

Role Of CT Virtual Colonoscopy In Diagnosis Of Colo-Rectal Neoplasms

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Abstract

Purpose: to assess the role of CT colonography (virtual colonoscopy) as a non-invasive imaging technique in detection and diagnosis of colorectal neoplasia using conventional colonoscopy and/or operative findings as a reference standard, as well as highlighting its advantages and possible pitfalls.

Methods: sixty patients were examined by CT after standard bowel preparation, rectal insufflation and IV contrast injection. Imaging was performed in both supine and prone positions. Evaluation consisted of review of the transverse CT images, sagittal and coronal reformations and 3D endoluminal Images. CT colonographic findings were correlated with standard conventional colonoscopic and/or operative findings.

Results: Virtual colonoscopy correctly identified all 6 carcinomas (100%), 12 out of the 13 polyps that measured 10mm or more (92.3%), 19 of the 23 polyps that measured 6 - 9 mm (82.6%) and 28 out of 48 polyps that measured 5mm or less (58.3%). There were 11 false positive findings of polyps by virtual colonoscopy and no false positive findings of cancer. Virtual colonoscopy also detected 35 incidental extracolonic findings in 25 patients while non were detected by conventional colonoscopy. 17 of the 24 patients who had no lesions during conventional colonoscopy were considered free of lesions by CT colonography yielding a per-patient specificity of 70.8%

Conclusion: CT colonography has high sensitivity for the detection of clinically important polyps and cancer as well as multiple advantages over conventional colonoscopy in imaging of colorectal neoplasms.

Introduction and aim of work

Colorectal carcinoma is among the leading causes of malignancy related deaths in the world. Because of the natural history of the progression from colorectal polyp to carcinoma, with most frank colo-rectal cancers arising from pre-existing polyps, early and prompt diagnosis can have a significant effect on patient mortality (1). Not only will detection and removal of precursor adenomas result in a decrease in the incidence of colorectal cancer, frank colo-rectal neoplasia has a great potential for cure when detected at an early stage.

There is a continued search for method of early detection of colorectal neoplasms that is cost-effective, safe, and acceptable to patients. Current methods used to detect colorectal polyps and colonic cancer include sigmoidoscopy, colonoscopy, and double-contrast barium enema examination. The effectiveness of each modality remains controversial, and each method has inherent limitations (2).

Though colonoscopy is currently considered the reference standard for the detection of colorectal neoplasia it has various potential limitations. First, up to 10% of colonoscopic examinations are technically difficult even for experienced colonoscopists. In addition to poor bowel preparation, an experienced colonoscopist may be unable to complete the colonoscopy and intubate the cecal pole for a variety of reasons (redundant colon; colonic spasm; marked diverticulosis; obstructing masses or strictures; and angulation or fixation of colonic loops, most commonly due to previous pelvic surgery). Second, it does not allow evaluation of the liver and other organs outside the colon. Third, it has a blind area, as a colonoscope passes in only one direction. For example, the opposite side of a colonic fold cannot be evaluated exactly. Finally, it is invasive and uncomfortable (3).

Therefore, in search for a rapid, less invasive, accurate, and well-tolerated technique which can

image the entire colon and reliably identify colonic neoplasms, computed tomographic (CT) colonography, or “virtual colonoscopy,” has evolved quickly. CT colonography refers to a CT examination of the fully prepared and air-distended colon. Volumetric CT data in the entire colon are acquired with only a few seconds to minutes of scanning and with a total of 15 minutes or less of examination time. By combining these data with advanced imaging software, the colon is examined at an off-line workstation by using the combination of two-dimensional (2D) and 3D images (4).

The aim of this study is to assess the role of CT colonography (virtual colonoscopy) as a non-invasive imaging technique in detection and diagnosis of colorectal neoplasia using conventional colonoscopy and/or operative findings as a reference standard, as well as highlighting its advantages and possible pitfalls.

Patients and methods

This study included 60 patients thought to have colorectal neoplasms whether benign or malignant

Inclusion criteria:

Patients of either sex with findings or symptoms suggestive of colonic or rectal mass lesions such as hematochezia, stools with a positive hemocult test, iron deficiency anemia, alteration of bowel habits.

Personal or family history of colonic neoplasms

Exclusion criteria:

Pregnant or lactating females

Patients known to have elevated serum creatinine levels more than 2.5mg/dl and not on regular dialysis

All CT colonography examinations were followed by conventional colonoscopy and / or surgery depending upon clinician's recommendations and accordingly findings at the colonoscopy and / or the surgery were considered as a reference standard.

Image acquisition

All CT examinations were performed on a 64 MDCT at a private radiology clinic. Prior to the examination all the patients were subjected to

consent writing and history taking. The day before the CT examination was scheduled to be performed all patients underwent standard bowel preparation that typically consisted of a clear liquid diet, an orally administered laxative, a cathartic colon preparation, and an enema. Patients were asked to fast 6 hours before the examination.

All patients underwent rectal room air insufflation on the CT table using a standard enema tube. Once adequate distention of all colonic segments was ensured by checking a scout view, 50-75 ml of iodinated contrast agent, iopromide (ultravist 300), was administered intravenously and CT scanning was then started in the cranio-caudal direction with the patient in the supine position. Once finished the patient was then turned to the prone position and scanning was repeated. Patients were asked to hold their breath during data acquisition. If this was not possible, data acquisition was achieved with superficial respiration.

Technical parameters

Scanning was performed 64 channel MSCT scanner. The scanning parameters were as follows beam collimation 0.75 mm, a pitch of 1–1.5. CT scanning was performed at 120 kVp, 400 mA, 240 mAs, 600 msec gantry rotation time. Image reconstructions were performed with 1 mm reconstruction thickness with 0.7 mm reconstruction intervals.

Image processing and data interpretation

The axial images of the patients were then transferred to a work station for computer post-processing using commercially available software that provides surface and volume renderings. The processed images included sagittal and coronal two-dimensional (2D) reformatted as well as three-dimensional endoluminal images which were viewed continuously providing an endoscopic like examination.

The evaluation consists of initial review of the magnified 2D transverse CT images followed by review of the endoluminal images in the interactive (fly-through) mode, as well as the reformatted coronal and sagittal 2D CT images.

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The transverse and reformatted coronal and sagittal 2D CT images were displayed alongside the endoluminal images in a four-quadrant display format to allow easy verification of any identified lesion on all images . Endoluminal viewing was performed in both antegrade and retrograde directions and with the patient in both supine and prone positions to avoid blind areas.

The results of CT virtual colonoscopy of the patients were compared with the findings of conventional colonoscopy and/or surgical findings regarding:

- Site of the lesion
- Size of the lesion
- Appearance (morphology) of the lesion
- Extra-luminal extension if any
- Other incidental colonic findings if any such as colonic diverticular disease,etc.
- Extra-colonic manifestations if any such as distant organ metastases and lymph node enlargement

Results

This study involved 60 patients thought to have colorectal mass lesions. 35 patients were women and 25 were men with a mean age of 55.

Virtual colonoscopy and conventional colonoscopy were performed on all of the 60 patients. Only six out of the sixty patients underwent surgery. The entire colon was seen by the virtual colonoscopy in the 60 patients while complete visualization of the colon by conventional colonoscopy was possible in 59 patients as one patient had an obstructing mass lesion hindering the passage of the colonoscope to the more proximal colonic segments.

Conventional colonoscopy

Of the 60 patients, 24 patients had normal findings on conventional colonoscopy. A total of 84 polyps and 6 carcinomas and a single lipoma were identified in 36 patients. Of these 84 polyps, 48 polyps measured 1-5 mm in diameter, 23 measured 6-9 mm in diameter and 13 polyps measured 10mm or larger (**Table 1**).

Table 1: Number of Polyps by size at colonoscopy

Polyp Size (mm)	Number of Polyps
1-5 mm	48
6-9 mm	23
≥10 mm	13

All of the 6 carcinomas were adenocarcinomas located as follows; 2 were located at the ascending colon, 1 at the caecum encroaching upon the ileocaecal junction, 1 at the right side of the transverse colon,1 at the descending colon and 1 was located at the rectosigmoid region. All underwent surgery. (**Table 2**).

Table 2: Segment Location and Number of cancers

Rectum	-
Sigmoid colon	1
Descending Colon	1
Splenic flexure	-
Transverse Colon	1
Hepatic flexure	-
Ascending Colon	2
Caecum	1

Colonoscopy was complete in 59 patients. The single case where the colonoscopy was incomplete was due to the presence of an obstructing carcinoma in the transverse colon.

Virtual colonoscopy

The findings at virtual colonoscopy were compared to conventional colonoscopy findings which were considered as the reference standard by using two different methods: the direct by- polyp comparison and by- patient comparison.

By using direct by- polyp matching, which took into account polyp size and location for identification and matching of polyps when comparing the results with findings of conventional colonoscopy, that is a polyp noted at virtual colonoscopy was considered to have matched with a polyp seen at conventional colonoscopy when it was located in the same or adjacent segment and was of similar size, a total of 59 polyps out of the 84 polyps detected by conventional colonoscopy were correctly identified by virtual colonoscopy giving an overall sensitivity rate of 70.2% for polyp detection by virtual colonoscopy. The sensitivity of polyp detection by virtual colonoscopy according to size of the polyp was as follows; 28 of 48 polyps measuring between 1-5 mm were detected by virtual colonoscopy with a sensitivity of 58.3%. Out of the 23 polyps measuring 6-9 mm in diameter 19 polyps were correctly identified by virtual colonoscopy with a sensitivity of 82.6%. The highest sensitivity for virtual colonoscopy at detection of polyps was for polyps measuring 10 mm or larger where 12 out of 13 polyps were accurately identified by virtual colonoscopy with a sensitivity of about 92.3% (**Table 3**).

Table 3: Polyp Detection Rate at CT Colonography

Polyp Size (mm)	Number of Polyps (n=84)	Sensitivity
1-5 mm	28/48	58.3%
6-9 mm	19/23	82.6%
≥10 mm	12/13	92.3%

Virtual colonoscopy had a 100% (6 of 6) sensitivity for the detection of carcinomas. 5 out of the 6 carcinomas were correctly staged by virtual colonoscopy. Using the modified Astler-Coller-Dukes system 2 carcinomas were correctly staged as B2, 2 were staged as stage C and one was accurately staged as stage D. Findings were considered accurate after being found consistent with surgical findings and histopathological assessment. Only one case of malignancy was understaged by virtual colonoscopy which staged it as stage A but was proven to be stage B1 by histopathology.

Virtual colonoscopy demonstrated 11 false positive polyps. Only one measured 10mm, 6 measured between 6-9 mm and 4 measured between 1-5 mm. 8 of these false positive findings were in colonic segments containing residual fecal matter and 3 were in regions of thickened and complex haustral folds which were misinterpreted as polyps. Virtual colonoscopy did not produce any false positive carcinomas (Table).

Table 4: False positive Polyps related to Poor preparation and Complex haustral folds at CT Colonography

Polyp Diameter (mm)	Poor Preparation	Complex Folds
1- 5 mm (n=4)	4	-
6-9 mm (n=6)	4	2
≥10 mm (n=1)	-	1

Virtual colonoscopy did not reveal 25 polyps out of the 84 polyps identified by conventional colonoscopy (false negatives). 20 of these missed polyps measured between 1-5 mm in diameter, 4 of these polyps measured between 6-9 mm and 1 measured more than 10 mm. Only 2 of the 20 polyps measuring between 1-5 mm were in poorly distended areas of the colon, while the remaining 18 polyps were in clean and well distended segments of the colon. The small size of the polyps in relation to the available image resolution probably accounts for most of these false negative results. The remaining 5 polyps that were not detected by virtual colonoscopy were present in either fluid filled segments of the bowel (3) or in

poorly distended colonic segments (2). The polyp measuring more than 10 mm that passed undetected by virtual colonoscopy was one of the above mentioned 2 located in poorly distended colonic segments (Table 5).

Table 5: False Negative Polyps related to Poor Preparation and Poor Colonic Distention

Polyp Diameter (mm)	Poor Preparation	Poor Distention
1- 5 mm (n=20)	-	2
6-9 mm (n=4)	3	1
≥10 mm (n=1)	-	1

Results of virtual colonoscopy were also analyzed on a per-patient basis. In this assessment, the findings at virtual colonoscopy and at conventional colonoscopy were considered to coincide if both studies showed at least one polyp or if neither test showed a polyp. Only the presence of at least one polyp was considered, and the size, number and location of polyps was not used in determining study concordance. This type of analysis is clinically important in light of the assumption that if virtual colonoscopy is used as an initial screening test, patients with any lesion seen at virtual colonoscopy would be marked to undergo either subsequent follow up examinations at suitable intervals or standard conventional colonoscopy for further investigation depending upon lesion identified. When results of virtual colonoscopy were analyzed according to this method of by- patient comparison, the performance of virtual colonoscopy improved. 17 patients were free of colonic lesions by virtual colonoscopy; that is true negatives with 7 false positive cases. 32 patients had a colonic lesion by virtual colonoscopy; that is true positives with 4 false negative cases. The overall sensitivity and specificity were 88.9% and 70.8% respectively. The positive predictive value was 82% (32 of 39), and the negative predictive value was 80.9% (17 of 21).

Virtual colonoscopy detected 35 incidental extracolonic findings in 25 patients distributed as seen in the following table (table 6)

Table 6: showing diagnoses and number of extracolonic findings detected by CT colonography

Incidental extracolonic findings	Number
Liver Cirrhosis	2
Splenomegaly	2
Gall Stones	5
Intussusception	1
Hepatic Deposits	2
Lung Deposits	1
Para-aortic lymphadenopathy	1
Bowel containing inguinal hernia	2
Fat containing inguinal hernia	4
Retroperitoneal collection	1
Renal Cysts	6
Uterine fibroid	3
Aortic atherosclerosis	5

Discussion

In this study which involved 60 patients CT colonography accurately detected all the 6 invasive carcinomas detected by the conventional colonoscopy giving a sensitivity rate for detection of carcinomas of 100%. Results showed that a greater number of right sided colonic lesions detected, in contrast to the commonly upheld opinion that colorectal malignancy is invariably more common at the left sided colonic segments. These results coincided similarly with those of a study performed by Silva *et al* (*1*) where they reported that this left-to-right shift in cancer distribution during the latter half of the 20th century was most likely the result of colon screening, with more frequent use of sigmoidoscopy and polypectomy, which has decreased the incidence of distal lesions.

Histologically, most colon carcinomas arise from the mucosal lining and are adenocarcinomas (*1*). This was also consistent with the findings of our study where all of the 6 invasive carcinomas detected were proven histologically to be adenocarcinomas. Their appearance and clinical behavior depend on where they originate. In their study of the varied appearances of colorectal carcinoma Silva *et al.* (*1*) reported that left-sided lesions form annular masses, which tend to be diagnosed earlier because they cause obstruction, and are susceptible. Right-sided lesions are generally diagnosed later because of the relatively larger caliber of the right colon, and they tend to grow into polypoid fungating masses with a propensity for necrosis. Likewise, lesions in our study behaved similarly where almost all right sided lesions assumed the form of polypoidal outgrowths of variable size, whereas those arising on the left side were invariably represented by either focal or more extensive circumferential wall thickening compromising the colonic lumen to variable degrees.

Contrast material enhanced CT colonography has the potential advantage of providing images of the bowel wall, extracolonic tissues and the liver in one setting, therefore it can be used to

stage colorectal cancers by a feat which cannot be performed by conventional colonoscopy.

Colorectal carcinomas are clinically staged by using the modified Astler-Coller-Dukes staging system or the TNM system established by the American Joint Committee on cancer. While CT colonography does not allow differentiation of a carcinoma confined to the mucosa from that invading the submucosa and thus cannot be used to differentiate stages T1 and T2 (coinciding to stages A and B1 of the modified Astler-Coller-Dukes staging system), it can reliably stage higher grades of colorectal cancer (*1*).

This was true in our study where out of a total of 6 patients with colorectal carcinoma, using the modified Astler-Coller-Dukes staging system, 5 patients were accurately staged by CT colonography, with only one patient being incorrectly staged. Findings were as follows:

- 2 patients were accurately diagnosed as stage B2 (coinciding to T3N0M0), where the CT colonography images showed a poorly defined peripheral wall with a rounded or nodular margin and pericolonic fat infiltration or a pericolonic mass.
- 2 patients were accurately diagnosed as stage C (coinciding to any T N1or2 M0), where the CT colonography images showed enlarged or clustered small pericolonic lymph nodes.
- 1 patient was accurately diagnosed as stage D (coinciding to any T, any N, M1), where the CT colonography images showed distant metastasis or direct local invasion.

Only 1 patient was incorrectly staged by CT colonography. This patient was understaged where the CT images showed a well-defined peripheral wall with clear adjacent fat suggesting stage A whereas the histopathological examination following surgery accurately put them at stage B1 (coinciding to T2N0M0), thus underlining the inability of CT colonography to accurately differentiate a tumor confined to the mucosa from one actually invading the submucosa as previously mentioned.

With synchronous colon cancers or precancerous colonic polyps occurring in approximately 5% of cases with diagnosed colorectal cancer as cited by Macari and Bini (5), it becomes of utmost importance to evaluate the entire colon. This is especially important in cases with an obstructing carcinoma, beyond which the conventional colonoscope fails to pass. Coppel et al (6), reported that their study findings indicated that CT colonography is an accepted technique for evaluation of the non-visualized part of the colon after incomplete colonoscopy and that it can increase the diagnostic yield of masses and clinically important polyps in this part of the colon. The same situation was encountered in our study where 1 of the patients with colorectal carcinoma had an obstructing mass at the level of the transverse colon with failure of passage of the colonoscope beyond this level. In this patient complete evaluation of the proximal colon was possible with CT colonography where the presence of any clinically significant synchronous lesions was ruled out as none were detected.

Results of several studies evaluating CT colonography showed promise in the ability of virtual colonoscopy to detect colorectal polyps. Our study revealed a sensitivity of 92.3%, 82.6% and 58.3% in detection of polyps in measuring 10mm or more, 6-9 mm and 1-5mm respectively. This coincided similarly with results of several large studies whose sensitivity values for polyp detection lie within close range. In a study involving 300 patients Yee et al (2) showed that the sensitivity was 90% (74 of 82) for the detection of polyps 10 mm or larger, 80.1% (113 of 141) for polyps 5.0–9.9 mm, and 59.1% (178 of 301) for polyps smaller than 5 mm. In the largest study performed to date, recruiting a total of 1233 adults Pickhardt et al (7) reported sensitivity values 93.9% ,93.8% and 88.7% for polyps at least 10mm , 8mm, and at least 6mm in diameter respectively . Fenlon et al (8), in a study involving 100 patients, demonstrated CT colonography to have a sensitivity of 91% for polyps that were 10mm or larger and 82% for polyps that were 6-9mm in size.

As can be expected, the performance of virtual colonoscopy is highly dependent on the size of

the lesion, with rate of detection of polyps decreasing as size of the lesion decreases. However, the clinical importance of these small lesions and the importance of their detection is questionable. Macari et al (9) cited that up to as many as 90% of all colorectal carcinomas develop from benign adenomas through a series of genetic alterations. Unfortunately, however, most imaging studies cannot predict the histology of colorectal lesions. The imaging criterion that has primarily been used to determine clinical significance is size. Size has been shown to be the most simple and practical indicator of polyp abnormalities and is closely related to the degree of dysplasia in the lesion. Chung et al (3) and Macari et al (9) both reported that the majority of diminutive polyps, those measuring 5mm or smaller, are not adenomas, but more often these small lesions represent hyperplastic polyps or normal mucosal tags at histological assessment that have no clinical potential to become cancer, hence negating the importance of their detection. However, some controversy exists. Macari et al (9) reported that in a study of 1,048 colorectal polyps measuring up to 6 mm, researchers found that 61% were neoplastic (adenomas); the remainder were divided equally between hyperplastic polyps and normal colonic mucosa .Nevertheless, the authors also reported that most diminutive adenomas never progress through the complete adenoma carcinoma sequence. In fact in that cohort of polyps, the incidence of carcinoma was extremely low, 0.1%. Moreover, the tiny percentage of diminutive adenomas that do progress through the adenoma-carcinoma sequence do so very slowly. According to Macari et al (9) analysis of data from the National Polyp Study shows that an average of 5.5 years is required for the transformation of a large adenomatous polyp into cancer. An average of 10 years is needed for the smallest polyps to develop into cancer. Thus in light of the above, the importance of detection of small polyps by CT colonography is not paramount as the vast majority of these lesions are benign with no malignant potential. As for those diminutive lesions unfortunate enough to have malignant potential, if an appropriate screening and surveillance interval were established for CT colonography, small

adenomas that could be missed by colonography and should subsequently increase in size would be detected on follow up studies before they reach the stage of invasive carcinoma. Macari et al (9) suggested that in patients with normal findings on CT colonography examinations, follow-up imaging is recommended in 5 years.

Other than the size of the lesion, two other commonly encountered causes of false negative results in this study were residual fluid and collapsed bowel segments.

In our study 3 of the false negative polyps, i.e, those detected by conventional colonoscopy and not by virtual colonoscopy were in fluid filled segments of the bowel. They could not be detected on either prone or supine images, owing to the large amount of fluid present that could not shift enough to allow for adequate mucosal visualization. In presence of smaller amount of fluid, however, adequate mucosal visualization is achieved via careful evaluation of both prone and supine image sets. These findings were in concordance with those reported by Mang et al (10) in their assessment of the pitfalls encountered in CT colonography. They cited that residual fluid obscures colonic lesions and leads to perceptual errors. Because of gravity, residual fluid is always found more commonly in the descending colon and rectum with the patient in the supine position, whereas they reported, that the fluid moves to the transverse colon with the patient in the prone position. Consequently, they stressed the importance of performing CT colonography with the patient in both prone and supine positions, which will shift any retained fluid into other colonic segments, rendering hidden lesions visible. However, if large amounts of fluid are present, visualization of the entire mucosa may not be guaranteed at prone and supine imaging, as was also depicted in this study.

A further cause of false negative results met with in this study was colonic underdistention. As reported by Mang et al (10), optimal colonic distention is a necessary pre-requisite to accurate CT colonographic data interpretation, as underdistention leads to luminal narrowing or colonic segment collapse which results in lesions going undetected. They stated that the diagnostic performance of virtual colonoscopy

can be improved by evaluating both prone and supine image sets, as gas tends to move to the highest part of the colon. Commonly, the left colon, rectum and sigmoid colon are collapsed when the patient is supine, whereas the transverse colon is often collapsed when the patient is prone. In this study 4 of the polyps detected by conventional colonoscopy and missed by virtual colonoscopy were in collapsed bowel segments that failed to adequately distend even after patient repositioning, highlighting the importance of ensuring adequate bowel distention of all colonic segments on the initial scout view and redistention of any collapsed segment with rectal insufflation of additional gas.

There was a total of 11 false positive results, representing those lesions detected by virtual colonoscopy and not on conventional colonoscopy in this study.

Analysis of results and retrospective evaluation of CT images revealed that 8 of these lesions were in poorly cleansed bowel segments containing residual fecal matter which was mistakenly diagnosed as polypi in these cases. The remaining 3 false positive lesions were in areas of complex haustral folds which were inaccurately diagnosed as polyps.

As can be inferred from the above, the commonest cause of false positive findings in this study was residual fecal matter. Similarly, in the study performed by Macari et al (11), they reported that residual fecal material accounts for the vast majority of false positive findings at CT colonography. They cited that through careful evaluation of several characteristics, it is possible to differentiate residual stool from true polyps. Retained stool often contains incorporated air that can be recognized at CT as a heterogeneous filling defect on 2D images. A lack of wall attachment and movement of the suspected lesion on supine and prone images also indicate the fecal nature of the suspected abnormality. Colorectal polyps have homogenous soft tissue attenuation without intratumoral air. Despite these differentiating points cited by Macari et al (11), which allowed us to properly differentiate polypi from residual stool in many cases in this study, however some lesions displayed overlapping features giving

rise to misdiagnoses and false positive results. Residual fecal material occasionally, appeared homogenous internally and was adherent to the colonic wall thereby simulating polyps and was falsely diagnosed as such.

3 of the false positive lesions encountered in this study were in areas of bulbous and irregular interhaustral folds, namely along the short limb of hepatic and splenic flexures, and in poorly or inadequately distended colonic segments. Though in many instances scrolling through contiguous axial images at the workstation, revealed the linear nature of the fold, further confirmed by viewing the endoluminal images which provided an en face view of the mucosa that was helpful in distinguishing between the round shape of polyps and the longitudinal structure of folds, this was not possible in all cases. In poorly distended colonic segments especially where colonic folds were originally of a more complex nature, such as those mentioned above, continuous navigation through the colon was difficult leading to false positive diagnosis of complex and thickened folds which appear as rounded or polypoid lesions on 2D images as polyps. Likewise, complex interhaustral folds were mentioned as a common cause of false positive results by a host of studies including those performed by Mang et al (10) and Macari et al (11).

As cited by Johnson and Dachman (4), the ability to evaluate the extracolonic organs of the entire abdomen and pelvis, in addition to assessing the colon, is an important benefit inherent in CT colonography. No other colorectal screening examination has this use. Since the vast majority of the patients likely to be referred to virtual colonoscopy are likely to belong to the older age group, other abdominal diseases are likely to be encountered incidentally. The potential for saving many lives by detecting life-threatening lesions in organs outside the colon in the course of colon screening is real and is an exciting potential benefit.

In our study a total of 35 incidental extracolonic findings were detected. While some of these findings were of significant clinical importance such as intussusception, hepatic and lung metastatic deposits, most were of moderate or

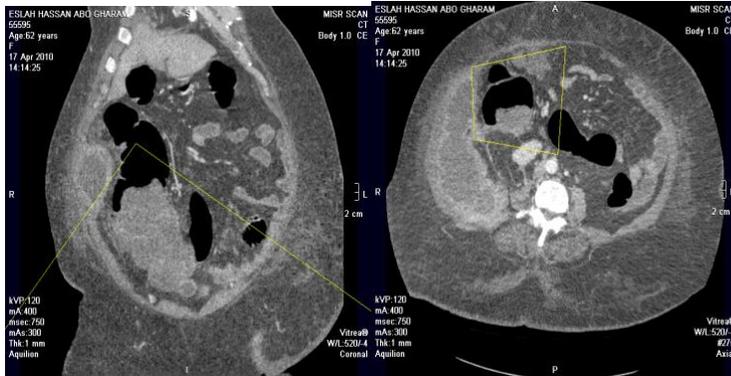
low clinical importance such as splenomegaly, and gall stones. Whether the findings were of high clinical importance necessitating surgical interference or radio and chemotherapy or simply requiring medical treatment and follow up, the ability to evaluate the entire abdomen and the pelvis in the course of a colonic examination holds the promise for earlier detection at a more curable stages.

Conclusion

The results of our study show that CT colonography is a sensitive test for detection of clinically important polyps measuring 10mm or larger and can reliably depict colorectal carcinoma. Its main limitation is its lower sensitivity for smaller polyps, yet if patients undergo routine interval screening at suitable time intervals, missing small lesions is likely to be clinically insignificant. Among other disadvantages of CT colonography at this point includes the need for bowel preparation similar to that for standard colonoscopy. Poor colonic distention or preparation limits the accuracy of CT colonography, however it is encouraging that technical problems related to retained fluid, residual stool, and incompletely distended segments of the colon can often be corrected by careful evaluation of both prone and supine sets of images. Prone imaging in combination with supine imaging will readily move colonic fluid and often will move retained stool into opposite parts of the colon. Nevertheless measures undertaken to ensure proper colonic distention and preparation remains necessary to improve the diagnostic performance of CT colonography. Advantages of CT colonography compared with conventional colonoscopy include a shorter procedural time, less risk to the patient, and no need for intravenous sedation. Furthermore, CT colonography may be more accurate in precise localization of lesions, can evaluate the colon proximal to an obstructing lesion, reliably stage advanced invasive colorectal malignancy and can detect incidental extracolonic findings of clinical importance. Finally, it is important to note that by having a non invasive tool available for colorectal examination, more patients will ultimately undergo colorectal examination, thereby leading to increased detection and ultimately removal of clinically important precancerous lesions.

Cases

Case 1: female patient, Islah Hassan Abu gharam, 62 years old complaining of progressive loss of weight and abdominal pain. Fig. (a) coronal contrast enhanced 2D image shows a polypoid adenocarcinoma in the right colon with extensive direct extracolonic extension and retroperitoneal fluid collection. Fig (b) axial contrast enhanced 2D image shows polypoid adenocarcinoma in the right colon along with retroperitoneal collection. Fig (c) Virtual colonoscopic intraluminal 3D image shows polypoid mass projecting into colonic lumen.



(a)

(b)

(c)

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Case 2:

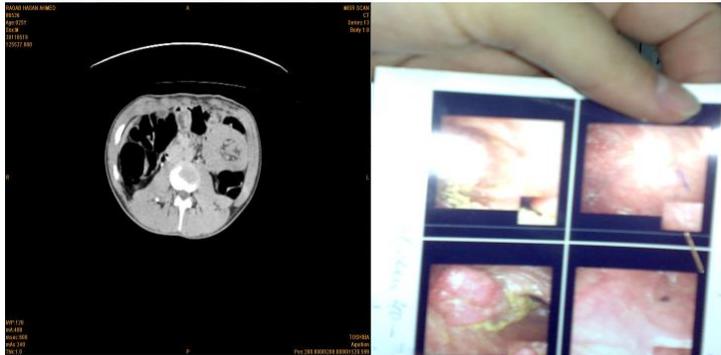
Male patient, Ragab Hassan, 25 years old complaining of bleeding per rectum. Multiple colonic polypi were found the largest was seen at the descending colon. Incidentally intussusception was also discovered. Fig (a) axial contrast enhanced 2D image shows polyp measuring 18mm x 13mm at the descending colon. Adjacent intussusception is seen indenting the colonic wall. Fig (b) sagittal contrast enhanced 2D showing the polyp and the adjacent intussusception. Fig (c) endoluminal 3D virtual colonoscopic image shows polyp at the descending colon. Fig (d) conventional colonoscopic image shows polyp at the descending colon. Fig (e) axial contrast enhanced 2D image shows intussusception indenting colon wall.



(a)

(b)

(c)



(d)

(e)

Case 3:

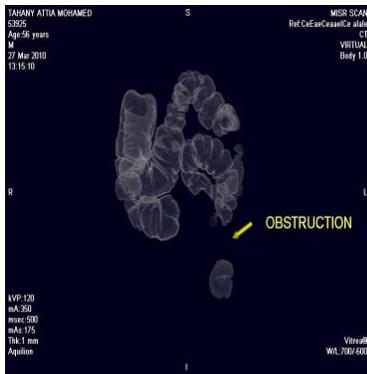
Female patient, Tahany Attia, 56 years old complaining of progressive constipation. Fig (a) sagittal contrast enhanced 2D image shows malignant stricture at rectosigmoid colon with surrounding soft tissue thickening of colonic wall. Fig (b) intraluminal 3D virtual colonoscopic image shows markedly narrowed colonic lumen. Figs (c), (d) volume rendered images show persistent discontinuation of colonic lumen at site of stricture



(a)

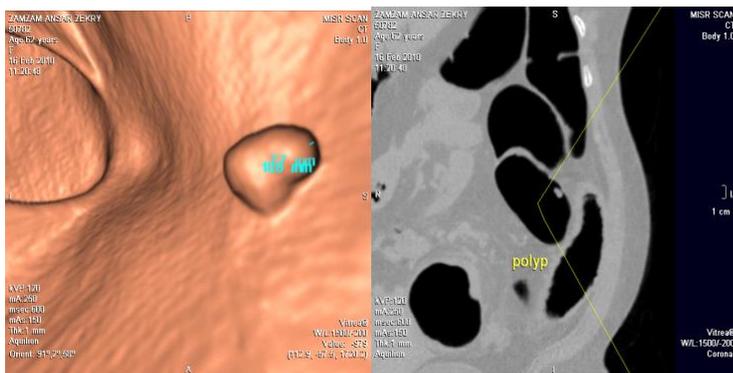
(b)

(c)



(d)

Case 4: Female patient, Zamzam Ansary, 53 years old with family history of colonic polyposis. Fig (a) coronal contrast enhanced 2D image shows 6mm polyp in rectosigmoid colon. Fig (b) virtual colonoscopic endoluminal 3D image shows 6mm polyp in rectosigmoid colon.



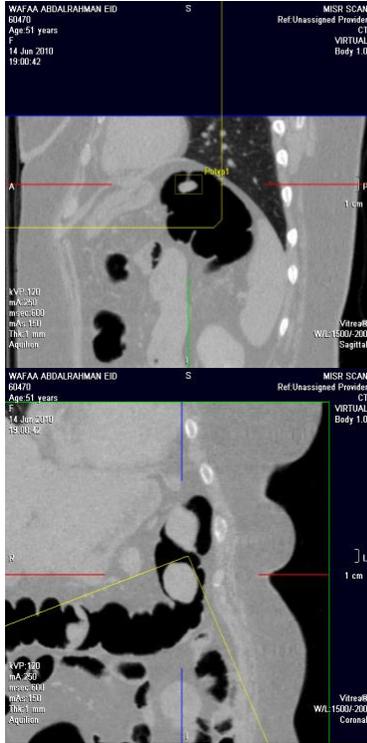
(a)

(b)

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Case 5:

Female patient , Wafaa abdel rahman, 51 years old with positive family history of colonic polypi and recurrent attacks of bleeding per rectum. Multiple colonic polypi both sessile and pedunculated were found the largest at descending and transverse colon measuring up to 40-60mm. fig (a) sagittal contrast enhanced 2D image shows pedunculated polyp at the proximal part of descending colon fig (b) virtual colonoscopic image of the same pedunculated polyp. Fig (c) coronal contrast enhanced 2D image showing large sessile polypi at the region of the splenic flexure and a smaller one at the transverse colon. Fig (d) virtual colonoscopic image of the most distal polyp seen at the region of the flexure. Fig (e) conventional colonoscopic image of the same polyp.

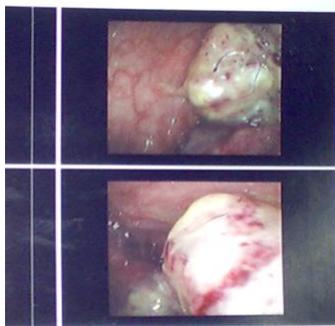


(a)

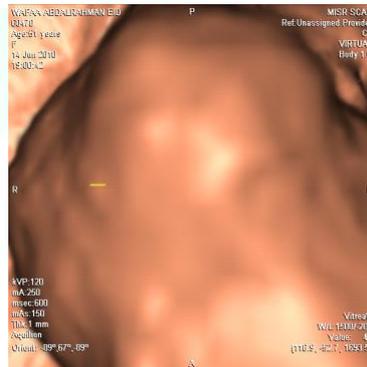


(b)

(c)



(d)



(e)

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