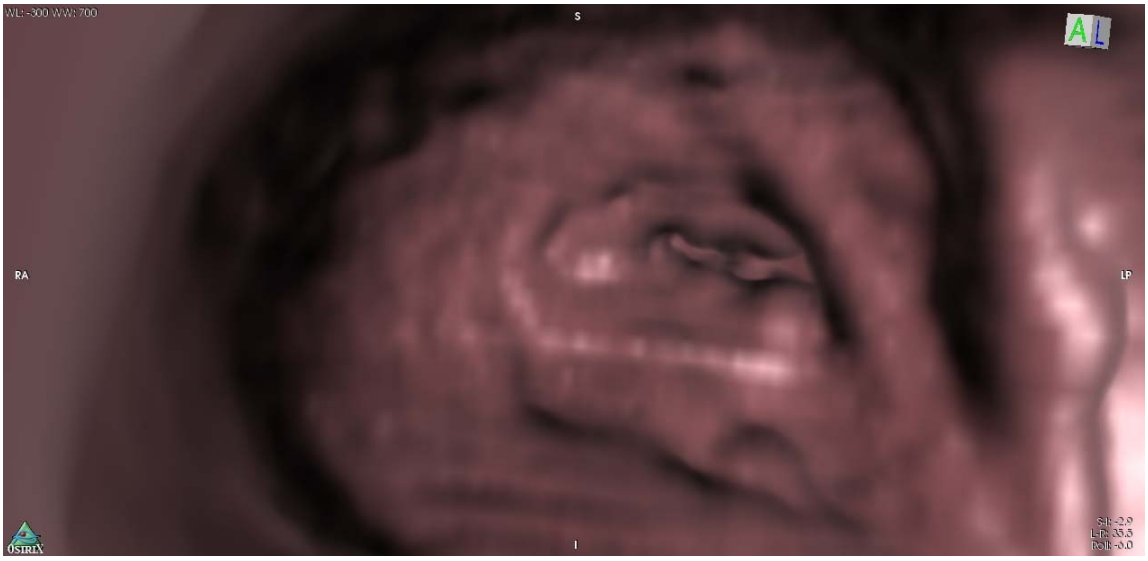


Figure 31: 3D reconstructed image of the same case showing luminal narrowing

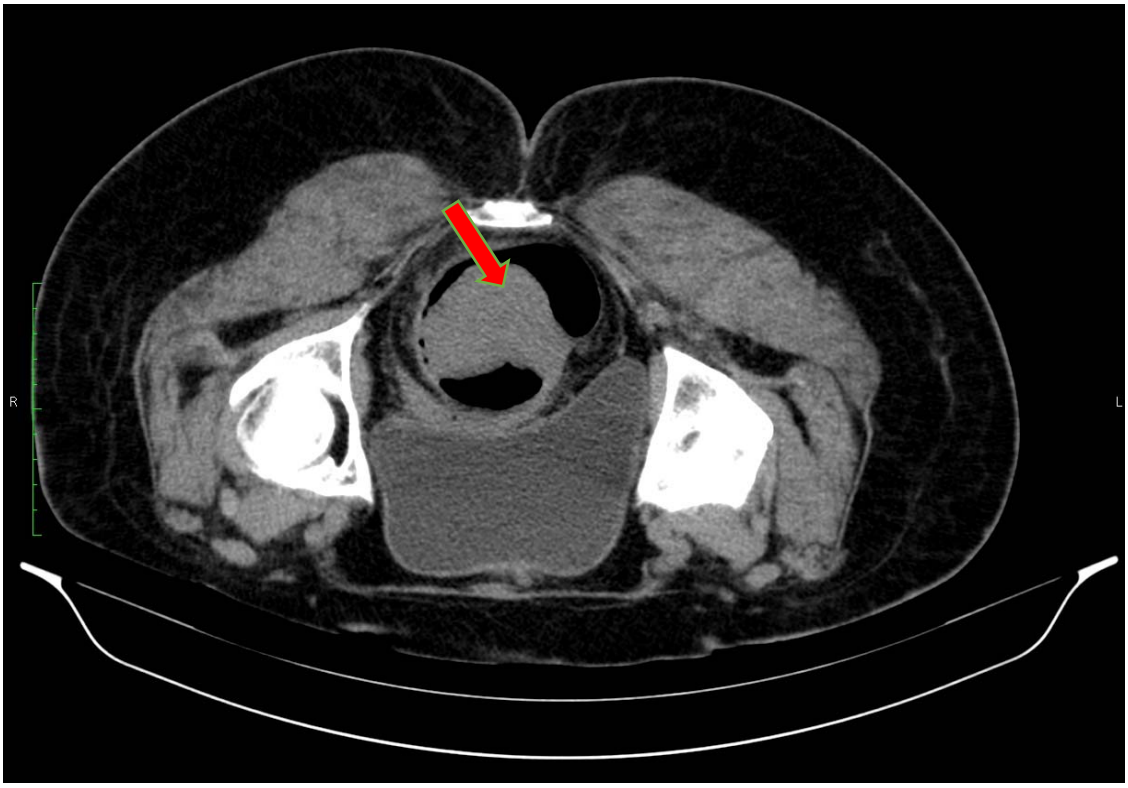


Figure 32: Large pedunculated growth arising from the rectal wall with perirectal fat stranding

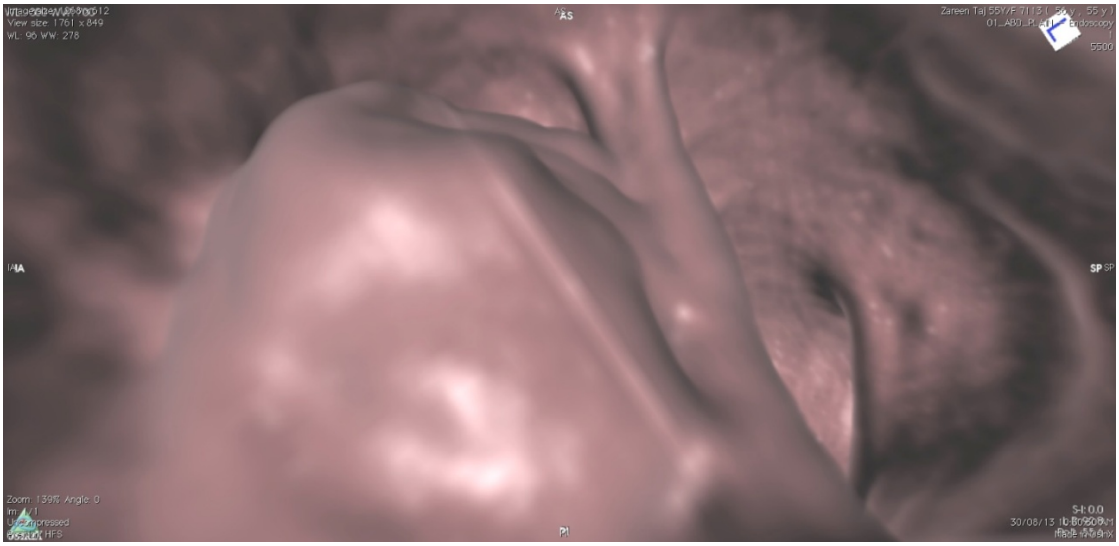


Figure 33: Large pedunculated growth arising from the rectal wall with perirectal fat stranding

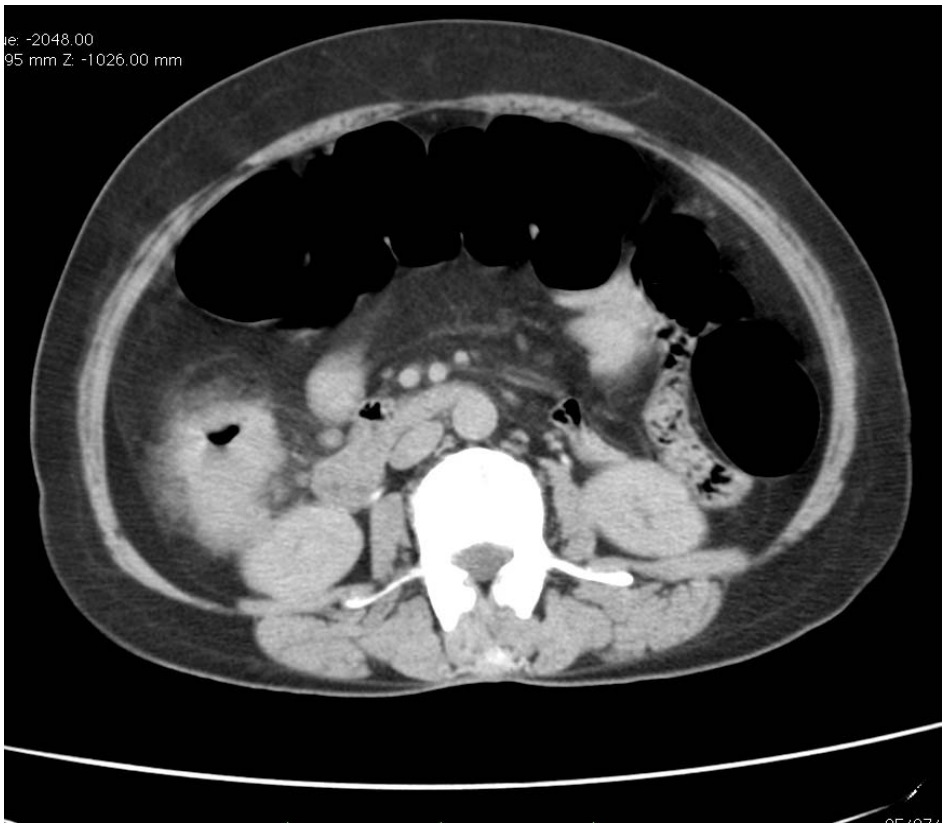


Figure 34: Circumferential wall thickening of ascending colon

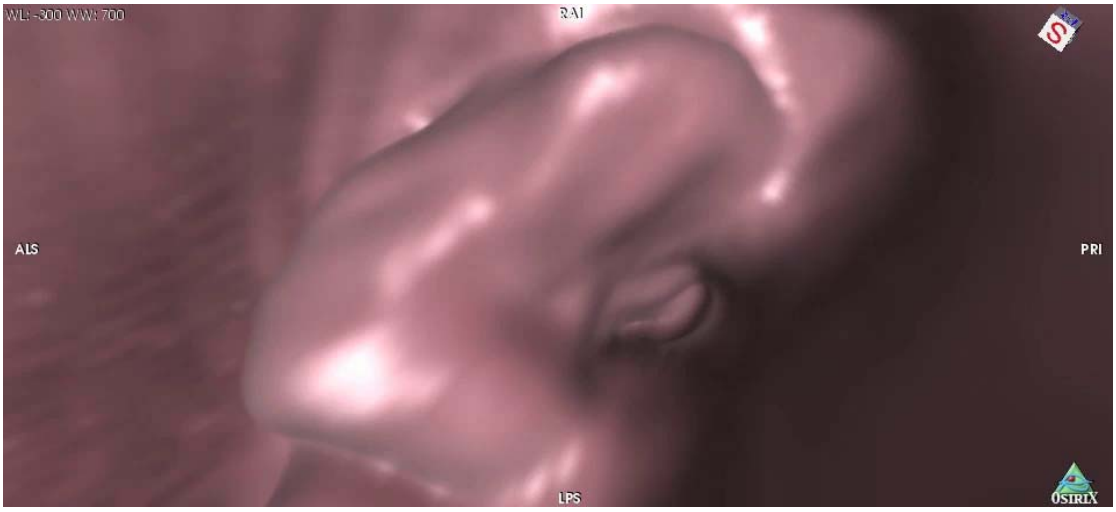


Figure 35: 3D reconstructed image of the same case showing irregular circumferential growth causing luminal narrowing

DISCUSSION

It is now compelling evidence that screening markedly reduces mortality from CRC, however, there is still debate about the optimum screening technique for CRC. Fecal occult blood testing detects only 30-40% of CRC and 10% of adenomas. Sigmoidoscopy fails to evaluate proximal colon and misses 10% of sigmoid colon carcinomas. Barium enema and CC permit visualization of the entire colon, but barium enema misses 15% of all carcinomas and 30-50% of polyps smaller than 1 cm. CC fails to reveal the entire colon in 10-15% of cases, misses 10% of carcinomas in the area viewed, results in colonic perforation in 1 in 500-1000 cases, and incurs a cost triple that of barium enema.[64-66]

Since its description in 1994, VC has emerged as a promising method for colorectal evaluation. Although investigators have used a variety of terms and scanning techniques, the same basic imaging principles apply: thin-section, helical CT of the air-distended, prepared colon, with interpretation of data based on both axial two-dimensional images of the colonic mucosa and computer generated, three-dimensional, reconstructed images.[67,69]

Both CC findings and VC findings in all 30 patients in our study were similar, except in few cases where in CC entire colon was not evaluated due to obstructive lesion

or uncooperative patient. In such instances VC evaluated the entire colon. VC also gave additional findings such as enlarged lymphnodes and fat stranding which could not be evaluated in CC.

In a study it was found that majority of cases, rectum was more commonly involved than the rest of the colon.[68]The same result was found in our study where 70% of cases (n = 21) out of 30 cases had abnormal growth in rectum.

In our study we had only 1 case of familial adenomatous polyposis. This may be due to the fact that our sample size was less and the incidence of colonic polyps in Indian population being less as mentioned in Indian J Gastroenterol (Jan–Feb 2011).[3]Another fact could be due to discomfort of undergoing CC, many patients having the symptoms of colonic pathology do not agree to undergo the procedure leading to less number of diagnosed cases of polyps.

VC is relatively simple and is less invasive than CC. Although full preparation of the colon is required, the procedure takes considerably less time than CC and does not require sedation. Most patients experience some abdominal discomfort as a result of air insufflation, but the examination may be more acceptable to patients than CC.[69,70,71]

In a study for compliance regarding which investigative modality patient will choose for evaluation of colon, 95% patients responded that they preferred CTC over colonoscopy. The three most common reasons for preferring CTC were safety (20.4%), expectations of a normal examination (16.7%), and unpleasant previous colonoscopy experience (14.8%).[72]Many other studies also showed the same compliance towards virtual colonoscopy as shown by table 6.

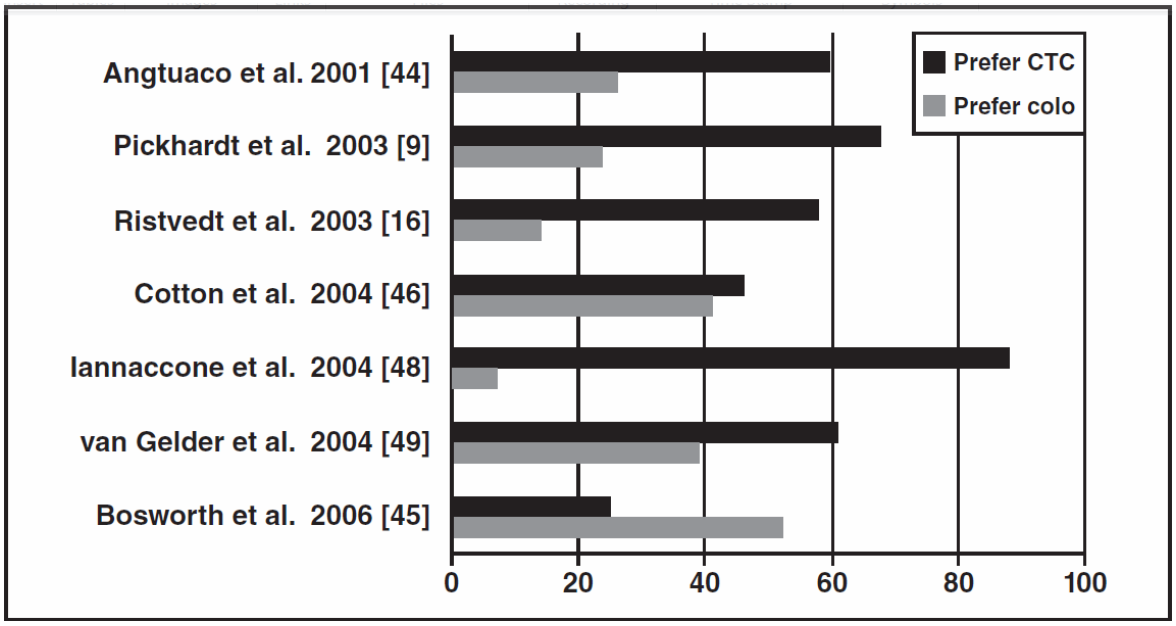


Table 6: Multiple studies have evaluated patient preference between Virtual "CT" colonography (CTC) and colonoscopy (colo).

We also received the same feedback where patients were more comfortable during VC procedure compared to CC.

One of the concerns is of radiation dose given to the patient. In the present study, 12 cases were scanned only in supine position and each patient received radiation dose of 8 mSv. 18 patients were scanned in both supine and prone positions and each received radiation dose of 16 mSv, which is well below the radiation dose limit.

CONCLUSION

Virtual colonoscopy is as sensitive as conventional colonoscopy in colonic lesion detection.

In addition, virtual colonoscopy has advantages over conventional colonoscopy, viz, better patient comfort, better patient acceptability, fewer complications and more importantly the ability to depict the lesion and its relation to surrounding structures, and to evaluate extra colonic structures such as peritoneum, lymphnodes and liver which cannot be done in conventional colonoscopy.

But the main disadvantages of virtual colonoscopy are that patient will not have histological diagnosis as we cannot take biopsy of the lesions as in conventional colonoscopy.

Thus virtual colonoscopy can be used as an initial tool in screening or in evaluation of patients suspected to have colonic pathology. Conventional colonoscopy can be reserved for patients who have lesions which need histological confirmation.

SUMMARY

Colorectal cancer (CRC) is a major health issue receiving much attention in recent years. Conventional colonoscopy (CC) is the gold standard for screening and early diagnosis of CRC. However it has its disadvantages in the form of pain, discomfort and rarely perforation of colon. Virtual colonoscopy (VC) is a recent radiological technique to evaluate the colon without causing much pain and discomfort to the patient with virtually no risk of perforation.

The aim of the study is to evaluate the sensitivity and specificity of VC in detection and diagnosis of colorectal pathologies in comparison with CC which is presently the gold standard.

The study was conducted on 30 patients who underwent conventional colonoscopy during the period of January, 2013 to June, 2014. Patients were taken up for VC immediately after CC procedure by inflating the colon with room air using a catheter introduced through the anus and non-contrast CT scan was performed. Two-dimensional images were obtained after which three-dimensional images were generated on the workstation using flythrough technique. Virtual colonoscopic findings were recorded and compared with conventional colonoscopic findings.

Similar intraluminal findings were obtained on both conventional and virtual colonoscopy. Additional findings such as fat stranding and enlarged lymphnodes were seen in virtual colonoscopy and not in conventional colonoscopy. In 16 patients there was incomplete evaluation of colon by conventional colonoscopy due to either obstructive intraluminal growth or patient compliance. In these cases entire colon was evaluated by virtual colonoscopy.

Virtual colonoscopy is as sensitive as conventional colonoscopy in detection of colonic lesions and can be used as an initial tool in screening or in evaluation of patients suspected to have colonic pathology.

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ANNEXURES

Master chart

Proforma

Consent form

CASE PROFOMA

Name:

Age:

Sex:

Hospital number:

Presenting complaints:

Conventional colonoscopy findings:

Virtual colonoscopy findings:

CONSENT FORM

Mrs/Ms

Age: Years:

Address

Hereby give consent to **Dr. AADITYA KUMAR SINGH,** for performing the procedure related to the study as previously explained to.

I have completely understood the purpose of the procedure and the associated possible complications.

I hereby give my consent to co-operate with him and agree by my own free will and in complete consciousness without any influence.

Signature of the patient

Sl NO	Name	Age	Sex	Hospital Number	Conventional colonoscopy findings	Diagnosis	Virtual Coloscopy Findings	Diagnosis
1	Linga Reddy	47	Male	879624	Circumferential proliferative growth with irregular margins which bleed on touch 35 cm from anal verge. Scope could not be negotiated beyond the mass.	CA descending colon	Short segment circumferential wall thickening in descending colon with luminal narrowing with few enlarged mesenteric lymphnodes	Suggestive of CA descending colon
2	ZareenTaj	56	Female	897375	Polypoidal annular growth 10 cm from anal verge. Lumen not occluded. Bleeds on touch. Scope could not be negotiated beyond the growth	CA rectum	Pedunculated growth arising from rectum wall. Perirectal fat stranding with few perirectal and mesenteric lymphnodes.	Suggestive of CA rectum
3	Rukmaniyamma	60	Female	940986	Proliferative friable mass arising from rectum	CA rectum	Irregular wall thickening 10 cm from anal verge, perirectal fat stranding, perirectal lymphadenopathy	Suggestive of CA rectum
4	Bhagya Lakshmi	30	Female	959806	Circumferential proliferative growth noted involving the ascending colon and causing luminal narrowing which bleeds on touch. Scope could not be negotiated beyond the growth.	CA ascending colon	Circumferential irregular wall thickening involving the ascending colon and causing luminal narrowing. Pericolonic fat stranding noted with few enlarged mesenteric lymph nodes.	Suggestive of CA ascending colon
5	Jayamma	65	Female	966786	Proliferative growth noted in rectum with irregular margins. Rest of the colon appears normal.	CA rectum	Wall thickening noted in posterior aspect of rectum with maximum thickness of 3 cm. Perirectal fat stranding noted.	Suggestive of CA rectum
6	Munirajappa	62	Male	934229	Circumferential proliferative growth in the rectum which bleeds on touch. Scope could not be negotiated beyond the growth.	CA rectum	Circumferential wall thickening in the rectum with maximum thickness of 2.5 cm. Perirectal fat stranding noted.	Suggestive of CA rectum

Sl NO	Name	Age	Sex	Hospital Number	Conventional colonoscopy findings	Diagnosis	Virtual Coloscopy Findings	Diagnosis
7	Radhamma	30	Female	977232	Circumferential proliferative growth with irregular margins seen 6 -7 cm from anal verge. Scope could not be negotiated beyond the mass	CA rectum	Circumferential wall thickening 5cm from anal verge with maximum thickenes of 2.5 cm. Perirectal fat stranding with mesenteric lymphadenopathy	Suggestive of CA rectum
8	Chinna Reddy	47	Male	928495	Circumferential proliferative growth seen 7 cm from anal verge in the rectum causing luminal narrowing and bleeds on touch.	CA rectum	Circumferential wall thickening 8 cm from anal verge with maximum thickness of 4 cm causing luminal narrowing. Perirectal fat stranding and perirectal lymphadenopathy noted.	Suggestive of CA rectum
9	Narsimhappa	65	Male	1009777	Proliferative growth in the rectum 3 cm from anal verge measuring 6 cm. Scope could not be negotiated beyond transverse colon due to mucosal edema	CA rectum	Diffuse circumferential wall thickening 2.4 cm in thickness with multiple intraluminal polypoidal projections and distal luminal narrowing and perirectal fat stranding with perirectal lymphadenoathy	Suggestive of CA rectum
10	Sarasa	58	Female	945424	Circumferential proliferative growth involving the sigmoid colon causing luminal narrowing. Probe could not be negotiated beyond the growth	CA sigmoid colon	Asymmetric circumferential wall thickening involving sigmoid colon with large exophytic mass	Suggestive CA sigmoid colon
11	Reddyma	45	Female	31037	Polypoidal growth annular growth noted 7 cm from anal verge which bleeds on touch and causing mild luminal narrowing. Entire lumen could not be evaluated due to uncooperative patient	CA rectum	Polypoidal growth noted in the rectum 6-7 cm from anal verge causing mild luminal narrowing. Perirectal fat stranding with few peri rectal lymphadenopathy.	Suggestive of CA rectum

Sl NO	Name	Age	Sex	Hospital Number	Conventional colonoscopy findings	Diagnosis	Virtual Coloscopy Findings	Diagnosis
12	Jayamma	50	Female	6500	Large polypoid mass lesion 5 cm from anal verge causing complete occlusion of lumen. Probe could not be negotiated beyond the growth.	CA rectum	Intra luminal soft tissue mass lesion having irregular margins arising from rectal wall causing near completer obstruction of rectal lumen with perirectal lumphadenopathy	Suggestive of CA rectum
13	Pushpa	35	Female	32776	Circumferential growth approximately 4 cm from anal verge causing mild luminal narrowing. Rest of the colon appears normal.	CA rectum	Diffuse asymmetricwall thickening involving rectum 3 cm from anal verge with a length of 8.6 cm and thickness of 2 cm, perirectal fat stranding and perirectal lymphnodes	Suggestive of CA rectum
14	Papamma	65	Female	993081	Circumferential proliferative growth involving the rectum causing luminal narrowing. Scope could not be negotiated beyond the growth	CA rectum	Circumferential assymetrical wall thickening of maximum thickeness of 3 cm noted in rectum 10 cm from anal verge with perirectal fat stranding and few perirectal lymphnodes	Suggestive of CA rectum
15	Ramaswamy	60	Male	27339	Circumferential growth approximately involving the sigmoid colon causing mild luminal narrowing. Rest of the colon appears normal.	CA sigmoid colon	Asymmetrical wall thickening involving splenic flexure of colon with mild luminal narrowing, pericoloninc fat stranding and few	Suggestive of CA sigmoid colon
16	Anusiyamma	60	Female	2478	Proliferative growth which bleeds on touch in rectum causing mild luminal narrowing.	CA rectum	Mass lesion with asymmetric wall thickening in the recto sigmoid junction 9 cm from anal verge with extraluminal extension into adjacent fat plane with peri rectal fat stranding and perirectal matted lymphadenopathy	Suggestive of CA rectum

Sl NO	Name	Age	Sex	Hospital Number	Conventional colonoscopy findings	Diagnosis	Virtual Coloscopy Findings	Diagnosis
17	Sharadamma	80	Female	996556	Circumferential proliferative growth involving rectum 3 cm from anal verge causing mild luminal narrowing	CA rectum	Circumferential wall thickening, 2.5 cm from anal verge with maximum thickness of 1.3 mm involving right lateral wall of rectum	Suggestive of CA rectum
18	Gundappa	58	Male	1004330	Annular growth extending 3 cm from anal verge, Length 10 cm, Full colon could not be evaluated as scope could not be negotiated	CA rectum	Asymmetric circumferential wall thickening with length of 11.4 cm and thickness of 5.5 cm with perirectal fat stranding and iliac lymphnodes	Suggestive of CA rectum
19	Ramaiah	60	Male	993948	Circumferential growth involving proximal descending colon causing mild luminal narrowing	CA descending colon	Asymmetrical circumferential wall thickening (5 cm) involving splenic flexure of colon with mild luminal; narrowing and pericolonic fat stranding with pericolonic lymphadenopathy	Suggestive of CA descending colon
20	Srivenkatesh	50	Female	3504	Circumferential proliferative growth approximately 4 cm from anal verge causing mild luminal narrowing. Rest of the colon is normal.	CA rectum	Heterogenously enhancing asymmetric circumferential wall thickening in rectum with perirectal fat stranding and perirectal lymphadenopathy	Suggestive of CA rectum
21	Dhanalakshmi	60	Female	930994	Circumferential proliferative growth involving the rectum which bleeds on touch. Scope could not be negotiated beyond the growth	CA rectum	Circumferential mass lesion 2 cm in thickness and 8 cm in length in rectum with luminal narrowing, perirectal fat stranding and peri rectal lymphnodes	Suggestive of CA rectum

Sl NO	Name	Age	Sex	Hospital Number	Conventional colonoscopy findings	Diagnosis	Virtual Coloscopy Findings	Diagnosis
22	Veerappa Reddy	60	Female	1015060	Circumferential proliferative growth involing the rectum which bleeds on touch and causing luminal narrowing. Scope could not be negotiated beyond the growth.	CA rectum	Asymmetrical circumferential wall thickening 9.6 cm in length extending from recto sigmoid junction with luminal narrowing with perirectal fat stranding and perirectal lymphadenopathy	Suggestive of CA rectum
23	Narayanaswamy	48	Male	888047	Circumferential growth involving the rectal wall causing mild luminal narrowing.	CA rectum	Diffuse circumferential wall thickening of rectal wall (14 mm), perirectal fat stranding, rest of the colon normal	Suggestive of CA rectum
24	Chinnamma	60	Female	928495	Polypoidal mass lesion arising from rectum wall which bleeds on touch causing luminal narrowing. Scope could not be negotiated beyond the growth.	CA rectum	Polypoidal mass lesion arising from rectal wall and occupying the lumen measuring 6.5x4.3x3.8 cm with few peri rectal lymphnodes.	Suggestive of CA rectum
25	Pyare Jan	67	Male	883102	Circumferential proliferative growth involving the rectum causing mild luminal narrowing.	CA rectum	Circumferential wall thickening in rectum 5.5 cm from anal verge with maximum width of 0.9 cm	Suggestive of CA rectum
26	Ravishankar	46	Male	1002389	Circumferential growth noted in the ascending colon wall causing luminal narrowing. Scope could not be negotiated beyond the growth.	CA ascending colon	Circumferential wall thickening involving ascending colon with maximum thickeness of 5 cm with surrounding fat stranding and mesenteric lymphadenopathy	Suggestive of CA ascending colon
27	Pilappa	70	Male	914134	Circumferential proliferative growth involving the transverse colon which bleeds on touch and causing mild luminal narrowing. Rest of the colon appears normal.	CA transverse colon	Irregular bowel wall thickening noted involving transverse colon with minimal ascites	Suggestive of CA transverse colon

Sl NO	Name	Age	Sex	Hospital Number	Conventional colonoscopy findings	Diagnosis	Virtual Coloscopy Findings	Diagnosis
28	Job K.	62	Male	42084	Proliferative growth noted at transverse colon causing mild luminal narrowing.	CA transverse colon	Diffuse asymmetrical wall thickening of splenic flexure of colon with large exophytic soft lesion with pericolonic fat stranding	Suggestive of CA transverse colon
29	Achamma	40	Female	27693	Multiple approximately 8-9 mm polyps noted involving the visualized colon from rectum upto sigmoid colon. Rest of the colon could not be	Familial adenomatous polyposis	Visualized distended colon showed multiple approximately 7 8 mm polyps. Pneumoperitoneum noted.	Familial adenomatous polyposis
30	Munivenkatamma	70	Female	854002	Proliferative growth 6 cm from anal verge noted in rectum which bleeds on touch and causing mild luminal narrowing	CA Rectum	Intra luminal soft tissue mass lesion 7 cm from anal verge having irregular margins arising from rectal wall causing mild luminal narrowing with perirectal lymphadenopathy	Suggestive of CA rectum