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Early Detection of Colorectal Carcinoma by Virtual CT colonoscopy

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A B S T R A C T

Colorectal cancer is the third most common cancer in the world and the second leading cause of cancer-related deaths in the United States accounting for approximately 10% of all cancer deaths in both men and women combined. CT-colonography including virtual colonoscopy is one of the most important recent applications of cross-sectional imaging evolved during the last years**.** Low-dose virtual colonoscopy was shown to have excellent sensitivity and specificity for detection of colorectal neoplasms 10 mm and larger. This study was conducted in the radiology department /CT angiography at Al- Sader medical city. Thirty patients with suspected features of colorectal cancer who refused Conventional colonoscopy or cannot complete it , had been examined by virtual colonoscopy(TOSHIBA AQUILON CT Scanner, 64 Slice made in Japan).Data collection continued from July 2011 to May 2012 with structured questionnaire for all the patients. Preparation of patients for colonoscopy to clean lower bowel. Patient education is important as patient's comfort will likely contribute to the larger goal of improving compliance for colon cancer screening. Therefore, steps that reduce patient anxiety will improve easier performance and quality of the exam. The procedure takes about 10 minute and does not required sedation. Patients were placed in the right lateral decubitus position on the CT table, a small catheter is inserted into the rectum and using a plastic bulb connected to the rectal catheter. Adequate distension is crucial for accurate assessment of the colon as polyps may be obscured in collapsed bowel segments. Statistical analysis was carried out using SPSS version 18. Categorical were presented as frequencies and percentages. Continuous variables were presented as means with their 95% confidence interval (CI). The Pearson's *chi-square test*(x^2) test was used to determine the associations between categorical variables. Independent sample t-test was used to compare means between two groups. Binary Logistic regression was used for multivariate analysis. A *p*-value of < 0.05 was considered as statistically significant. This study showed that12 patients were diagnosed as having polyps, two of them with radiological sign of malignant polyp and proved by histopathological examination, 4 with diverticulae, 1 patient with colitis ,one patient was diagnosed with primary colorectal tumour prior to virtual colonoscopy with provisional diagnosis confirmed that no additional pathology in the rest of colon.Meanwhile, 14 cases were negative by virtual colonoscopy.Four patients were excluded from the study due to inadequate colon preparation in one patients , failure of fixing a tube in anus in other patient, and the last two patients refused to complete the procedure.

Introduction

Colorectal cancer is the third most common cancer in the world and the second leading cause of cancer-related deaths in the United States accounting for approximately 10% of all cancer deaths in both men and women combined[1, 2]. Globally, the incidence of

CRC varies widely with higher incidence rates in North America, Australia, northern and western Europe. Developing countries have lower rates, particularly Africa and Asia [3, 4].The adenoma carcinoma sequence of colorectal cancer refers to the process of transformation of small adenomas into large adenomas, then into non-invasive carcinoma and finally into invasive carcinoma, through a series of genetic mutations. Colorectal cancer is a curable disease if detected early and may be prevented if precursor adenomas are detected and removed. Regular colon cancer screening has been recommended by the medical community for all individuals over 50 years of age and for individuals over 40 years of age with a significant family history .(5)

Virtual colonoscopy is a procedure used to look for signs of precancerous growths, called polyps, cancer, and other diseases of the large intestine. Images of the large intestine are taken using computerized tomography (CT) or, less often, magnetic resonance imaging (MRI). A computer puts the images together to create an animated, three-dimensional view of the inside of the large intestine.

CT-colonography including virtual colonoscopy is one of the most important recent applications of cross-sectional imaging evolved during the last years [6]. In a recent study, potential patients preferred virtual to conventional colonoscopy, whereas physicians favoured conventional colonoscopy [7].

Another study on 50 patients with a history of previous surgery for colorectal carcinoma, contrast-enhanced virtual colonoscopy was concluded to be a promising method for detecting local recurrence and distant metastases [8]. In addition, one study on virtual colonoscopy was shown to have an overall staging accuracy of 81% for colorectal cancer and was superior to barium enema in visualizing colonic segments proximal to obstructing colorectal lesions [9]. Virtual colonoscopy is still developing. Present research is directed towards obtaining thinner slices using multi-detector technology [10], reducing the radiation dose [11] and investigation of methods to obviate the need for complete colonic cleansing, mostly based on tagging the faeces with oral suspension such as barium sulphate[12,13]. New methods dealing with how to improve usage of the large amount of image data in virtual colonoscopy by computer aided diagnosis of polyps [14, 15] or by automated segmentation of the colonic wall from adjacent tissues is also being developed [16].

Indications for Virtual Colonoscopy

1.Failed or incomplete colonoscopy ,that occurs in 5–15% of studies due to obstructing colorectal lesions or technical reasons such as long and tortuous colon, or patient's discomfort [17].

2.Contraindication to endoscopic , such as (severe co-morbid disease, advanced age, bleeding disorders, very tortuous colon, prior allergic reaction to sedation, etc). These patients may benefit from virtual colonoscopy.(18,19)

3.Patients' refusal to colonoscopy, some patients that require colonoscopy refuse to have the procedure due to lack of information or afraid and may agree to have virtual colonoscopy.(20)

4.Extrinsic compression of the colon on colonoscopy , the reason for the extrinsic compression (adjacent spleen, liver impression or distended bowel loops) may be demonstrated on the 2D images.**(21)**

So far, indications for Virtual colonoscopy have mainly been screening for and detection of polyps in the colon [22] or examination after incomplete conventional colonoscopy [23, 24 , 25]However, the thin slices obtained during Virtual colonoscopy can also be useful in the preoperative staging of colorectal cancer. If the entire abdomen is examined in the same session, the liver and retro-peritoneum can also be assessed as well as the primary tumour and detection of synchronous tumours in the colon. If intravenous contrast is administered, this can potentially not only improve evaluation of polyps [9] but also improve depiction of liver metastases [26]. Histological differentiation of polyps is invariably difficult radiographically, so the majority of lesions require endoscopic sampling [27].

Table 1. Differentiation of benign and malignant polyps [19]

Benign polyp	Malignant polyp
Size < 1 cm	Size > 2 cm
Stalk Present (pedunculated, thin)	Stalk absent (sessile)
Contour Smooth	Contour irregular, lobulated
Single	Multiple
Underlying colonic wall Smooth	Underlying colonic wall indented, retracted

Table 2. Distribution of adenomatous polyps and cancer [28]

Location	Polyp frequency	Cancer frequency %
Rectosigmoid	52	55
Descending colon	18	6
Transverse colon	11	11
Ascending colon	13	9
Caecum	7	13

Limitations of Virtual Colonoscopy

A big size patient may not fit into the opening of a MDCT Scanner or may be over the weight limit (usually 450 pounds) for the moving table. Virtual colonoscopy is strictly a diagnostic procedure. If any clinically significant polyps are found, they will have to be removed by conventional colonoscopy. The ability of virtual colonoscopy to differentiate stool from artefacts and smaller polyps may not be as good as that of conventional colonoscopy. Virtual colonoscopy is not recommended for patients who have active Crohn's disease, ulcerative colitis, inflammatory bowel disease or diverticulitis, because of increased risk of perforating the colon. Patients with a history of bowel perforation and those experiencing severe pain or cramps on the day of the examination should not undergo virtual colonoscopy[29].

The lifetime risk of developing fatal cancer as a result of ionizing radiation exposure is estimated by the International Commission on Radiological Protection, or ICRP, to be approximately 5% per Sievert [30]. Because of the long latency period, radiation-induced cancer death becomes less probable. The targeted population for CTC is 50 years of age and older. The ICRP data indicate that the probability of inducing fatal cancer in this age group is approximately 2.5% per Sievert, and at the age of 70, the risk is half this value. The effective dose of CTC is estimated at about 8.8 mSv. (range 4–12 mSv.) and carries a risk of 0.02% in a 50 year-old individual and is lower for older patients [31]. In order to minimize the dose, efforts have been made to adapt the tube current to the minimum accepted dose while not diminishing study performance. No change was reported in the diagnostic efficacy when lowering the tube current from 140 to 70 mA using single-detector CT

[32] and multidetector CT [33]. Low-dose virtual colonoscopy was shown to have excellent sensitivity and specificity for detection of colorectal neoplasms 10 mm and larger [34]. The performance of virtual colonoscopy using an ultra-low radiation dose of 10 mAs has been shown to compare favourably with conventional colonoscopy in the detection of polyps larger than 6 mm with markedly decreased performance for small polyps of 5 mm or smaller [35]. The reduction in tube current has been shown to result in more noise with degradation of image quality. However, it has recently been shown [36] that combined x, y and z-axis tube current modulation leads to significant reduction of radiation exposure without loss of image quality. Until recently, it was thought that the only complications of virtual colonoscopy were mild to moderate abdominal discomfort due to the colonic insufflations and radiation exposure. Recent article published [37] that evaluated large patient cohorts of 11,870 and 17,067 studies, respectively, reported a risk of colonic perforation during virtual colonoscopy of 0.06–0.08%. Older age and underlying concomitant colonic disease such as inguinal hernia containing the colon, severe diverticulitis and obstructing colonic mass were present in most patients with perforation [38].

Patients and Methods

This study was carried out in the radiology department /CT angiography at Al- Sadder Teaching Hospital. All patients has been examined with virtual colonoscopy by TOSHIBA AQUILON CT Scanner, 64 Slice made in Japan.

30 patients with suspected signs and symptoms of colorectal cancer referred from GIT centre and from other departments, those patients refused conventional colonoscopy or cannot complete it, advice to do VC. The period of data collection continued from July 2011 to May 2012.

Preparation for colonoscopy to clean lower bowel, each patient was instructed to drink clear liquid one day before examination , in addition to clear liquid , the patient given a coloclean powder (4 packets) each packet dissolve in 4 glasses of water (total 16 glasses) and drink a glass of solution in every 15 minutes , beginning from day of preparation until evening , patient was instructed to put (10) anal suppositories of (biscodyl laxatives) on the evening prior to the examination. And in the day of examination (at morning),before doing the VC the patient instructed to put another 2 anal suppositories of (biscodyl laxatives), patient must drink all the clear liquid above and he can drink more fluid but not less , on the day of examination the patient was instructed not to drink any liquid and not to eat breakfast.

First thing we did in our department is patient education; patient's comfort will likely contribute to the larger goal of improving compliance for colon cancer screening. For each patient, we provide information to appropriately set the patient's expectations. Patients often experience considerable anxiety as they approach colon examinations, in part due to their expectation of perceived embarrassment and discomfort. Therefore, steps that reduce patient anxiety will improve easier performance and quality of the exam[24 , 25]. The procedure takes about 10 minutes and does not required sedation. Patients were placed in the right lateral decubitus position on the CT table, a small catheter is inserted into the rectum and using a plastic bulb connected to the rectal catheter.

Air room pumped gently through the tube to expand the large intestine for better viewing. The amount of air that is insufflated is

determined by patient tolerance or 1-2 litter, the rectal tube was clamped and left in place. Adequate distension is crucial for accurate assessment of the colon as polyps may be obscured in collapsed bowel segments.

After the colon is insufflating, patients supine on a table. CT scout image is obtained in the supine position to assess the degree of colonic distension. Distension considered adequate when a continuous column of gas was visible at CT throughout the well-distended colorectal. If the amount of air considered insufficient, additional air insufflations was performed. The patient is scanned in the supine position after ask in the patient to hold their breath to steady the images and then turned onto the prone position. A second scout image is obtained to assure that colonic distension is still adequate and the study is then completed. Dual positioning has been shown to improve colonic distension allowing confirmation of suspected findings and to increase detection of colonic polyp.

A structured questionnaire was used to collect the data from all the patients. This questionnaire consists of eight items, namely, patient's age, gender, smoking history and family history of colorectal cancer, signs and symptoms of colorectal cancer, virtual colonoscopy findings.

Variables Statistical analysis was carried out using SPSS version 18. Categorical were presented as frequencies and percentages. Continuous variables were presented as means with their 95% confidence interval (CI). The Pearson's *chi-square test*(x^2) test was used to determine the associations between categorical variables.

Independent sample t-test was used to compare means between two groups. Binary Logistic regression was used for multivariate analysis. A *p*-value of < 0.05 was considered as statistically significant.

Results and Discussion

Table.3 shows the findings of virtual colonoscopy, 12 patients were diagnosed as having polyps two of them with radiological sign of malignant polyp and proved by biopsy and histopathological examination, 4 with diverticulae, 1 patient with colitis , one patient was diagnosed with primary colorectal tumour prior to virtual colonoscopy with provisional diagnosis confirmed that no additional pathology in the rest of colon . Mean while, 14 cases were negative by virtual colonoscopy .

Four cases were failed due to failure of fixing a tube in anus in one case, the other patient was inadequate for colon preparation and high faecal colonic load , and the last two patients refused to complete the procedure , these four cases did not include in this study.

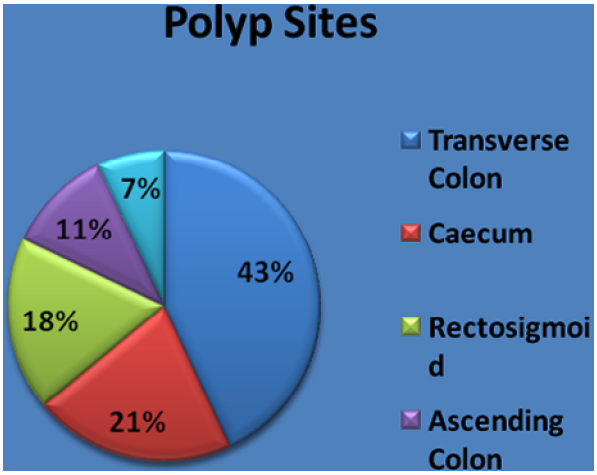


Figure.1 Show site of polyps in the colon

Table.3 Shows findings of Virtual Colonoscopy

Virtual colonoscopy finding	No. of patients
Known colonic cancer	1
Colonic polyps	12
Diverticulum	4
Colitis	1
Negative	14
Failed	4 (not included in this study)
Total	32

Table.4 Shows polyp localization, size and number as detected by Virtual Colonoscopy

Polyp site	**Polyp no.**	**Polyp size (mm)**
Transverse colon	12	5, 6, 7, 7.5, 8, 9, 10 ,12 ,14 ,15 and 37
Caecum	6	6, 6.3, 8, 9, ,11 and 25
Sigmoid	5	4.7, 5, 6 and 7
Ascending colon	3	7, 8 and 9
Descending colon	2	10 and 13
Hepatic flexure	1	9
	Total	**29**

Table.5 Shows diverticulum localization, size and number as detected by Virtual Colonoscopy

Diverticulum site	**Diverticulum no.**	**Diverticulum size(mm)**
Sigmoid	3	6, 6.3 and 6.5
Transverse colon	1	6.5

Table.6 Shows the association between Virtual Colonoscopy finding and its associated risk factors i.e. age, gender, smoking habit, family history, signs and symptoms of colorectal cancer. The proportion of Virtual Colonoscopy finding was significantly higher with female patients. On the contrary, there were no significant associations between the Virtual Colonoscopy Finding and other risk factors.

Variable	Virtual colonoscopy			P values
	Yes (%)	No (%)	Total	
Age Groups (years)				
< 60 years	9 (56.3)	7 (43.8)	16 (53.3)	0.261
≥ 60 years	5 (35.7)	9 (64.3)	14 (46.7)	
Gender				
Male	4 (26.7)	11 (73.3)	15 (50.0)	**0.028***
Female	10 (66.7)	5 (33.3)	15 (50.0)	
Family history of colorectal cancer				
Positive	2 (100.0)	0 (0.0)	2 (6.7)	0.118
Negative	12 (42.9)	16 (57.1)	28 (93.3)	
Signs and symptoms				
Bleeding per rectum	10 (55.6)	8 (44.4)	18 (60.0)	0.232
Others	4 (33.3)	8 (66.7)	12 (40.0)	

- Significance level p value < 0.0

Figure.2 Polypoidal Tumor

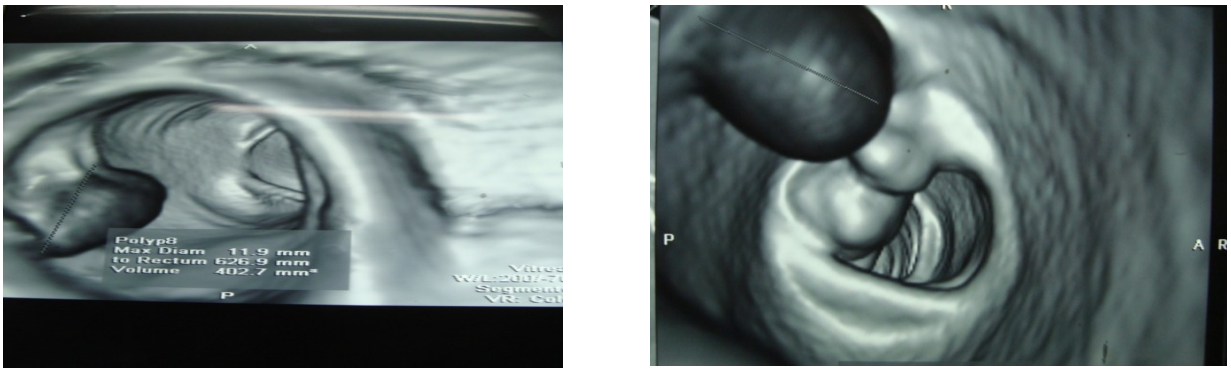
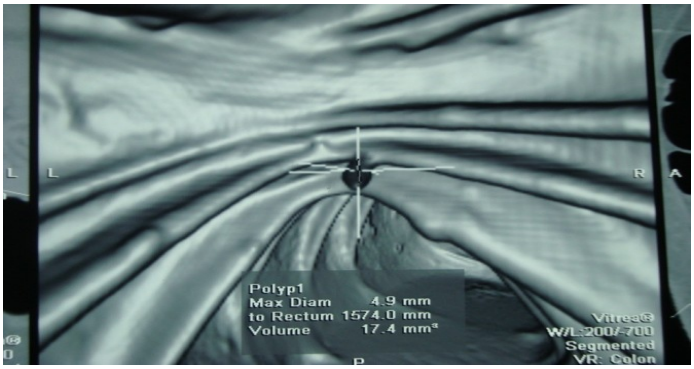


Figure.3 Shows pedunculated polyp and sessile polyp



Pickhards et al evaluated the VC in comparison with gold standard-conventional colonoscopy. They found that, the sensitivity of VC to adenomatous polyps bigger than 10 mm was (93.8%), to polyps sized (8-10)mm was (93.9%), and to polyps sized (6-8)mm was (88.7%), and specificity of virtual colonoscopy was (96.0%), (92.2%) and (79.6%) respectively (36). Furthermore, pineau et al found that the sensitivity for lesions bigger than 6 mm was (84.4%) and specificity (83.1%), for lesions bigger than 10mm the sensitivity was (90%) and specificity (94.6%), upon detection of lesions bigger than 10 mm, the virtual colonoscopy excluded further necessity of colonoscopy in (80%) of patients, and in (68%) for lesions bigger than 6 mm[(37) .]

Pedersen et al found polypoid lesions bigger than 6 mm, its sensitivity was (81%) and specificity (97%) , however only in (76%) of patients a technically sufficient colon distension was achieved . In conclusion , the authors specify that virtual colonoscopy and conventional colonoscopy feature the same sensitivity for the detection of polypoid lesions > or = 6mm [38].

Virtual colonoscopy has been used in two basic indications. First, for severe impassable colonic strictures, which prevent us from excluding a duplicate tumour , and further in patients with a negative experience from previous examinations when patients refused colonoscopy . In both indications, virtual colonoscopy has fully proved itself. In our study, VC detects 29 polyps: - 3% of them less than 5mm , 59% between5-10 mm , 38% more than 10 mm.

From those polyps there were two cases with sign of malignancy, one in transverse colon: large adenomatous polyp with absent stalk “sessile” irregular contour, lobulated, the underlying colonic wall indented and retracted. The other case was large polypoidal mass with irregular outline in Caecum as seen in figure (2), however when tumour was detected, we did not recommend a surgical intervention based on VC only, but we insisted on histological verification. Therefore, a conventional colonoscopy with tumour biopsy and histological examination it was positive for those polyp.

In this study, signs and symptoms of patients with colorectal cancers represented abdominal pain (76.6%), bleeding per rectum (40%), weight loss (16.6%), diarrhoea (26.6%), constipation (30%) and anaemia (56.3%). However , these finding were in agreement with the findings of Ries et al., (2007) and Johns *et al.,* (2001) who reported that bleeding per rectum, diarrhoea, constipation, abdominal pain and anaemia are the most common signs and symptoms of colorectal cancer [37 , 38]

The study show differences in the standard frequency of polyp as compared with *Rex,D., et al* who evaluated that frequency of polyp was in recto sigmoid 52%, descending colon 18%, transverse colon 11%, ascending colon 13% and caecum 7% (40).

Meanwhile, in this study shows that transverse colon 43%, ascending colon 11%, caecum 21%, recto sigmoid 18%and descending colon 7 % .[(39]Also there was one case referred from GIT centre as known case of CA sigmoid with long malignant stricture as seen in(Fig 4) , they cannot pass beyond it to see if there is synchronous tumour , VC confirmed that no additional pathology in remainder of the colon.

Figure.4 Shows malignant stricture in sigmoid by 2D, and arrow shows irrgular colonic wall prior to stricture

There were some limitations due to technical device, crowding of patients, enema tolerance from patient, patient preparation, cooperation, and exposure to radiation in young age group. Other limitation drawback on this study regarding doctors acceptance to this new technology they prefer conventional colonoscopy according to the experience in this field, they still not well familial with this imaging modality.

Conclusions

Among patients with signs and symptoms of colorectal cancer seen at Al Sader hospital from July2011 to May 2012, the proportion of the patients with positive finding for colorectal cancer by VC was (53.3%). High specificity by using of VC indicated that, the examination results by using of VC get better interpretable for both radiologists and surgeons. Virtual colonoscopy is probable a method of the future.

Recommendations

1-VC with high specificity and sensitivity for detection of colorectal lesion so we suggested to included in our examination.

2-VC new method of investigation needs training for staff and sub staff who work on this technology.

3-In order to be more oriented, more experiences with good skills in VC , we suggest more study done with large sample.

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