Original article

Computer tomographic colonography (virtual colonoscopy). A new method for the early detection of colorectal cancer

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SUMMARY

Background: **Colorectal cancer (CRC) and its precursors lesions (polyps) consist a world-wide health problem. Many screening tests are available, but none has gained universal approval. Recently, a new non-invasive technique (virtual colonoscopy V.C.) was developed, that uses computerized reconstructed images of computer tomography. There are some reports with good results in detecting neoplasias of the colon.**

Aim: **To evaluate the effectiveness of V.C. in detecting CRC or polyps.**

Material and Methods: **Forty-eight patients (30 males and 18 females, mean age 64 years) underwent V.C. at "Ag. Savvas" anticancer Hospital. The findings of V.C. were compared with those of a recent colonoscopy.**

Results: **At colonoscopy 14 CRC and 48 polyps were found. All lesions were detected by V.C. The two tests were also in accordance concerning the size and location of the lesions. Additionally, V.C. was able to evaluate colon wall invasion in case of CRC.**

Conclusions: **V.C. is an effective method of colorectal screening.**

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INTRODUCTION

Colorectal cancer (CRC) is an important disease, with significant morbidity and mortality in the populations of the industrialized nations. In the United States is the third most common cancer and the second most frequent cause of death from malignancy.[1] In 1991 there were 157.000 new cases in this country and 61.000 related deaths.[2] In Greece, in 1981, there were 1.500 new cases and 700 deaths.[3]

The average lifetime incidence of colorectal cancer is 6% and the figure is even higher in persons with a family history of colorectal neoplasia or with other well-established colorectal cancer risk factors.[4] Patients with cancer limited to the colonic wall have a corrected 5-year survival of about 90%. For those with lymphatic spread of the tumor, this figure is merely 30%.[5,6]

90-95% of malignant tumors of the colon and rectum almost invariably evolve from preexisting adenomatous polyps.[7] Detection and removal of the polyp in an early stage reduce the incidence of CRC.[6]

Although CRC is one of the most common neoplasias in humans, with high rate of mortality, the existing screening strategies are imperfect.

Massive screening studies or programs have been performed in the United States and West Europe for individuals 45 to 70 years old.[8-15] In these strategies were used: annual fecal occult blood test (F.O.B.T.) for one or two years followed by double-contrast barium enema (D.C.B.E.) or colonoscopy when F.O.B.T. was positive. In these studies the compliance was 50-90% in the first year and lower in the second. In massive screening programs the percentage of tested individuals was 20-30%.[16,17] F.O.B.T. is characterized by low sensitivity (25-63%) and

a rather low specificity of around 10-30%.[18-20] D.C.B.E. has been shown to be considerably more sensitive than F.O.B.T. but patient's discomfort and radiation exposure have motivated the more frequent use of colonoscopy. This technique causes, also, considerable discomfort to the patient, cannot visualize the entire colon in a minority of cases and is associated with a low risk of colonic perforation. One of its major drawbacks is its relatively high cost.[21]

Computed tomographic colonography (virtual colonoscopy -V.C.) is a new technique that uses volumetric CT data combined with advanced imaging software to create two-dimensional or three-dimensional images of the colon, resulting in a simulation of the endoluminal perspective of colonscopy. The two- and three-dimensional images offer the most robust performance for the detection of colorectal polyps and cancers.[22-25] V.C. has yet to be perfect. Ideal images require large data-sets on one hand, but these are difficult to be used by lower priced computer systems on the other.

Since the effectiveness of this method to detect colorectal neoplasias is not well established, we undertook this study, in order to evaluate its feasibility and its diagnostic accuracy in detecting neoplasias of the colon and rectum. This was done by studying patients with recently endoscopically proved tumors of the colon.

MATERIAL AND METHODS

Forty-eight patients (30 males and 18 females, mean age 64 years, range 46-85) were studied during the period from November 1997 to May 1999 at "Saint Savvas" anticancer Hospital. Only patients with CRC and polyps larger than 8 mm were included in the study.

Firstly, all patients underwent a total colonoscopy that served as the gold standard. The preparation of the colon included liquid diet, laxatives and enemas. During the procedure, if minimal liquid remainings were present, they were sucked. If the colon could not be entirely cleaned, the patient was withdrawn from the study.

Subsequently, patients were scanned using a helical CT (Toshiba, X-Vision). Additional air was administrated to the colon with an enema tube in order to achieve desired distension of the colon. The following parameters were used: KV 120, mA 200, table feed 3 mm/sec, slice thickness 5 mm and reconstruction intervals 2,5 mm. Using SPARC Station 20 (Sun. microsystems, Mountain View LA) V.C. was generated.

Two radiologists who randomly and independently reviewed the data sets performed the radiographic analysis. The observers were blinded to the number, location, size and morphology of the lesions found in colonoscopy. They also, tried to evaluate extraluminal extension in case of CRC.

In all colonoscopies the cecum was reached. In all patients the preparation of the colon was considered adequate. In 19 patients, 28 benign polyps with diameter from 8 to 15 mm, were detected. They consisted 45% of all neoplasias in our study group. In 16 patients, 20 (32,3%) benign polyps, with diameter over 15 mm were found. Additionally, in 14 patients a solitary CRC was identified (22.6% of all neoplasias). Finally, in all cases all remaining liquid stools were successfully aspirated.

V.C. visualized all tumors (sensitivity 100%). The two techniques were in accordance concerning the location and approximate size of all tumors. V.C. also, identified extraluminal extension in 4 cases of CRC that were later verified in the theatre.

DISCUSSION

V.C. using three-dimensional images of the colon was first introduced in 1994.[26] Several studies have reported results using only reformatted two-dimensional images of the large bowel. In one non-blinded study of ten patients with 30 endoscopically proved polyps, all polyps larger than 1 cm were detected with V.C.[27]

One other more recent publication found that combined two- and three-dimensional imaging, provided greater polyp detection (especially for polyps with diameter between 6 and 10 mm) than two- or three- dimensional imaging alone.[22]

In several studies, various CT scanning parameters have been evaluated using an artificial colon model containing simulated polyps.

Parameters for an optimal result are the proper bowel cleaning; the infusion of an adequate quantity of air; patient's position (supine-prone) and the use of the correct technical parameters (slice thickness, table feed, radiation dose).

The proper bowel cleaning is necessary for a successful V.C. Retained stool or fluid can lead to diagnostic error. False-positive examinations were due to misinterpretation of retained stool. Retained fluid within the colon is often isodense with the colon wall and increases the possibility of false positive or negative results. This

problem can potentially be solved with the use of a colonic lavage medium that provides dry colon, or by adding a radiopaque marker to the lavage preparation.

Another common problem is the incomplete distension of the colon. This may be solved with administration of air room or carbon dioxide or with administration of glucagon.

In a publication of 1997 the combination of supine and prone position of the patient improved bowel's image assessment and increased the sensitivity of the method. In our study all individuals were examined in supine position. In 12 (25%) cases with inconclusive findings, the patients were rescanned in prone position. The images of the colon were optimal in 10 cases (23%).

From 1994 to 1999, there were several publications in the international literature about the technical parameters of the method. Initially, slice thickness was 3-10 mm, the table feed 5 mm/sec and the reconstruction intervals 1mm. Increased reconstruction intervals and table feed, degraded both the two- and three- dimensional image quality. Today the optimal scanning parameters are considered slice thickness 5 mm, table feed 1-2 mm/s and reconstruction intervals 2.5 mm.

The radiation dose of this method is very low. In a non-blinded clinical evaluation, no difference was found in polyp detection rates using a 70 mA setting compared with the use of 140 mA.[28] This low dose setting results in a 75% reduction in radiation administered to the patient, compared with a standard CT body examination (280 mA). This dose is half of the dose of a fluoroscopic barium enema. This reduced dose has became possible due to the high contrast between the air-filled colon and the soft tissue of the colon wall. Only very overweight patients and those with internal metallic devices (e.g. hip arthroplasty) require higher doses (140 mA).

V.C. is a non-invasive new approach to colorectal imaging. It provides the possibility to radiologist to "fly through" the large bowel, without much discomfort of the patient and without the risks associated with the conventional colonoscopy. Moreover the examiner can detect any existing extraluminal extension of CRC and can see though strictures and masses. Other advantages of the method are: the possibility of re-reviewing and reproduction of the images, the creation of educational archieves and the delivery of data-sets through the Internet. Weaknesses of this method are: its inability to detect small lesions and to perform biopsies.

In our study V.C. was found to have the comparable sensitivity with standard colonoscopy in detecting CRC or clinical meaningful polyps. In our group V.C. was able not only to detect all tumours, but also to determine its approximate site and size, as were defined during colonoscopy. Obviously, since it was performed under ideal situations (perfect cleaning of the bowel, highly dedicated radiologist, ability to re-scan patients if problems during the initial examination were noted) any conclusions about its role in CRC screening are to early too be drawn.

The rapid technological evolution of the method necessitates its continuous study, in order to determine its diagnostic accuracy and performance. Large prospective studies must be performed in order to compare the method with the other screening tests. Also the future clinical role of VC has to be determined.

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