CT-Colonography after Incomplete Colonoscopy: Our Experience in a Tertiary Care Academic Center

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Abstract: Background: CT-Colonography (CTC) has an increasing role in evaluating colonic lesions from polyps to colonic cancer. Its role in colonic evaluation in cancer colon proximal to partially obstructive lesion with incomplete endoscopy is extremely valuable. **Aim** To demonstrate the role of CT colonography (CTC) in evaluating entire colon in patients referred after incomplete colonoscopy for exclusion of synchronous lesions in colorectal cancer and delineation of possible etiology of incomplete endoscopy. **Patients and Methods:** 71 CTC examinations performed in successive patients suspected tohave colorectal cancer, 33 females and 38 males. Patients were referred after incomplete colonoscopy done same day (N=58) or colonoscopy is contraindicated or refused by patient (N=13). Examinations performed in supine and prone positions after having adequate carbon dioxide insufflation and fecal tagging given in two different protocols. Examinations were analyzed by three consultant radiologists who had experience with this technique. Results were correlated with colonoscopy/biopsy or post-surgery pathology findings. **Results:** CT colonography (CTC) was successful in delineating synchronous lesions in 8 patients(11.3%),different pathologies in 42 patients including recto-sigmoid cancer in 15(21.1%), Descending colon cancer in 7(9.9%), diverticular disease in 3(4.2%), sessile fatty lesion near ileocecal valve in 1 (1.5%), right colonic mass in 1(1.5%), transverse colon mass in 1(1.4%). 3 (4.2%) patients had sigmoid polyp(s) and 7 other patients with other colonic polyps (9.9%) with one of them described as large polyp pathologically proven as tubo-villous adenoma. CTC was normal in 18(25.4%) and suboptimal in 8(11.3 %). CTC showed successful correlation with colonoscopy demonstrating 11(15.5%) constricting masses, 3(4.2%) splenic flexure lesion,3(4.2%) descending colonic mass, 3(4.2%) fungating transverse colon mass. 13 patients did not have colonoscopy(18.3%). Extra-colonic findings were seen in 12 patients (16.9%) **Conclusion:** CT colonography with proper technique and optimal fecal tagging is effective in evaluating colonic segments not visualized with incomplete, contraindicated or refused colonoscopy as well as in detecting extra-colonic findings.

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Abbreviations:
CT = Computed Tomography; CTC =CT colonography;VC=Virtual colonoscopy; OC = Optical colonoscopy
IV = Intravenous; CO2= Carbon Dioxide; CRC= Colo-rectal cancer

1.Introduction

CTC or "Virtual colonoscopy" was first described by David Vining more than a decade ago.[(1)] The examination is based on volumetric, thin-collimation CT acquisition of a cleansed and air-distended colon; CT datasets are edited off-line in order to produce multiplanar reconstructions (coronal and sagittal images) as well as three-dimensional (3-D) modelling,including endoscopic-like views.[(2)] Several studies demonstrate VC ability in detecting colonic neoplastic lesions, not only large carcinomas but also polyps [(3,4)].Currently, the most widely accepted clinical indication for VC is incomplete or unsuccessful colonoscopy, which may be the result of redundant colon, patient intolerance to procedure, spasm not resolving even with spasmolytics or obstructing colo-rectal cancer. The major advantage of VC, when compared with barium enema, is that VC can be performed on the same day of colonoscopy without additional bowel preparation. VC can complete the examination in most of the cases, being also able to provide the cause of endoscopic failure. [(2)] Colonoscopic examination may be incomplete for a variety of reasons. In patients treated with anticoagulants or those with medical conditions that increase the risk of sedation. In these patients colonoscopy may not be a suitable first step for colonic evaluation.[(5)] In elderly patients, the rate of

incomplete colonoscopies has been reported to be as high as 22–33%. [6] CTC provides structural evaluation of the entire colon, including the cecum, even in patients who had undergone incomplete colonoscopy[7] Advantages of CTC over colonoscopy include its noninvasiveness, lack of need for sedation, lower cost, ability to detect significant extarcolonic abnormalities and more accurate lesion location. CTC main disadvantage is the inability to obtain biopsy, as it is a noninvasive imaging test. [8]

The interest in developing tagging regimens is related to potentially improving patient experience by decreasing or eliminating the need for cathartics. Stool/fluid tagging may also help improve the sensitivity and specificity of polyp detection by CTC. Solid particles that are tagged should be more easily differentiated from soft tissue density of polyps. Tagged fluid can allow easier discrimination of soft tissue polyps that may be submerged within it. [9] Using automated CO2 delivery system resulted in both improved colonic distention and decreased post-procedural discomfort. [10] It is more comfortable and useful for patients with malignancy with diminished peristalsis. Automated CO2 insufflations improve colon distension and operate on a lesser infusion rate than manual insufflations. There is also less abdominal cramping and fullness because CO2 is easily absorbed from the colon. The benefits of CTC for patients with malignancy include the ability to evaluate metastasis, local invasion, stenosis of the colon, and colonic dissemination. CTC also has the ability to evaluate extra-colonic findings, unlike conventional CT without preparation. [11]

As polyps are evaluated by size, nonadenomatous and noncarcinomatous lesions have the potential to be removed during colonoscopy, whereas CTC has the added benefit of axial imaging, so these abnormalities can be better evaluated and perhaps excluded as benign lesions. The real benefit for the evaluation of polypoid lesions seen on colonography is when they are the result of extrinsic lesions and wall abnormalities. These are difficult to evaluate by colonoscopy. [7] Although the subject of controversy, there is evidence that CTC sensitivity compares favorably with that of colonoscopy in colorectal neoplastic detection. [6]

An increased percentage of truly therapeutic colonoscopic examinations would represent better use of limited resource that is more costly and more invasive than CTC.[10] Continued advances in the CTC technique, including improvements in software, colonic preparation, and colonic distention, led to consistently higher quality and better patient's tolerated examinations. Recent improvements in the 3D Colon software greatly reduced interpretation time, with reading-time of 10 minutes or less. [12]

Although CTC is noninvasive, potentially serious adverse events have been reported in 0.08% of symptomatic patients and perforations have occurred in 0.05%to 0.059%. By comparison, colonoscopy perforation rate reported in the same and similar hospitals was 0.13%, suggesting much lower risk with CTC. [8]

We aim to demonstrate the role of CTC in evaluating entire colon in patients referred after incomplete colonoscopy for exclusion of synchronous lesions in colorectal cancer and/or delineation of possible etiology of incomplete endoscopy.

2. Patients& Methods:

Patients:

71 CTC examinations performed in patients whom suspected to have colorectal cancer, 33 females and 38 males. Patients referred for CTC examination between January 2010 and October 2012 mainly due to incomplete colonoscopy (n=58). Endoscopy was not done in 13 patients either due to contraindication or patient refusal. Incomplete colonoscopy was due to inability to pass the colonoscopy due to partial obstruction by colonic mass (n=30), extra redundancy, extra folding of the colon (n=23), inguinal hernia (n=2) and other causes such as patient distress or excessive air distension during the exam. (n=3) (Fig.1). Age range was 36 to 83 with average mean age being 53 years old.

Methods:

Colon Distention:

Using Carbon dioxide (CO_2) gas pump (VIMAP VMX-1000A, Godores Electronic Medico, Spain) in all patients procedure started by insufflation (using rectal catheter with balloon) in prone position, followed by scanogram to assess proper distension. When acceptable, prone axial CT examination was done, followed by turning patient into supine position, Axial CT was repeated. Air distension is done after rectal and bladder evacuations. Maximum pressure was set at 25mmHg and maximum CO2 volume at 4 liters.

Patient Preparations:

Patients referred to our department after incomplete colonoscopy.We took the advantage of colonoscopy preparation. CTC was done in same day except if a deep biopsy was taken. Patients are kept on fluid diet and given fecal-tagging material.

Fecal Tagging:

Two protocols were used. First ~~was~~ used 4ml Omnipaque added to 250ml water, patient was given 150ml divided into 3 doses separated by 4 hours each. Starting April 2011, 30-50cc of Gastrografin (Schering AG) was used as new fecal tagging protocol 30-50 cc nondiluted, 3-4 hours before the examination.

CT Examination:

All examinations were done using GE Multi-slice light speed VCT-XTE 64 slices or HD Discovery 750,64 multislice (GE Medical Systems, Milwaukee WI, USA) in supine and prone position with 100Kv, auto mAS (50-440) in all patients, slice thickness = 1.25mm interval 1.25mm pitch 1.375mm section overlapping every 0.7mm, rotation time 0.5 sec.

IV Contrast:

Only two patients were done post IV contrast administration. Patients with malignancy are routinely (in our institution) investigated using IV contrast enhanced CT of the chest, abdomen and pelvis. All patients' well-tolerated examination with no minor or major complications according to our protocol. All patients with a previous superficial biopsy were examined initially by non enhanced (Plain CT) examination in supine position with no CO_2 insufflations, to exclude post-colonoscopy perforation. Patients with previous deep wall colonoscopic biopsy were delayed for 10-14 days. As the accepted protocol, by our surgeons, for staging of CRC was post-contrast study of chest, abdomen and pelvis, no routine plans were done to combine CTC with IV contrast to avoid unnecessary nephrotoxicity.

Data Analysis:

Image processing/ interpretation done Using Colon VCAR EC on G.E Healthcare Advantage Window equipped with Shareware 4 (software 4.5) (vital images, Plymouth, MN, USA).

Evaluation of CTC:

All examinations were reviewed by 3 consultant radiologists in consensus obtained 3 courses of approved training on CTC. They were interpreted first by reviewing primary 2D axial images (supine & prone) with the use of 3D endoluminal views and dissection views and bookmarking as problem-solving methods. Details of colonic data (polyp size, location, edges or tumor size and location) in addition to extra-colonic findings are recorded in specially designed sheet and master-table. All patients that underwent colonoscopy and biopsy, pathology results were correlated to CTC findings. This was also done in surgically-treated patients.

3. Results:

We prospectively perform CTC in our department in the period between January 2010-October 2012. A total number of 71cases were examined (33 females and 38 males). Age-range was 22- 83 years with average age of 53 years.

Clinical presentations for colonic assement were shown in (**Fig.1**). The findings of CTC ~~(Fig.1)~~ were: 15 patients had constricting sigmoid cancer (21.1%) (Fig.5 A&B) ,7 patients had descending colon cancer (9.9%), 3 had diverticular disease of the colon (4.2%); 1 patient had sessile fatty lesion near the ileocecal junction (1.4%) 1 patient had ascending colon mass (1.4%); and one had transverse colon mass (1.5%),3 patients had sigmoid polyp(s)(4.2%)& 7 patients with other colonic polyps(9.9%) with one of them described as large polyp pathologically proven as tubo-villous adenoma (Fig.6). and 8 out of 71 patients had at least 2 synchronous lesions(11.3%) (Fig.5 C&D), 1 patient with inactive Crohns disease (1.4%), 18 patients had normal CTC (25.4%); 8 out of 71 patients had suboptimal / incomplete CTC (11.3 %).

Colonoscopy was incomplete in 58/71 patients for different reasons (81.7% of the study population) (Fig.2). Colonoscopy findings (N=58) were (Fig.3): Constricting sigmoid mass in11 patients (also seen in CTC) representing 18.97%, Splenic flexure lesion was seen in 1 patient (1.4%), a descending colonic mass seen in 4 patients (6.9%) and was also confirmed by CTC, fungating mass in transverse colon in 3 patient (5.2%) also seen on CTC (Fig.4) . 25 colonoscopies were normal (43.1%) Reasons of incomplete colonoscopy (Fig.2) were; obstructive rectal/colonic cancer in 30 patients (51.7%) *all were described in CTC*. 13 patients did not have colonoscopy representing (18.3% of the cases) and they are not included in the study statistics. Additionally seen in both (colonoscopy and CTC) was fibrotic Crohn's disease in one patient (1.4%) and 3 diverticular disease (4.2%). Extra-colonic findings were seen on CTC in 12/71 patients.

4. Discussion

Colonoscopy is the standard method for colon evaluation. This technique allows evaluation of the entire colon in most patients. It also allows biopsy of suspicious lesions and polypectomy may be performed during colonoscopy. However, colonoscopy is invasive, requires patient sedation, and is not accepted by all patients. Even when performed by experienced endoscopists, approximately 6–26% of colonoscopic examinations[11,12] are incomplete and fail to reach the level of the cecum.The reasons for incomplete colonoscopy are redundant or tortuous colon, marked diverticular disease, obstructing masses and strictures, angulations or fixation of colonic loops, adhesions due to prior surgery, spasm, or poor colonic preparation [12].

Fig.1 Clinical presentation

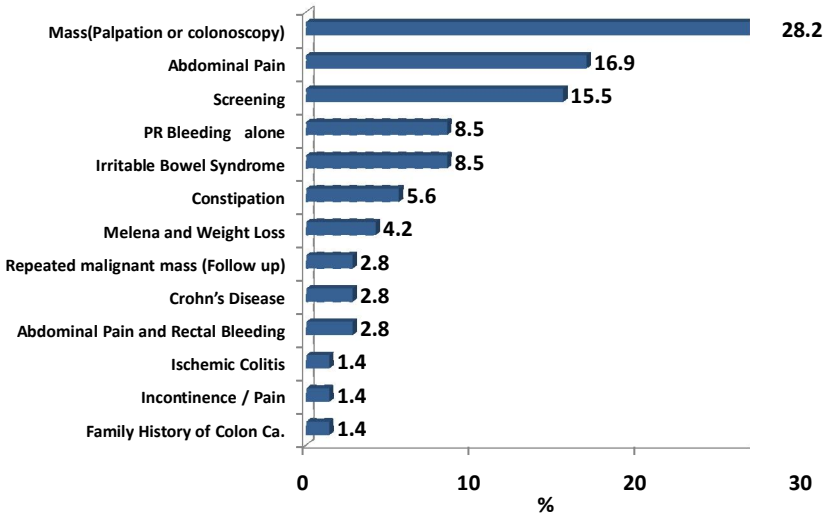


Fig.1: Graph of clinical presentation of patients referred for CTC.

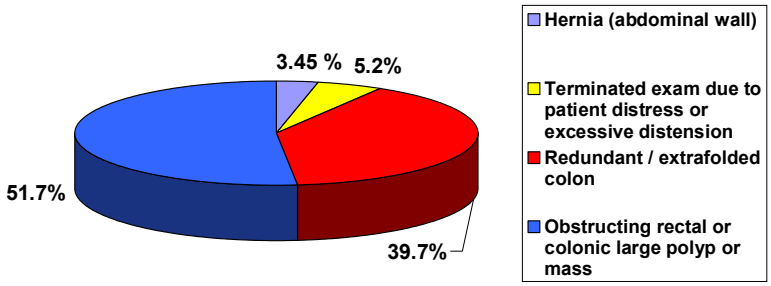


Fig.2: Reasons for incomplete colonoscopy

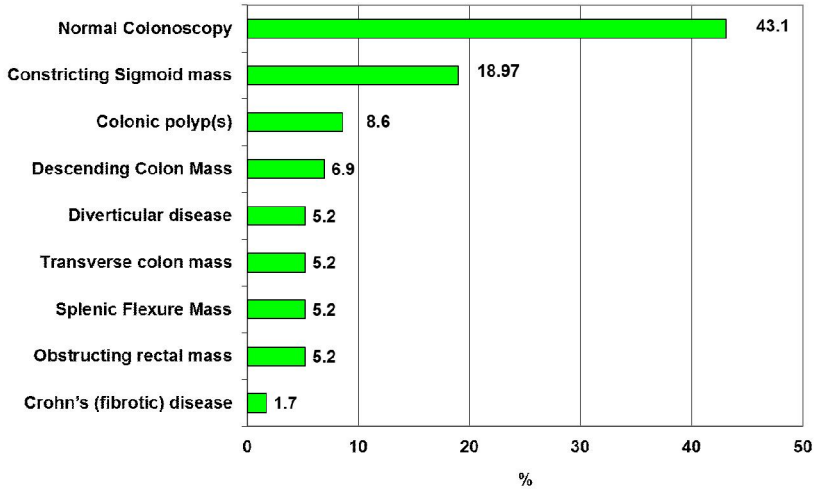


Fig.3:Findings of incomplete colonoscopy in CTC patients

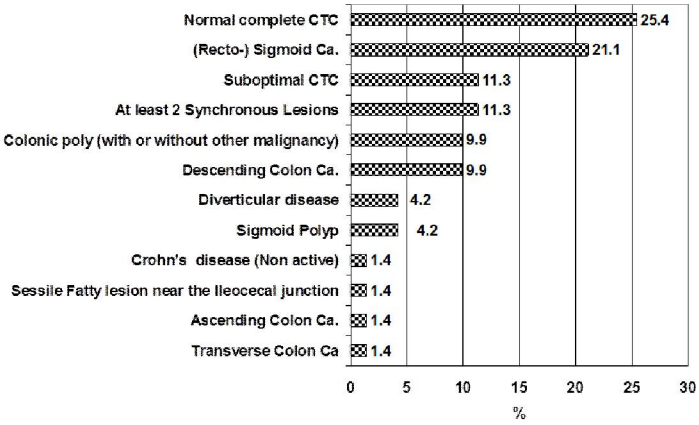


Fig.4: Findings in on CT Colonography

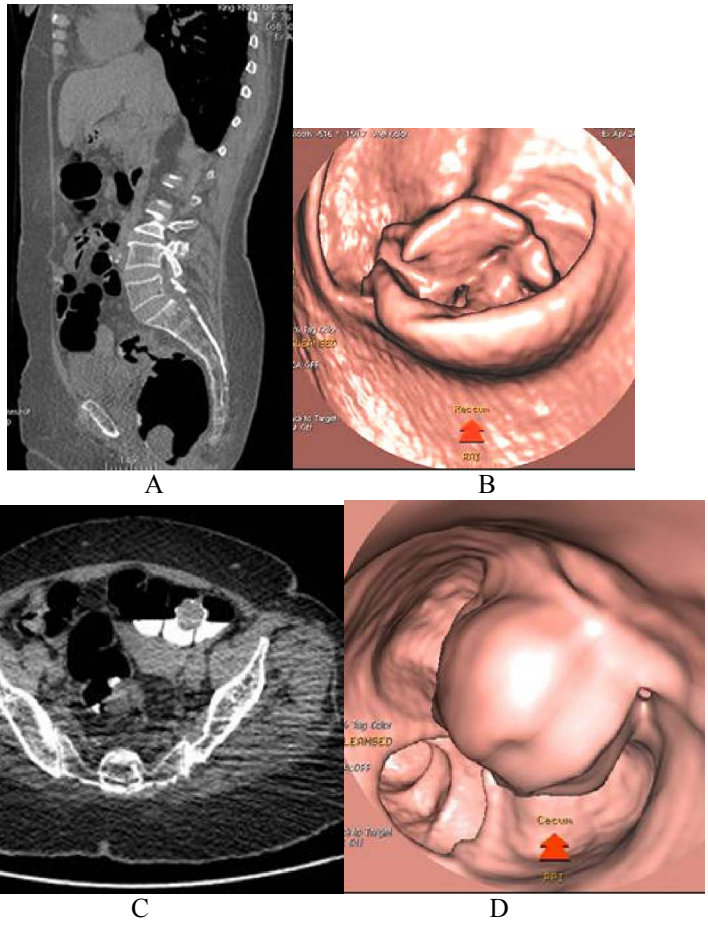
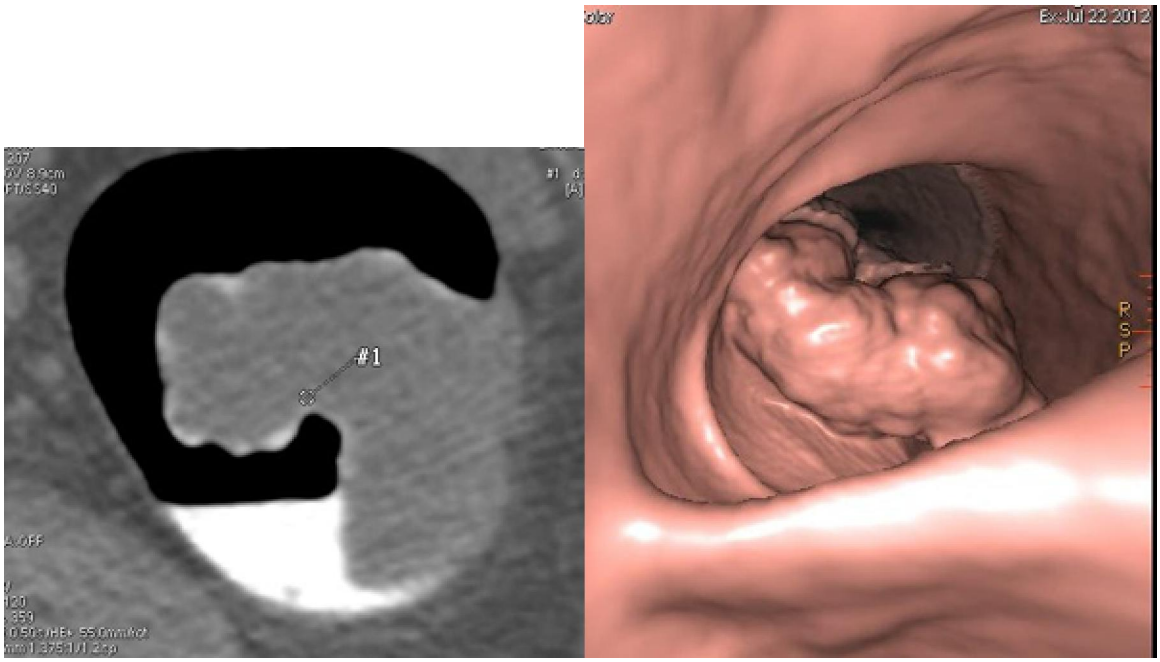


Fig.5: Rectal cancer with synchronous lesion:

A. Coronal reconstructed CT with constricting mass.
B. endoluminal 3-D CTC view of rectal cancer.
C. Axial 2-D CTC image with oral contrast with sigmoid polyp in the same patient.
D. 3-D CTC endoluminal view for the synchronous polyp of the sigmoid colon.



A B

Fig.6: Tubo-villous adenoma of the sigmoid colon:
A. Axial 2-D image with large sessile polyp filling most of the lumen of the sigmoid colon and delineated by oral contrast (digitally non- cleansed image).
B. endoluminal 3-D CTC image showing clearly the edges of the mass with clear visualization of the normal status of the noninvolved colonic lumen(digitally cleansed image).

CTC after incomplete colonoscopy (occurring in 4-19%) may be especially helpful for evaluation of the non-visualized parts of the colon, and it can increase diagnostic yield of masses and clinically important polyps in this context. This frequency is an important indication for performing immediate CTC in order to avoid repeating bowel preparation whenever possible.[1] This is in agreement with Park et al [13] who reported the high sensitivity of CTC in detecting synchronous cancers proximal to a stenosing colorectal cancer.

In colon cancer with luminal compromise the passage of the colonoscope can be replaced by less stiff materials. Hence the alternatives to conventional colonoscopy include sigmoidoscopy, double-contrast barium enema, magnetic resonance colonography, and CTC. [14] 27% of our patients were diagnosed by clinical palpation and/or colonoscopy as colonic mass and this was proven by CTC. Although colonoscopy can confirm this by biopsy, CTC in our patients (with incomplete colonoscopy) had the advantages of passing visualization of the colon proximal to obstruction diagnosing synchronous lesions in 11.3% of patients (Fig.5) in addition to 1 patient with a sessile fatty lesion of benign characters was seen at ileocecal valve area and 3 patients diagnosed with diverticulosis where the prior CT examination (before CO2 insufflation) excluded diverticulitis. Extra colonic findings were another advantage of CTC particularly in patients with no malignant colon lesions (as that will be examined by staging ~~complete~~ contrast enhanced CT of the abdomen). Extra colonic findings were described in 12 patients who can guide to the necessity for further assement.

As CTC provides the advantages of minimal invasiveness, short acquisition time [6] and minimal discomfort, along with no recovery time or need for sedation [6, 7], no sedation was used in our patients and no post-procedure complications were met in our patients. In CTC, CO2 distension (or room air) of the colon (combined with oral contrast for fecal tagging) the problem of passing through the incompletely obstructing lesion is overcomed. We used automated CO2 injector which was well tolerable by all of our patients as recommended by literature. [1, 10] This allowed visualization of the endoluminal surface, the colon, and extra colonic structures which is another advantage over colonoscopy due to its axial examination dimension.The addition of oral contrast/fecal tagging improves visualization of polyps[9] in patients with residual colonic fluid and helps differentiate polyps from retained fecal material. As regard complication, colon perforation is much less in CTC than OC and tolerability and outcome after using CO2 in CTC is much better than room air used in OC. [8] In our study we didn't face

the problem of colon perforation (neither on CTC or colonoscopy).

In this study we had the chance of comparing 2 types of fecal tagging, the first was before April 2011 (35 patients) using diluted water soluble contrast and after April 2011 (36 patients) using 30-50cc of non diluted oral contrast. The readers (3 Radiology consultants) responses were clearly accepting the results of the later fecal tagging with no evidence of artifacts (as compared to the fractionated doses of diluted oral contrast) with additional more clear data by using the automatic (digital) cleansing process of the software on the workstation (Fig.6). It was also more tolerable by the patients.

Conclusion:

CTC with proper technique and optimal fecal tagging is technically effective in evaluating colonic segments not visualized during incomplete colonoscopy and detecting extra-colonic findings. CTC does not replace colonoscopy in diagnosing colon cancer but it has adjunctive role in patients with incomplete, contraindicated or refused colonoscopy. Fecal tagging using single dose of nondiluted contrast was more tolerable by patients and much more acceptable, as regard examination quality, by the evaluating radiologists compared to fractionated doses of diluted oral contrast.

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