STUDY ON VIRTUAL COLONOSCOPY

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ABSTRACT

BACKGROUND

Current options available in the investigations of colorectal carcinoma include screening using digital rectal examination, sigmoidoscopy, barium enema and fiberoptic colonoscopy, virtual colonoscopy. The aim of the study was to prospectively evaluate patient acceptance of virtual colonoscopy compared with that of conventional colonoscopy when performed in patients with or suspected of having colorectal disease.

MATERIALS AND METHODS

The study had been conducted on patients attending Department of Radiology for a period of 1 year. Patients with primary or secondary complaints of pain abdomen, lump in abdomen, bleeding per rectum, loose motions/constipation, altered bowel habits, loss of appetite and weight and anaemia, so total number of cases were 51.

RESULTS

In our study, the patients were in age groups of 21-70 years. Both sexes were represented in our study. Male preponderance was noted in 51 patients. Cases of adenoma were more commonly found 37 (72.78%). The sensitivity of the CT colonography for the polyps more than 10 mm is 100%, polyps 6-9 mm is 90%, less than 6 mm is 80%. Our study consists of 51 patients; among them, 30 patients showed acceptance for CT colonography, 10 patients for optical colonoscopy. Our study consists of 51 patients, the polyps (more than 10 mm) detected in 2D viewing were 24, 2D and 3D viewing of 24, the polyps (less than 10 mm) detected in 2D viewing were 15, 2D and 3D viewing were 17. 3D viewing resulted in increased sensitivity for identification of patients with larger polyps more than 1 cm, (70-85% sensitivity) and patients with smaller polyps less than 1 cm (increased sensitivity 75-88%).

CONCLUSIONS

Multislice CT (64) colonography is a good alternative to other colorectal screening tests because it has high sensitivity for polyps 10 mm or more in diameter is relatively safe, clinical effective, minimally invasive, cost effective and filter for therapeutic optical colonoscopy.

KEYWORDS

Virtual Colonoscopy, Colorectal Disease, Adenoma.

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BACKGROUND

Colorectal cancer is a potentially curable disease if detected early. Screening techniques may decrease the morbidity and mortality associated with it by early detection leading to early removal of premalignant adenomatous polyps before they become invasive age. Current options available in the investigations of colorectal carcinoma include screening using digital rectal examination, FOBT (faecal occult blood testing), sigmoidoscopy, barium enema and fiberoptic colonoscopy, virtual colonoscopy.

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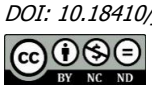


Virtual Colonoscopy or Computed Tomographic (CT) colonography is a recent radiological technique enabling detection of tumoral lesions in the colon. As in the past two decades, its radiological predecessor, Double-Contrast Barium Enema (DCBE) has lost most of the it's adherents. CT colonography constitutes a real opportunity for gastrointestinal radiologists to play a preponderant role in the diagnosis and treatment of colorectal cancer and the adenoma.[1] Since then, CT colonography has dramatically evolved by the refinement of existing techniques and the introduction of new ones: faecal tagging with the option of reducing the cathartic or laxative part of the preparation. The use of carbon dioxide to inflate the colon, the introduction of multidetector CT scanners producing spectacular images with isotropic resolution and reducing the examination, time for the patient, the use of ultra-low-dose scan protocols reducing the radiation burden, improvement of the image post-processing with fast three-dimensional functions and Computer-Aided Diagnosis (CAD).

These technical improvements help both the radiologist and the patient.

For the former, there is an improvement of the reading conditions possibly improving diagnostic accuracy; for the latter, the preparation and examination are more comfortable.[2] Meticulous technique of preparation with faecal tagging, colonic inflation, scanning parameters and reading conditions. CT colonography obtained better scores than optical colonoscopy. In experienced hands, CT colonography seem to be ripe for prime time colorectal cancer screening. Our study is to evaluate the diagnostic efficiency of virtual colonoscopy in the detection of colorectal tumours by comparing it with conventional colonography in patients with high risk of colorectal cancer. To study the advantage of combined 2D and 3D viewing over 2D or 3D viewing alone.

MATERIALS AND METHODS

The study had been conducted on patients attending the Osmania General Hospital and MNJ Institute of Oncology and Regional Cancer Center in the present study extending from September 2014 to November 2015. Patients with primary or secondary complaints of pain abdomen, lump in abdomen, bleeding per rectum, loose motions/constipation, altered bowel habits, loss of appetite and weight and anaemia, so total number of cases were 51. For computed tomography, equipment used is Hitachi W 700 scanner IV generation was used in MNJ Institute of Oncology and Regional Cancer Center. Toshiba, Asteion TSX-021A Spinal CT was used in Osmania General Hospital, SOMATOM-Sensations- 64 slice CT was used in MNJ Institute of Oncology and Regional Cancer Center.

Scan Protocol and Parameters

Multidetector Spiral (MDCT) with thin collimation and overlapping reconstruction is currently the technique of choice for VC. The multidetector spiral scanner had many advantages over the single slice spiral scanners. The major advantage is the ability to cover a large anatomic volume by using thin collimation and can provide coverage of the entire abdomen with a slice collimation of 1 mm in a single breath hold. To obtain optimal quality images, the patient's bowel should be free of stool. Various marketed preparations are available, which consist of salt and electrolyte mixtures like Polyethylene Glycol (PEG), oral sodium phosphate and oral magnesium citrate. Adequate bowel distension is must for adequate visualisation (especially for detection of small polyps). Hence, the colon is insufflated with air at room temperature using a balloon (30-40 puffs) through a rectal tube. Patients are placed in the right lateral decubitus position on the table and a rectal enema tube was inserted. Patients are then turned supine and room air gently insufflated in the colon to maximal patient tolerance.

Studies have however proved that pressure controlled carbon dioxide results in better distension and is better tolerated by the patient as the intestinal mucosa can passively reabsorb the carbon dioxide, however, requires a dedicated insufflation system for the same. Spasmolytic therapy was given after placement of the rectal tube to allow optimal colonic distension, minimise peristalsis and alleviate spasm scanning technique.

Patients first underwent plain, nonenhanced axial scans using a multidetector scanner followed by transfer of these images to a 3D workstation. A scout image (topogram) is first obtained to verify adequate bowel distension and preparation. If the distension is not adequate, additional filling is undertaken to achieve the desired level. Scanning the patients in both supine and prone positions. Studies have indicated that this provides additional information as compared to utilising the supine position alone. However, this also leads to an increase patient dose equivalent to the number of reconstructed images, the post-processing time not accounting for interpretation time. When attempting to differentiate between a pathologic lesion and bowel content, the prone position maybe used in addition to the supine position.

Patients are given adequate breath hold instructions and are scanned with a collimation of 0.6 mm (single breath hold of 10 seconds) using an effective mAs (50-80), KV of 120 feed/rotation 0.5 mm. The data obtained from axial scan is reconstructed and smoothened and transferred to a dedicated workstation with Fly-Through endoscopic software. The Fly-Through Virtual Endoscopy application package used allows medical data to be visualised in multiple modes, volume rendered, surface rendered and multiplanar reformats in an integrated fashion. Virtual endoscopic views of the segmental data can be generated using surface display (SSD) techniques. The endoscope diameter, speed, viewing angle and the depth of the Volume Rendering Technique (VRT) can be altered to suit specific circumstances. The endoscope can be advanced, withdrawn and turned in steps. The entire VC image can be rotated by moving the orientation cube or simply by using the image rotate feature. Annotation, measurement and other such tools permit computation of various data parameters. The VC study thus generated can be saved as stills or in a cine format.

RESULTS

The study had been conducted on patients attending Department of Radiology for a period of 1 year. Patients with primary or secondary complaints of pain abdomen, lump in abdomen, bleeding per rectum, loose motions/constipation, altered bowel habits, loss of appetite and weight and anaemia, so total number of cases were 51.

Age in Years	Male	Female	Total
Up to 1	0	0	0
1-10	0	0	0
11-20	0	0	0
21-30	6	5	11
31-40	5	7	12
41-50	6	5	11
51-60	9	2	11
61-70	5	1	6
Total	**31**	**20**	**51**

Table 1. Age and Sex Distribution of the Lesions of the Large Intestine

In our study, the patients were in age groups of 21-70 years. Both sexes were represented in our study. Male preponderance was noted (number of patients studied 51, M:F-31:20).

Non-Neoplastic Lesion	Number of Lesions	Percentage (%)
Hyperplastic polyp	3	5.88
Juvenile polyp	2	3.92
Inflammatory polyp	1	1.96
Total	**6**	**11.76**
Neoplastic Lesion		
Adenoma	37	72.78
Adenocarcinoma	5	9.80
Lipoma	3	5.88
Total	**45**	**88.46**

Table 2. Neoplastic and Non-Neoplastic Lesions

Cases of adenoma were more common found 37 (72.78%).

Size of the Polyp	No. of Polyps Detected in Optical Colonoscopy	No. of Polyps Detected in Virtual Colonoscopy	Percentage
>10 mm	24	24	100%
6-9 mm	9	10	90%
<6 mm	8	10	80%

Table 3. Sensitivity of the CT Colonography

The sensitivity of the CT colonography for the polyps more than 10 mm is 100%, polyps 6-9 mm is 90%, less than 6 mm is 80%.

Examination	Patients Preferring Examination	Percentage
CT Colonoscopy	30	58.82%
Optical Colonoscopy	10	19.60%
No difference (with both the techniques)	10	19.60%
Missing	1	--

Table 4. Frequency Distribution of Examination Preference

Our study consists of 51 patients among them. 30 patients showed acceptance for CT colonography, 10 patients for optical colonoscopy. By above table, CT colonoscopy is highest preferred examination.

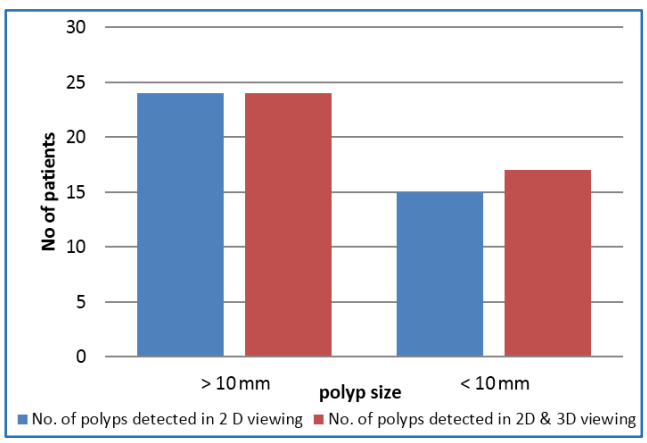
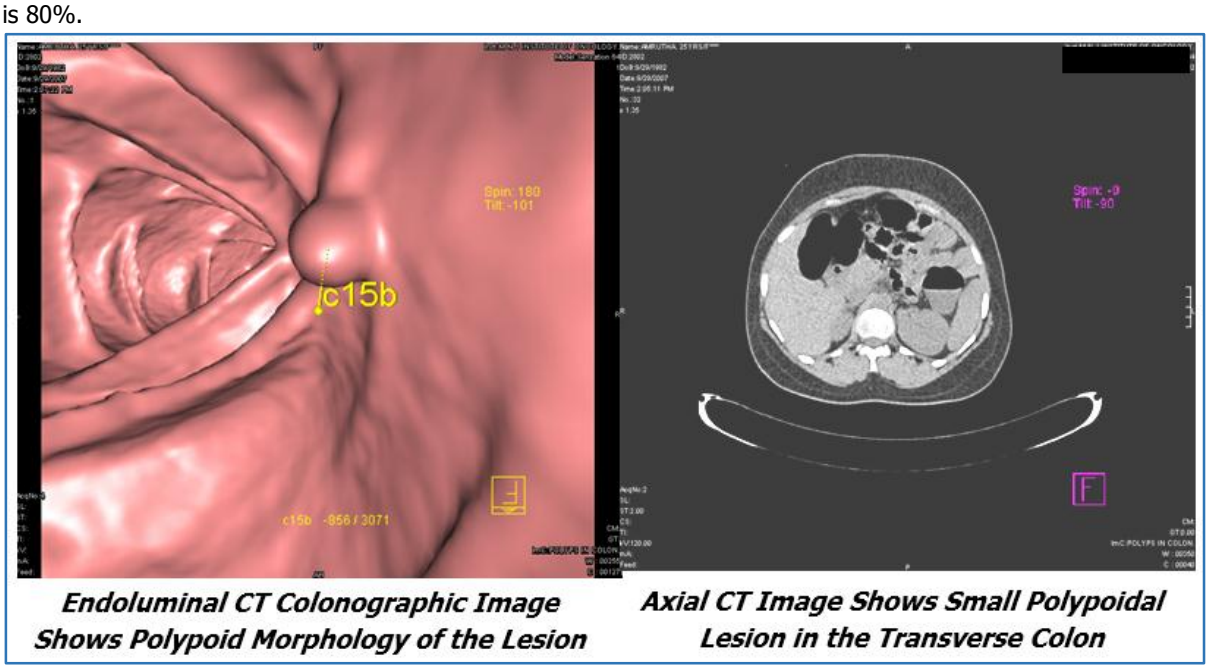


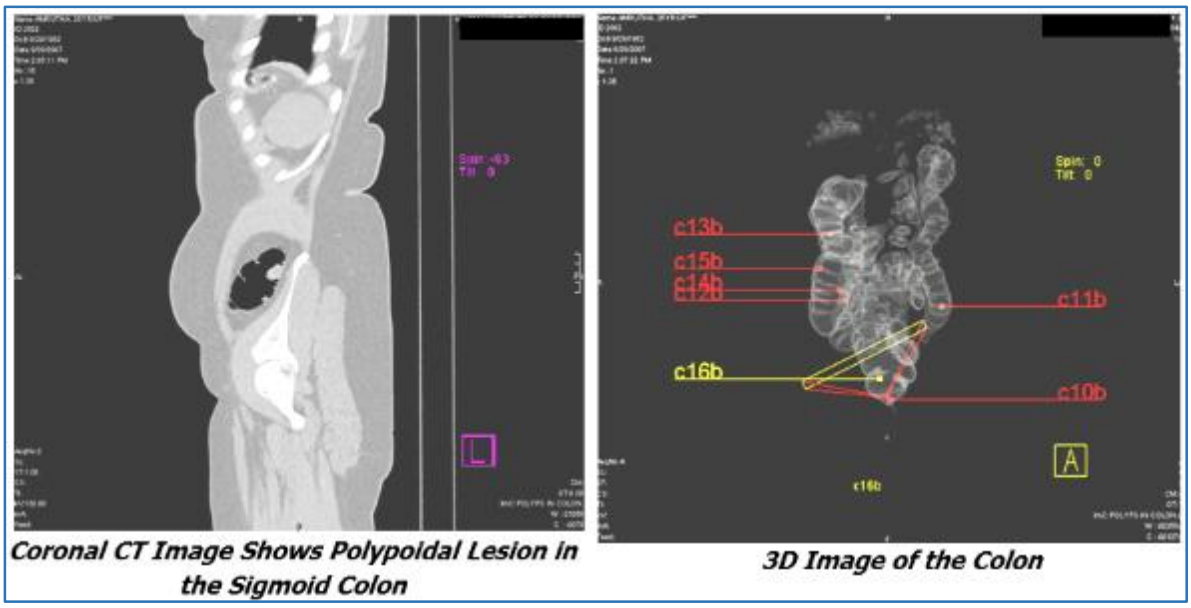
Table 5. Combined 2-Dimensional and 3-Dimensional Views for Detection of Polyps

In our study, incomplete optical colonoscopies are 3.



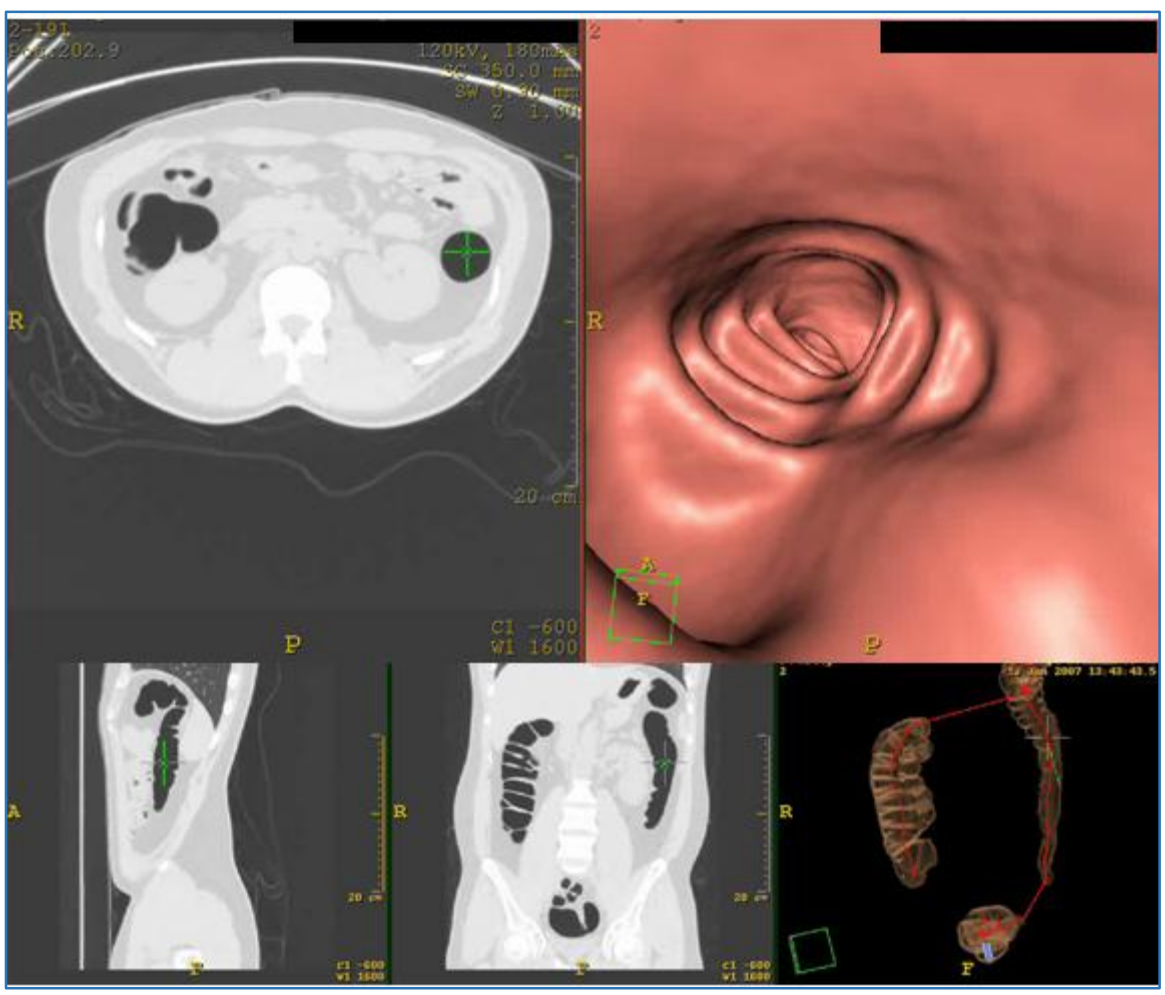
Endoluminal CT Colonographic Image Shows Polypoid Morphology of the Lesion

Axial CT Image Shows Small Polypoidal Lesion in the Transverse Colon



Coronal CT Image Shows Polypoidal Lesion in the Sigmoid Colon

3D Image of the Colon



Endoluminal 3D View Showing Large Polypoidal Lesion in the Ascending Colon

DISCUSSION

The main symptoms of the patients evaluated for large bowel masses had pain abdomen, bleeding per rectum, altered bowel habits, constipation, loss of appetite and weight loss. These patients had symptoms varying from 3 to 6 months.

In our study, the patients were in age groups for 21-70 years. Both sexes were represented in our study. Male preponderance was noted (number of patients studied 51, M:F- 31:20).

CT Colonography as a Screening Tool

We found CT colonography is highly specific particularly for polyps >10 mm in size, however, the reported sensitivities

for CT colonography vary widely even for large polyps. Our analysis revealed some factors that account for the wide range of sensitivities. First, scanners that used thinner collimation had higher sensitivity. Every 1 mm increase in collimation, width decreased, the subsequent sensitivities by almost 5%. That is, scanners with 1 mm slices had 98% sensitivity. Increasing the collimation width to 2 mm would decrease sensitivity to 93%. Second, scanners that used multiple detectors rather than single detectors were more sensitive. Finally, the mode of imaging also appeared to be important. The most recently developed fly-through technology had a sensitivity of 99%. In our study, the sensitivity of the CT colonography for the polyps more than 10 mm is 100%, polyps 6-9 mm is 90%, less than 6 mm is 80%. Our study correlates with the study of Mulhall et al[3] for detection of polyps less than 6 mm is 70%, for polyps 6-9 mm is 85%, for polyps more than 9 mm is 91%.

Patient Acceptance of CT Colonography

In our study, we chose to compare patient acceptance of CT colonography with that of conventional colonoscopy, because the latter is the primary diagnostic technique at our hospital. We constructed questionnaires to measure physical (i.e. pain, discomfort) as well as psychological (i.e. embarrassment, concern) aspects of the examinations and also attempted to control possible confounding influences such as differences in the quality of information provided to the patient and the reception given the patients. We were concerned that the response to the questions concerning patient acceptance of colonoscopy would be influenced by the sedative and analgesic drugs given at colonoscopy. The questionnaire concerning colonoscopy was therefore administered twice, which revealed agreement in opinions between occasions. According to the comparative questionnaire, CT colonography was regarded as less difficult in overall terms as well as less unpleasant than colonoscopy. A majority of the patients would have preferred CT colonography if they had been able to choose between examinations. The individual ratings after the respective examination were in agreement with the results from the comparative questions. The overall impression was systematically rated as better for CT colonography than for colonoscopy. In general, CT colonography appeared to be an acceptance examination, since only a few patients considered it more than slightly difficult overall.

Pain ratings were lower for CT colonography than for colonoscopy. Despite the fact that almost all patients received analgesic and/or sedative medication at colonoscopy, pain seemed to be an important problem with colonoscopy. It was also the most common subject of concern before the examination. Pain was often mentioned as a disadvantage of colonoscopy in the open-ended comments and correspondingly less pain was a common motivation for the choice of CT colonography as the preferred examination.

Although, pain was also the most frequent cause of concern about CT colonography. Only six patients considered CT colonography "fairly" or "very" painful. A more common problem with CT colonography was discomfort associated with air filling of the intestine. Most patients found it at least slightly unpleasant to have the intestine filled with air. Instrumentation at colonoscopy was not unpleasant to the same degree as air filling during CT colonography. Despite the relatively high rating of discomfort associated with air filling during CT colonography, a majority considered colonoscopy to be worse overall and CT colonography to be preferable. Pain thus seemed to have a more decisive influence on examination preference than did discomfort. This was also made evident by the fact that the rating of overall impression of each of the examinations showed a stronger relationship to the rating of pain than to the rating of discomfort during instrumentation and air filling, respectively. In this study group, irradiation at CT colonography did not seem to be a major concern. Only three patients reported concern about irradiation and two mentioned it as a disadvantage of CT colonography. Embarrassment associated with the procedure was expected to be an important factor in patient acceptance. However, it was not considered a problem for any of the examinations.

Our study consists of 51 patients. Among them, 30 patients showed acceptance for CT colonography, 10 patients for optical colonoscopy. Our study correlating with Macari M[4], Svensson et al[5] they studied on 68 patients among 68, 56 patients preferred CT colonography.

Benefits of Prone Positioning in Addition to Supine Positioning

The effectiveness of CT colonography as a screening technique for colonic neoplasia is dependent on the ability to facilitate detection of colonic polyps. Manoeuvers or rendering techniques that purport to improve this test can be evaluated only against the standard of improved accuracy particularly if the techniques involve increased cost. Prone imaging increases cost in terms of doubling the radiation exposure to the patient, increasing technologist and radiologist time. Our results indicate that there was significant improvement in the performance of CT colonography when prone images were acquired and reviewed in conjunction with supine images, both for the identification of patients with important lesions and for the detection of polyps. This improvement was true for both large (≥1 cm) and smaller (0.5-0.9 cm) polyps.

Prone imaging increased the sensitivity for polyp detection because of a number of factors that differ in importance depending on the colonic segment and the size of polyp being considered. Combined prone and supine imaging demonstrated additional polyps by helping overcome perceptual polyps by helping overcome perceptual errors in every segment for polyps 0.5-0.9 cm in size and in nearly every segment for polyps 1 cm or larger. When polyps 1 cm or larger were considered. Prone imaging increased sensitivity predominantly because of an increase in the number of polyps demonstrated in the rectosigmoid and right side of the colon.

Additional polyps detected in the sigmoid colon were usually identified because of better luminal distension, whereas those in the right colon were usually identified when perceptual problems overcome. Our study consists of 51 patients, the polyps (more than 10 mm) detected in supine position were 24, supine and prone position of 24, the polyps (less than 10 mm) detected in supine position for 15, supine and prone were 17. Prone positioning resulted in increased sensitivity for identification of patients with larger polyps more than 1 cm, (70-85% sensitivity) and patients with smaller polyps less than 1 cm (increased sensitivity 75-88%). Our study correlated with Gleucker TM, Fletcher JG et al.[6]

Combined 2-Dimensional and 3-Dimensional Views for Detection of Polyps

Two-Dimensional Image Display

Two-dimensional transverse images in the abdomen are obtained routinely as part of every CT examination. Radiologists are very familiar with this type of image display and interpretation. In the early development of CT colonography, two assumptions regarding image display techniques were made that have since been shown to be erroneous. The first assumption was that polyps would be detected more accurately by using the 3D endoluminal images since this image display simulated the colonoscopic examination, the standard of reference for colonic imaging. The second assumption was that the large amount of CT data that would be reviewed more efficiently by using the 3D endoluminal "Fly-Through" approach. It has now been shown clearly that polyp detection can be just as effective by using 2D images as by using 3D endoluminal images, but each is complementary to the other. The 3D endoluminal fly through of the colon often is a tedious and time consuming approach that requires more time than the 2D approach.[7,8]

Three-Dimensional Image Display

The role of 3D images in interpreting CT colonographic scans varies widely. Although, most investigators rely on 3D endoluminal images to confirm the presence of a lesion and to improve diagnostic confidence, few use it as the primary method of evaluating the colon. Two 3D rendering techniques exist: surface rendering and volume rendering. Both techniques have been implemented successfully for CT colonography and can be used to display the colon anatomy accurately. Surface rendering is based on a preprocessing step that identifies isointense surfaces from an endoluminal perspective and that reduces the data to a set of surface triangles. Data that are deep in relation to the identified surface are discarded. Since the quantity of data that remains is reduced markedly, computations can be performed quickly. Volume rendering in its traditional form does not discard any of the information within the volume of interest. Extraluminal soft tissues and attenuation data (opacity mapping) can be displayed with volume rendering. Because of the large amount of the data that must be managed by the computer, volume rendering computationally is more demanding, expensive and time consuming.

Advances in computer speed and lower costs have allowed many medical centres and CT manufacturers to adopt volume rendering for their workstations that are equipped with CT colonographic software. Although, the theoretic advantages favour volume rendering to our knowledge. There are no findings to suggest that one method is superior to the other diagnostically.[9,10]

Two-Versus Three-Dimensional Display

The complementary nature of 2D and 3D image displays was predicted by Hara et al by using a phantom model constructed from the data set of a patient with a normal sigmoid colon that contained 11 computer-simulated polyps, 1-10 mm in diameter. Blinded readers reviewed the same sets by viewing only 2D images, only 3D images and a display combining 2D and 3D images. The best polyp detection occurred with the combined 2D and 3D images display. All polyps greater than 2 mm were identified. The consensus opinion of experts today confirms this finding.[8]

Our study consists of 51 patients, the polyps (more than 10 mm) detected in 2D viewing were 24, 2D and 3D viewing of 24, the polyps (less than 10 mm) detected in 2D viewing were 15, 2D and 3D viewing were 17. 3D viewing resulted in increased sensitivity for identification of patients with larger polyps more than 1 cm (70-85% sensitivity) and patients with smaller polyps less than 1 cm (increased sensitivity 75-88%). Our study correlated with C. Daniel Johnson, et al.[11]

CONCLUSIONS

Multislice CT (64) colonography is a good alternative to other colorectal screening tests because it has high sensitivity for polyps 10 mm or more in diameter is relatively safe, clinical, effective, minimally invasive, cost-effective and filter for therapeutic optical colonoscopy. CT colonography was considered less painful and less difficult overall than colonoscopy and was the preferred examination. Acquisition and review of supine and prone CT colonographic images significantly improves the ability to identify patients with polyps 0.5 cm in diameter or larger. CT colonography is the test of choice for evaluating the colon in frail and elderly patients, in patients who have had a failed or incomplete colonoscopy, in those who refuse conventional colonoscopy and to evaluate the colon for synchronous lesions proximal to an obstructing cancer. A unique capability of CT colonography over other colorectal examinations is its capability of examining the entire abdominal and pelvic content. This offers the possibility of detecting extracolonic pathology. Combined 2D and 3D viewing increased reader accuracy compared with 2D/3D viewing alone.

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