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ORIGINAL ARTICLE

Value of Virtual Colonoscopy with 64 Row CT in Evaluation of Colorectal Cancer

Urszula Zaleska-Dorobisz[1ABCDEFG], **Mateusz Łasecki**[1BD], **Ewa Nienartowicz**[1BDEF], **Joanna Pelak**[2BDE], **Joanna Słonina**[1BDF], **Cyprian Olchowy**[1CD], **Marek Ścieżka**[2BDF], **Marek Sąsiadek**[1E]

[1] Department of Radiology, Wrocław University of Medicine, Wrocław, Poland
[2] Department of Gastroenterology, MCZ, Lubin, Poland

Author's address: Mateusz Łasecki, Department of Radiology, Wrocław University of Medicine, Wrocław, Poland, e-mail: m.c.lasecki@wp.pl

Summary

Background: Virtual colonoscopy (VC) enables three-dimensional view of walls and internal lumen of the colon as a result of reconstruction of multislice CT images. The role of VC in diagnosis of the colon abnormalities systematically increases, and in many medical centers all over the world is carried out as a screening test of patients with high risk of colorectal cancer.

Material/Methods: We analyzed results of virtual colonoscopy of 360 patients with clinical suspicion of colorectal cancer. Sensitivity and specificity of CT colonoscopy for detection of colon cancers and polyps were assessed.

Results: Results of our research have shown high diagnostic efficiency of CT colonoscopy in detection of focal lesions in large intestine of 10 mm or more diameter. Sensitivity was 85.7%, specificity 89.2%.

Conclusions: Virtual colonoscopy is noninvasive and well tolerated by patients imaging method, which permits for early detection of the large intestine lesions with specificity and sensitivity similar to classical colonoscopy in screening exams in patients suspected for colorectal cancer. Good preparation of the patients for the examination is very important for proper diagnosis and interpretation of this imaginge procedure.

MeSH Keywords: Colonic Neoplasms • Colonography, Computed Tomographic • Colonoscopes

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Background

Colorectal cancer (CRC) is the third most common malignancy and the second leading cause of cancer-related death in the industrialized nations [1–3]. The average lifetime incidence of CRC is 6% and even higher in cases with a family history of colon neoplasia or other well-established colon cancer risk factors [4,5]. The vast majority of CRC cases are believed to arise from adenomatous polyps [2–5]. Screening for colorectal cancer and early detection of both precursor adenomas and localized cancers are broadly recommended [3,4,6,7].

Imaging methods of the digestive tract play an important role in the diagnostics and treatment of patients with colon neoplasms [1–5]. However, conventional colonography has a low specificity and sensitivity, while colonoscopy is a more invasive method [8–10]. Computed tomography (CT) has been proposed as an alternative procedure for examination of the colon [5–7,11,12]. CT colonography also named "virtual colonoscopy"(VC) is a modern radiologic study for detection of colonic polyps and masses without the need for any endoscopic instrumentation.

VC was first introduced in 1994 by Viking et al. [3,11–14]. It offers advantages of a non-invasive study with a low risk of complications compared to conventional colonoscopy as well as a lower cost. The technique uses a combination of two- and three-dimensional axial reconstructions and multiplanar reformatted images, supplemented
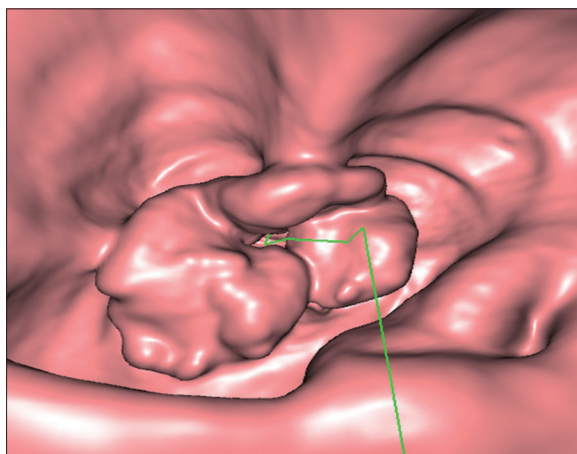
Figure 1. Virtual colonoscopy in an asymptomatic average-risk 62-year-old man shows a large 28-mm polyp in the transverse colon, which proved to be a well-differentiated invasive adenocarcinoma after removal at the same-day colonoscopy. The patient underwent subsequent extended right hemicolectomy without complications.

Table 1. Examination criteria.

VC inclusion criteria*	Conventional colonoscopy exclusion criteria
• Fecal occult blood (207) • Previous incomplete colonoscopy** (89) – length limitation (39) – procedure intolerance (50) • Anemia (60) • Abdominal LLQ pain (42) • Altered bowel habits (31) • Polyps detected in past examinations (31) • Bright red blood (25) • Family history of neoplasm (22)	• Active diverticulitis (28) • Inability to cooperate (26) • Patient refusal (8) • Multiple diverticula (5) • Angulation/additional loops (4) • Spasticity (2) • Ulcerative collitis (2)

* Part of the patients had more than one symptom; ** Procedures performed in other centers.

by three-dimensional endoluminal (perspective, volume rendered) view to examine the luminal surface of the colon [15–17]. In a vast majority of cases it covers the whole colon including cecum even in cases of obstructive lesions. The other important advantage of VC is that it combines visualisation of the colon with examination of some other basic abdominal organs – for example in the search of metastases, particularly in the liver [18–21]. Thus, it is not limited to endoluminal exploration of the colon. Improved techniques, including stool tagging and the use of a primary three-dimensional approach that mimics the endoluminal display of conventional colonoscopy, have improved significantly the detection of polyps of 6 mm in diameter and greater [3,4,18–20]. Its role in diagnostics of pathologies of the colon grows systematically, and in many medical centres of the world it is performed as a screening test in patients with a high risk of colon cancer.

In this study, we evaluated the quality of virtual colonoscopy using a 64-row CT scanner compared to conventional colonoscopy as a noninvasive and patient-friendly method for detection of colorectal abnormalities, particularly polyps and cancer of the colon.

Material and Methods

A total number of 360 patients (176 men, 184 women; mean age 49 years; age range 35–76 years) with a clinical suspicion of colorectal cancer were assessed. The study was approved by the institutional review board. All patients agreed to participate (after the presentation of the potential benefits and risks). CT colonoscopy (VC) was performed in every patient and 285 had an additional conventional colonoscopy. Mean scanning time for supine, prone or left lateral data acquisition was 24 seconds. Mean time the patient remained in the CT suite was 17–24 minutes (explanation of the examination procedure, positioning on the table, air insufflation, data acquisition). Patient preparation was assesed based on BBPS (Boston Bowel Preparation Scale). The following results were obtained:

280 patients (77.8%) showed good preparation, 50 patients (13.9%) – sufficient preparation, and 30 patients (8%) – insufficient bowel preparation (Figure 1). Median time required for data interpretation was 13 minutes (range 8–18). Evaluation of supine and prone two-dimensional data sets required an average of 10 minutes. Three minutes on average were necessary to verify suspicious structures with supplementary three-dimensional endoluminal images.

As many as 41 patients were excluded from conventional colonoscopy by VC. Basic exclusion criteria were: active diverticulitis (28), multiple diverticula with a history of acute diverticulitis episodes but without the symptoms during examination (5), severe colon angulation/additional loops (4), severe spasticity (2), active ulcerative colitis (2) (Table 1). Additional exclusion criteria were: patient's refusal or inability to cooperate (the reason for the difference between the number of conventional and virtual colonoscopies). The following clinical symptoms were considered: bright red blood per rectum, positive fecal occult blood test, altered bowel habits, anaemia of unknown aetiology and unexplained abdominal pain in the right lower quadrant. In 31 (8.6%) patients, previous polyps of the colon were a direct indication for VC. The family history of neoplasm was recorded in 22 (6.1%).

During conventional colonoscopy, lesions were photographed, measured and subsequently removed or biopsies were taken. Physicians who performed conventional colonoscopy were not involved in the interpretation of VC. In conventional colonoscopy, polyps were described according to their size and classified by the maximum dimension into three grups: lesions ≥10 mm, 7–9 mm, ≤6 mm.

VC was performed with a 64-row Siemens CT scanner. Every patient received information about the examination before the exam and had to undergo a special bowel preparation procedure. They were asked to keep a special diet for three days before the exam (no red meat), to take laxative medication (one bottle of X-Prep, 75 mL, a day) and to drink 2–3 liters of natural water every day. In the evening, before

Table 2. Change of the colon position in CT colonoscopy of 360 patients.

Changes of the colon position	Number of patients	%
Low position of the of transverse colon	60	16.6%
Elongation of the bowel	49	13.6%
Additional loops of sigmoid	29	8.0%
Additional loops of transverse colon	24	6.6%
Summary	162	45.0%

Table 3. Anatomical changes in CT colonoscopy of 360 patients.

Changes of the colon	Number of patients	%
Anatomical lesions	146	40.6%
Stenosis of the colon	14	3.9%
Diverticulitis and single diverticula	44	12.2%
Summary	204	56.7%

the examination, enema was performed to clean the colon. In all patients, air insufflation was carried out on CT table using a standard enema tube without a balloon cuff. Air insufflation into the colon with a rectal catheter (about two liters) was started in the left lateral position and terminated in the dorsal position. An adequate colon distension was checked with a scout view showing whether the entire colon was adequately distended and no segment of the colon was collapsed. After supine data acquisition, most patients were turned to the prone position, and twenty-two patients were examined in the left lateral position. Prior to the second acquisition, the scout view was repeated and air insufflations were reassessed. In 24 (6.6%) patients, additional air insufflation was performed. After preparation, CT scanning of the whole abdomen in every patient was carried out (from the diaphragm to the bottom of the pelvis) in prone and supine position. Technical parameters for CT examinations were as follows: beam collimation 5 mm, table feed 15 mm per rotation, and pitch 3:1. Image reconstructions were performed with a slice thickness of 2.5 mm with reconstruction intervals of 2 mm (overlap of 0.5 mm). CT scanning was performed in the supine and prone positions at 90 mAs and 120 kV, median dose of 6.15 mSv (SD 2.28) with a standard algorithm and a 512×512 matrix. Prior to scanning, all patients received an intravenous injection of 20 mg of N-butyl-scopolamine (Buscopan) to reduce bowel spasm during air insufflations and potential motion artefacts during scanning. When the bowel is distended with air, the entire parts of the colon can be seen. We can separate each wall, go through every curve and detect every lesion – polyps and cancers. The software was installed on the Singovia workstation and used a combination of two-dimensional and three-dimensional reconstructed and reformatted rendered images. In every case, the three-dimensional reconstructions were performed with a surface rendering algorithm. That program required a user-defined threshold between the intraluminal air and colon wall for three-dimensional data sets. Virtual colonoscopy enables two-dimensional interpretation, with luminal three-dimensional rendering of the colonic surface. The angle of vision for the intraluminal views can be interactively modified, but in nearly all cases an angle of 60° was used. Images were defined as having: good quality (good distension of the bowel wall allowing for assessment of the whole bowel wall), sufficient quality (suboptimal distension, allowing for evaluation of 90–95% of the bowel),

and insufficient quality (insufficient bowel distension and/or less than 90% of bowel wall displayed and suitable for evaluation). Polyp detection – on the per polyp basis – was assessed. Maximum diameters of cancers and polyps on transverse images and multiplanar reconstructions were measured and recorded. Specificity was assessed on the per patient basis — that is, the patient was considered as free of colon lesions or having a colonic lesion, independent of the size, histology (carcinoma, adenomatous or hyperplastic polyp), or number of lesions. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of VC for detection of colon cancers and polyps were determined.

Results

In our material, variable abnormalities of the colon (changes of the position, functional and anatomic changes in the wall) were detected in 246 patients (68.3%). Comparision of VC (for the detection of polyps/cancer) and conventional colonoscopy showed overall sensitivity at the level of 85% (95% CI: 80–91), specificity of 89.2% (95% CI: 87.1–91.8), PPV of 85% and NPV of 89.7%.

Non-polyps/cancer abnormalities of the bowel were diagnosed in 162 patients (45%). Table 2. The most common ones were: low position of the transverse colon, elongation of the bowel, additional loops of the sigmoid and transverse colon. In 60 patients (16.6%) we observed a low position of the transverse colon in pelvis minor.

Among anatomical benign changes, diverticulitis and single diverticula of different sizes, up to 1–2.5cm, usually in the sigmoid, rarely in the descending or transverse colon in 44 (12.2%) patients were diagnosed. Anatomical lesions, radiologically suspected as the CRC were detected in 146 cases (40.5%). Table 3. The detected polyps were classified by their size: 17 (4.7%) small polyps (≤6 mm), 50 (13.8%) medium lesions (7–9 mm), and 79 (21.9%) large polyps (1 cm or more). It was difficult for us to distinguish large polyps from cancer. Patients demonstrating polyps or tumours needed to be verified by traditional colonoscopy. In 14 cases (3.8%) of patients stenosis of the colon was diagnosed and in 140 cases (38.9%) functional changes (especially the spastic colopathy) were detected.

Conventional colonoscopy was performed in a group of 285 patients with suspicion of CRC (based on VC and/or laboratory tests). A total number of 134 (47%) anatomical

Table 4. The number of patients according to AJCC staging.

| AJCC Stage	T (tumor size)	N (node status)	M (metastasis)	Number of patients
I	T1	N0	M0	18
	T2	N0	M0	39
II-A	T3	N0	M0	13
II-B	T4	N0	M0	10
III-A	T1/T2	N1	M0	23
III-B	T3/T4	N1	M0	12
III-C	T1/T2/T3/T4	N2	M0	5
IV	T1/T2/T3/T4	N2	M1	8
				119

Table 5. VC compared to the conventional colonoscopy.

VC compared to the conventional colonoscopy	
Sensitivity	85.0% [CI 95; 80–91]
Specificity	98.2% [CI 95; 87.1–91.8]
NPV	89.7%
PPV	85.0%

changes in the colon were diagnosed. In 59 (20.7%) patients the tumour was found in the rectum, in the sigmoid in 50 (17.5%), and in the descending colon in 25 (8.8%) patients. In 19 (6.7%) patients, ischemic lesions of the entire descending colon were detected. *Comparision of VC and conventional colonoscopy showed sensitivity of VC at a level of 85% (*but it was lower for polyps measuring 6-9 mm)*,specificity of 89.2%, PPV 85% and NPV 89.7%.*

Among the 134 lesions which were found in conventional colonoscopy, 20 (14.9%) lesions were ≤7 mm, 43 (32.1%) were 7–9 mm, and 71 (53%) were ≥10 mm in diameter. After histopathological evaluation of all lesions, the following results were obtained: *119 cases (41.8% of all conventional colonoscopy patients and 88.8% of suspicious lesions) were cancers and 15 (58.2% and 11.2%, respectively) were benign polyps* (Table 4). Most of them were numerous composed polyps. All 134 patients with suspected polyps and tumours underwent surgery.

VC revealed 102 of 119 cancer foci (85.7%). As many as 61 malignant lesions had 9 mm and more in diameter, and 41 lesions were ≤7 mm. In the group of polyps of ≤7 mm, 10 were found retrospectively in the data sets. Among the 7 cases of cancers that could not be detected in VC retrospectively, conventional colonoscopy reveald their location in: recto-sigmoidal area (2 cases), caecum and ascending colon (3 cases), transverse colon (1 case), and in the descending colon (1 case) (Table 5).
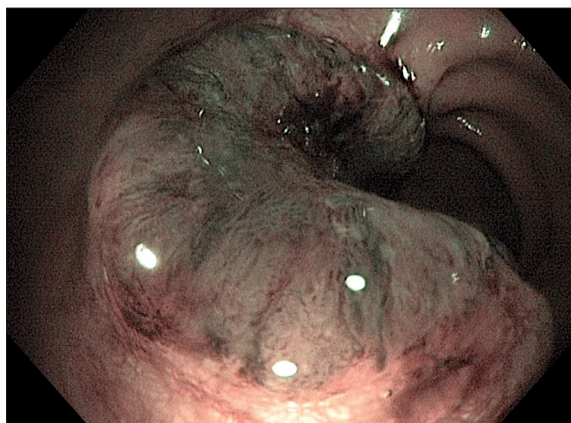
Figure 2. Conventional colonoscopy shows a big tumor in the transverse colon.

In 18 patients VC resulted in a false-positive diagnosis (wall thickening as a consequence of repeated diverticulitis and/or poor patient preparation). VC with the patient sedated was repeated within 1 week after VC and did not reveal malignancy (Figure 2). No severe complications in our study (perforation of the colon) were observed. No patient required sedation for CT scanning. As many as 36 patients (10%) were able to hold their breath during data acquisition. For the remaining 324 patients, data acquisition was achieved with superficial respiration. A total number of 41 patients (11.4%) were excluded from intervention by VC; colonoscopy was repeated with those patients sedated and it confirmed the VC diagnosis, i.e.: ulcerative colitis in 5 patients (biopsy and 2-year follow-up excluded malignancy) and no alterations indicative of colon cancer in 36 patients.

Discussion

Virtual colonoscopy can be used to evaluate the colon in patients with a prior allergic reaction to sedation, in elderly patients and in patients with cardiac or pulmonary disease who have colorectal symptoms [4–6]. Incomplete
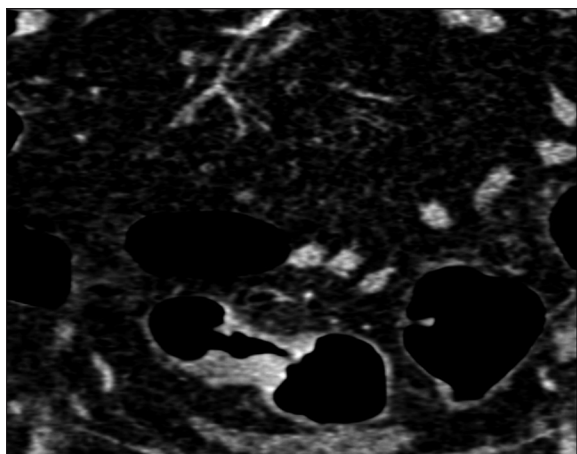
Figure 3. VC. MPR view of the ascending colon demonstrates irregular malignant infiltration narrowing the lumen of the colon.

Figure 4. VC. Endoluminal surface-rendered three-dimensional reconstruction of the ascending colon cancer.

conventional colonoscopy due to an obstructing tumour can be an indication to VC, too, when colonoscopy is impossible or in cases when colonoscopy did not reach the coecum, because of colon elongation.

For the last five years, VC has been a very quickly-developing imaging technique. It is a much safer and more patient-friendly method than conventional colonoscopy in colorectal cancer screening and detection of premalignant adenomatous polyps [3,5,11,12,14,15]. Many authors claim that sensitivity of VC in the detection of colorectal polyps and cancer exceeds that of a barium enema examination and approaches that of colonoscopy [12,13,16,20]. The aim of our study was to evaluate on the basis of the large material (360 patients) the diagnostic performance and potential of CT colonography, carried out with 64-multidetector CT, to identify space-occupying lesions of the colon.

VC is a sensitive screening test for detecting polyps of 10 mm or larger. Some authors describe sensitivity in those cases ranging from 75% to 100% [3,13–15,18,19]. The average sensitivity was 85%, but it was lower for polyps measuring ≤9 mm (≤70%) (Figures 3 and 4). This is an important limitation of this method. Polyp size is clinically the most important feature because it serves as a rough gauge for the risk of carcinoma and thus it dictates patient management. Therefore, polyps should be measured accurately and reliably with CT and patient management should be done according to the reported polyp size. Polyps measuring >10 mm should be reported on, with a recommendation for therapeutic colonoscopy [1,11–15], which gives a possibility of biopsy or excision of suspicious lesions.

VC is a relatively unpainful screening examination and patients may be more willing to undergo the procedure. Almost all our patients preferred virtual colonoscopy rather than conventional colonoscopy as well. However, according to other publications, VC examination puts patients at a low risk of misdiagnosis [2,21]. In the comparison of conventional colonoscopy and VC, about 82% of our patients favoured CT exams.

In the previous studies based on a "single"-detector array helical CT scanner, the results concerning sensitivity and
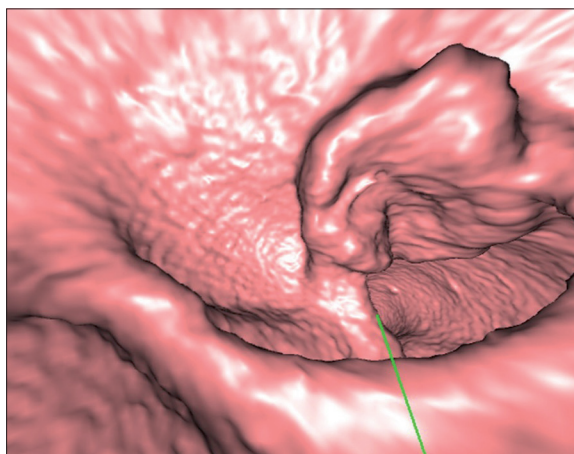
specificity were mediocre [16,17,20,21]. That was mainly due to false negative results related to poor data quality because of motion artifacts, residual fluid and retained faecal material. In the present study, sensitivity for the detection of lesions of ≥10 mm was 85% compared to 69% in the previous studies [16,17,20,21]. Several reasons may be responsible for this improvement. Most of all those were worse technical capabilities of CT scanners and spatial resolution and other limitations. Very good bowel preparation had high influence on results of those studies. The quality of bowel preparation improved in the present study: 280 patients (77.8%) revealed good preparation, 50 patients (13.9%) – sufficient preparation, and 30 patients (8%) presented insufficient bowel preparation. The potential of the Multislice CT lies in the possibility of faster data acquisition and improved spatial resolution. In this study, the whole abdomen could be scanned in an average time of 24 seconds. Mean time the patient remained in the CT suite was 17–24 minutes (explanation of the examination procedure, positioning on the table, air insufflation, data acquisition). There were other factors, beside better bowel preparation and fewer artefacts due to faster scanning, that may have influenced the increased sensitivity: the combination of supine and prone acquisition improves sensitivity by approximately 15%. Another contributing factor may be the increased experience of those who gained information from the previous study. The limitations and pitfalls of the method are illustrated by the following observations: 2 of 10 lesions larger than 10 mm were missed. Both were retrospectively found in the CT data sets. One was a flat polyp localized at the ileocaecal valve. Flat lesions have a height that does not exceed one third of the size of the base. Very similar results were presented in other papers [18–21]. Flat polyps are more likely to be missed than sessile ones as they do not, or only slightly, alter the colonic contour. However, they have a clearly different soft tissue attenuation compared to fat [17–21]. the aforementioned lesion was interpreted as a large lipomatous ileocaecal valve. The second missed lesion greater than 10 mm was a 10–15-mm polyp. It was localized on a fold on the superior and anterior aspect of the hepatic flexure. That polyp was missed in two-dimensional and three-dimensional data sets but retrospectively identified in two-dimensional sagittal views.
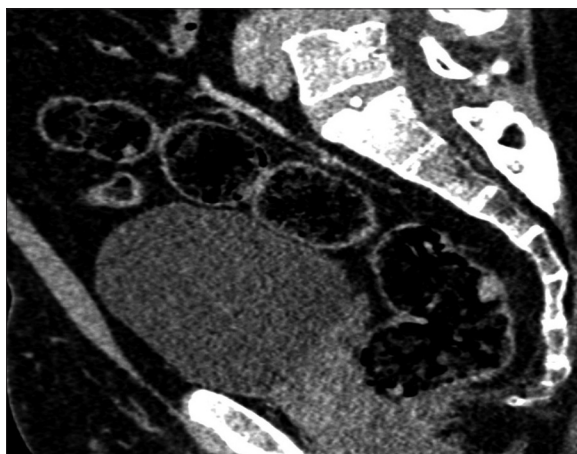
Figure 5. Polyp with atypical density. Axial image shows a lesion with focal central low density suggesting that it might be stool, but the lesion did not move when prone and supine views were compared. The use of intravenous contrast agent is an alternative way to help detect polyps. The decision to administer contrast, must be made at the time of examination.

In this study, VC revealed poor performance in case of lesions of 7–9 mm. Ten out of 15 lesions of 7–9 mm in diameter were initially missed on CT colonography. Among them, seven were found retrospectively and must be considered perceptive errors. Awareness of this fact and further training of readers in these methods may improve readers' performance in case of lesions of this size. Twenty missed polyps at VC exam could not be identified retrospectively in CT data sets and were considered as technical errors: two were localized in collapsed areas. Sensitivity for lesions smaller than 7 mm was only 23% – that is, only ten among 41 small polyps were detected. Retrospectively, 18 of the 40 missed small polyps were detected. Most polyps smaller than 7 mm that could not be detected were localized in the recto-sigmoid and caecum. Both areas are characterized by a complex anatomical structure with converging folds. Altered scanning techniques with beam collimation below 5 mm and a reconstruction interval of 1 mm or 1.25 mm could improve resolution and thus increase detection of smaller polyps if clinically indicated (Figure 5). However, this would significantly increase the radiation dose for the patient.

There is no consensus as to whether an increased detection rate for polyps smaller than 5–7 mm is necessary. Only about 5% of lesions smaller than 10 mm contain areas of high-grade dysplasia and only 1.3% of polyps smaller than 10 mm are malignant. In the current literature there is no general consensus concerning the clinical relevance of small polyps and the minimal size of polyps that should be targeted by screening methods [22,23]. As demonstrated in the retrospective data analysis, CT colonography in this series had a technical ability to detect all lesions ≥10 mm, 80% of lesions of 7–9 mm, and approximately 47% of lesion <6 mm.

On the other hand, conventional colonoscopy, which is considered as a suboptimal gold standard, can also miss some of the lesions. Indeed, several studies have indicated that

conventional colonoscopy has a high rate of missed lesions, especially in the proximal colon (35–52%) [24,25]. Our study was performed with readers having moderate experience in CT colonography with data sets of 360 patients. Further training was mainly obtained by review of previously missed lesions. The readers did not recognize all of the lesions demonstrated by multidetector CT scanners. Further training is necessary to obtain the best yield from the possibilities offered by VC performed with 64-row CT scanners.

CT colonography, performed with either the "single-slice" or now with the multi-slice helical CT, is a full structural colonic examination that is fast, does not require sedation, is non-invasive, and offers a possibility of detecting significant extracolonic findings. However, CT colonography is dependent on good bowel preparation, like conventional colonoscopy. Poor bowel preparation can result in erroneous conclusions as retained stool can either mask colon polyps or mimic polyps or masses [26]. Excess fluid remaining from bowel preparation can also mask colonic lesions. Attempts to minimize the deleterious effects of residual stool and fluid can be undertaken by scanning in different positions (to move stool and fluid) whereas during conventional colonoscopy excess fluid can be aspirated. In our opinion, CT offers good data quality with supine and prone data sets, thus assuring significant sensitivity per polyp and specificity per patient. CT colonography will benefit from further improvements in imaging techniques, computer software, and observer experience. VC is an important improvement in the "hardware", permitting a clear improvement in data quality of CT colonography compared with single detector array CT, and warrants further investigation. Further indications for CT colonography other than screening patients with a high or moderate risk of colonic neoplasms or incomplete colonoscopy may be detection of primary lesions in patients with known liver metastases. The main benefit of using CT colonography in the present study was to couple the evaluation of the entire endoluminal colon, as a supplement of unsuccessful colonoscopy, with the study of the liver. In our series, multiple reasons led to incomplete colonoscopy. Fenlon et al. [16] analysed a series of 29 patients who all had incomplete colonoscopy for distal occlusive carcinoma. In our study, 39 patients underwent VC for the same reason, but the study also included 50 patients in whom unsuccessful colonoscopy was due to patient's intolerance to examination-induced pain, postinflammatory strictures of the large bowel, or pericolic fibrosis after surgery of the pelvic floor. In this group, all occlusive carcinomas were identified with both VC and conventional colonoscopy, whereas synchronous lesions could be detected only with VC.

VC was effective in evaluating the colon, with a few exceptions in which residual fecal material in the descending colon and cecum hindered endoluminal visualization. However, in all cases the combination of the three-dimensional endoscopic perspective, transverse views, and multiplanar images was helpful to distinguish between residual faecal material and the colonic wall, and the enhancement achieved after administration of contrast material was helpful. Residual fecal material did not affect the diagnosis of colorectal cancer in our series, but we believe that it has some potential influence. This issue was recently

discussed by Morrin et al., who showed an increased diagnostic confidence provided by contrast-enhanced CT colonography with respect to the nonenhanced phase in the assessment of bowel wall conspicuity and the detection of medium-sized polyps (diameter of 5–9 mm) in suboptimally prepared colons. Our study was not aimed at demonstrating the usefulness of contrast material administration in detecting colorectal cancers, although it was always used in VC. Our experience has shown that in a selected group of patients who underwent incomplete colonoscopy, CT colonography provided information necessary to properly establish surgery of colorectal cancer and treatment of metastatic disease. Virtual colonoscopy is a more friendly method in detection of colon cancer and other abnormalities than colonoscopy using endoscopic instrumentation. On the other hand, the advantage of conventional colonoscopy is the possibility of biopsy or polyp excision.

Conclusions

As we showed, VC detected 69 of 71 lesions (97.2%) sized ≥10 mm (including retrospective studies) found later in conventional colonoscopy. We belive that continuous technological progress (introduction of 128- and 320-row CT scaners, better software, patient dose reduction, etc.) will allow for more accurate detection of smaller polyps (<7–9 mm), even by moderately experienced radiologists. However, the fact that 13 (9.7%) lesions were depicted only in a retrospective study shows necessity of continous training or/and working under the guidance of an experienced radiologist. Particular attention should be paid to the assessment of rectosigmoid area, caecum (especially ileocecal valve). In these particular areas most of the lesions occurred which were not visualized with VC. Even now, thanks to its noninvasiveness and good tolerance, VC may in some circumstances be a surrogate which would permit for early detection of lesions in the large intestine with specificity and sensitivity similar to classical colonoscopy in screening exams in patients suspected of colorectal cancer. On the other hand, the advantage of conventional colonoscopy is the possibility for biopsy or polyp excision. In both methods, good preparation of the patient for examination is very important for proper diagnosis and interpretation of this imaging procedure.

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