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ORIGINAL ARTICLE

Computed Tomography Colonoscopy with Faecal Tagging in the Detection of Colorectal Tumours: Report of Local Experience

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ABSTRACT

Objective: *To determine the sensitivity and specificity of computed tomography colonoscopy with faecal tagging in the detection of colorectal polyps, adenomas, and carcinomas, with colonoscopy as the reference method.*

Patients and Methods: *A total of 51 patients underwent computed tomography colonoscopy followed by standard colonoscopy between June 2004 and August 2004. Bowel preparation consisted of 2 L of polyethylene glycol mixed with 25 mL of iopamidol 370 g/L. After colonic air insufflation, patients underwent computed tomography scanning in the supine and prone positions with 1-mm collimation during a single breath-hold. Axial and 3-dimensional endoluminal images were interpreted by reporting radiologists. The computed tomography colonoscopic findings were correlated with standard colonoscopic and histological findings.*

Results: *Computed tomography colonoscopy had a 100% sensitivity for the detection of carcinoma. When direct by-lesion matching was used, the sensitivity of computed tomography colonoscopy for polyp or carcinoma detection was 68% for all lesions. The sensitivity was 59% for detection of polyps of all sizes and 86% for polyps of 5 mm or larger. The sensitivity was 67% for the detection of histologically confirmed adenomas and 85% for polyps of 5 mm or larger. When by-patient matching was used, the sensitivity of computed tomography colonoscopy for polyp or carcinoma detection was 74% for all lesions. The sensitivity for the detection of histologically confirmed adenomas or carcinoma was 81%. The overall specificity for polyp or carcinoma detection was 94%.*

Conclusion: *Computed tomography colonoscopy is excellent in detecting clinically important colorectal polyps and other tumours.*

Key Words: *Colonic polyps; Colonography, computed tomographic; Colonoscopy; Colorectal neoplasms; Feces*

INTRODUCTION

The incidence of colorectal cancer has increased rapidly in recent decades to become the second most common cancer and the third leading cause of cancer-related deaths in Hong Kong. There were approximately 3284 new cases and 1416 deaths from colorectal cancer in Hong Kong in 2001.[1] The mean lifetime risks of receiving a diagnosis of colorectal cancer and dying of this disease are 5.6% and 2.5%, respectively.[2] Most cases of colorectal cancer can be prevented with colonoscopic removal of the precursor adenomatous polyp.[3]

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The current methods that are used to screen for colorectal polyps and other tumours include faecal occult blood testing, sigmoidoscopy, colonoscopy, and double-contrast barium enema examination. These methods, however, have their limitations. The performance of faecal occult blood testing has been reviewed in large prospective trials, and the technique has been shown to decrease mortality caused by colorectal cancer by only 16% and to fail in detecting the majority of adenomas.[4] In contrast, the performance of the double-contrast barium enema study is better, with a detection rate for colorectal cancer ranging from 70% to 96%.[5] Sensitivity for adenomas larger than 1 cm is reported to be 75% to 90%, whereas sensitivity for the detection of smaller lesions is reported to be only 50% to 80%.[6,7] The specificity for polyps of all sizes ranges from 67% to 85%.[8] The double-contrast barium enema test is associated with a very small risk of perforation (0.0001%

to 0.0004% of cases).[8] However, in a recent study[9] comparing the double-contrast barium enema method and colonoscopy for surveillance after polypectomy, the sensitivity for polyp detection was 32% for polyps of 5 mm and smaller, 53% for polyps of between 6 mm and 9 mm, and 48% for polyps of 10 mm and larger. The overall sensitivity was only 39%. These discrepancies between sensitivity can be due to technical problems, perception errors, selection bias, or the lack of a reliable reference standard.

Colonoscopy has well-recognised advantages — namely, it has a high sensitivity, of 79% to 100% for polyps[10]; it enables the physician to take a specimen for histopathological diagnosis; and it provides the therapeutic option of polypectomy. However, it is associated with increased patient discomfort, an incomplete examination rate of 5% to 15%, and complications related to sedation (0.2%-0.5%) and perforation (0.08%).[11]

Computed tomography (CT) colonoscopy was first reported by Vining and Gelfand.[12] The method uses 3-dimensional images of the colon and rectum from an endoluminal perspective (which simulates endoluminal views at colonoscopy) to detect colorectal lesions. Recent prospective studies have demonstrated good overall sensitivity (70%-88%) and specificity (47-87%) for polyp detection.[13,14] So far, reports of local data are lacking. This prospective study determined the sensitivity and specificity of CT colonoscopy with faecal tagging in the detection of colorectal polyps, adenomas, and carcinomas at a regional general hospital, with colonoscopy as the reference method.

PATIENTS AND METHODS

A total of 51 adult patients who were referred to the Ruttonjee Hospital for standard colonoscopy between June 2004 and August 2004 for colorectal cancer screening or for the evaluation of symptoms were invited to enroll in the study. The last 2 patients who were scheduled to undergo colonoscopy in the afternoon sessions on Mondays and Fridays were invited to participate. If a patient refused, the previous patient on the list was recruited. Participants were patients with an above-average risk for colorectal cancer. Inclusion criteria included a personal history of colonic polyps or other tumours; history of rectal bleeding, iron deficiency anaemia, and a change in bowel habits or weight loss within the previous 12 months. Pregnant patients were excluded. Informed consent was obtained. The patients were instructed to maintain a low residual diet for 2 days and to fast the night before the examination. They underwent bowel preparation in the morning of the day of the CT colonoscopy examination by drinking 2 L of polyethylene glycol electrolyte solution (Klean Prep; Norgine, Heverlee, Belgium). Twenty five milliliters of an iodinated contrast agent (iopamidol 370 g/L) had been added to the bowel preparation solution, giving a final concentration of 12.5 mL per litre of solution (1.25%), to tag the faeces and residual colonic fluid. Patients were scheduled to undergo CT colonoscopy before conventional colonoscopy in the afternoon of the same day.

CT colonoscopy was performed with a multislice CT scanner (Aquilion 16; Toshiba, Otawara, Japan). The patients were placed in the prone position on the CT table. A 14-French Foley catheter was inserted into the rectum, and air was insufflated until the patient's maximum tolerance was reached — a mean of 30 to 40 bulb compressions — and then data acquisition was started. The scout CT image allowed rapid assessment of colonic distension. When necessary, further insufflation was given. A subset of 40 patients was given a bowel relaxant intravenously (Buscopan; Boehringer Ingelheim, Brussels, Belgium). A dose of 20 mg was injected slowly 1 to 2 minutes before scanning.

All the CT colonoscopy examinations were performed with a 0.5-second rotation time and a single breath-hold. Images were obtained from the top of the colon through the rectum, as determined from the scout image, with a collimation of 1 mm and a pitch of 16. The exposure settings were 50 mA and 120 kV. Scanning was performed in the prone position and then in the supine position.

Experienced endoscopists performed conventional colonoscopy immediately after CT colonoscopy with the use of a standard endoscope. They were unaware of the CT findings. The location and the size of the lesions were recorded. All the colorectal tumours also underwent biopsy examination, and all the polyps were removed. The specimens were sent for histopathological analysis. The CT colonoscopic findings were correlated with the conventional colonoscopic and histopathological findings.

Image analysis was performed using a software package that had volume-rendering capabilities (Vitrea 2.6; Vital Images, Minneapolis, MN, United States). Images

were interpreted by the reporting radiologist. A consensus judgement was made owing to the possibility of false-positive or false-negative results. The CT images were analysed first as magnified axial images using a lung window setting (width of 1500 Hounsfield units [HU], level of -200 HU) and then using a soft-tissue window setting (width of 400 HU, level of 10 HU). Any suspected lesions were marked with arrows. Additional, 3-dimensional endoluminal images of the suspected lesion were viewed for problem-solving.

The location and the size of the lesions visualised on CT scans were documented. The adequacy of colonic preparation was also assessed and recorded. The degree of fluid tagging was analysed by measuring the density of the residual colonic fluid in the ascending colon, descending colon, and psoas muscle. The last tissue remains unaffected by the administration of oral contrast and was therefore used as a reference. The faecal tagging was considered successful if there was an increase in Hounsfield units of the colonic fluid compared with psoas muscle. The uniformity of the tagging was also assessed. Positive findings were photographed in axial, endoluminal, and virtual double-contrast enema views (Figures 1 and 2). Incidental findings were also documented and photographed.

Using the findings of conventional colonoscopy as the reference standard, we compared the CT colonoscopic findings according to 2 different methods[14]: comparison by lesion and comparison by patient. For by-lesion comparison, the polyps noted at CT colonoscopy and conventional colonoscopy were considered matched if they were in the same or adjacent segment and had a discrepancy in size of less than 4 mm. For by-patient comparison, the findings of conventional and CT colonoscopy were considered matched if there was at least 1 polyp or if neither test showed a polyp. Through individual lesion matching, the sensitivities for polyp, adenoma, and carcinoma detection were calculated. Through by-patient comparison, the sensitivity and specificity of polyp detection were calculated. A 2-tailed Fisher's exact test was used to obtain p values.

RESULTS

A total of 51 patients (17 women and 34 men) were enrolled in the study. Their mean age was 61.9 years (standard deviation [SD], 9.4 years). Hence, 51 CT colonoscopies with conventional colonoscopy were performed. Complete colonoscopy to the caecum was achieved in 48 patients.

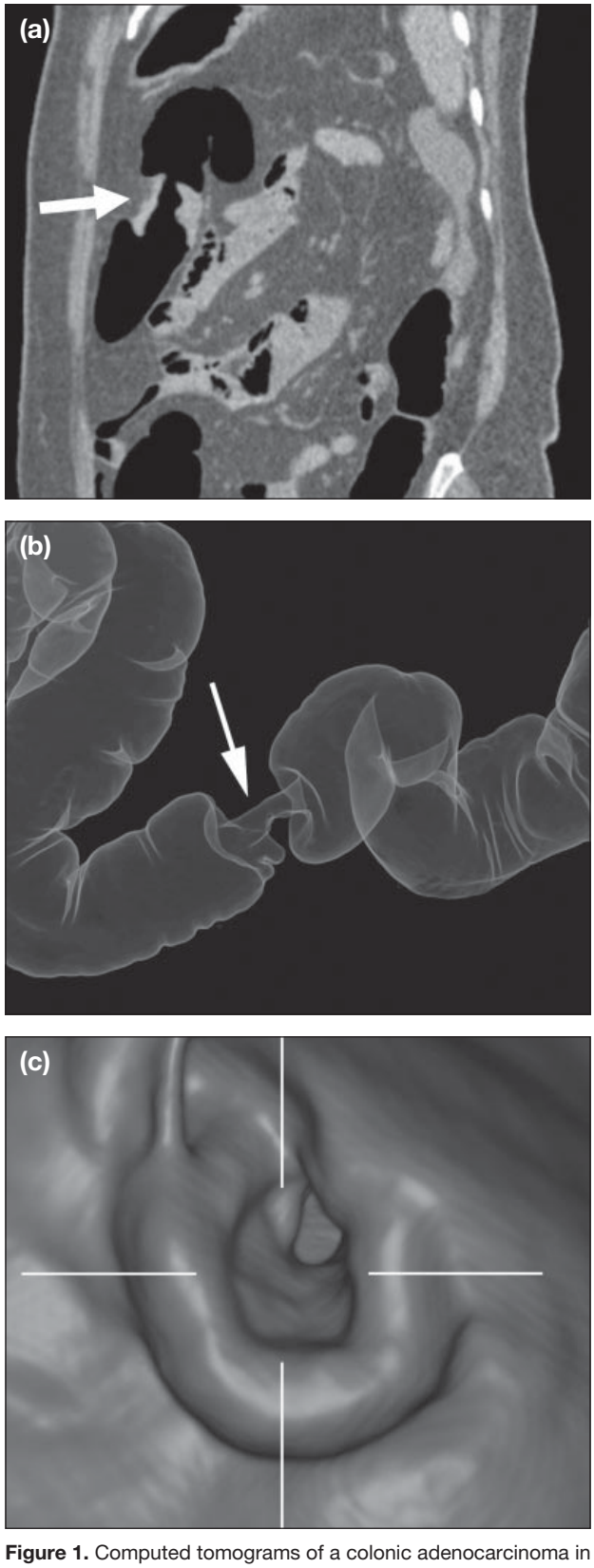

Figure 1. Computed tomograms of a colonic adenocarcinoma in a 58-year-old woman: (a) sagittal reformatted image showing annular stricture (arrow) of the transverse colon as a result of the tumour; (b) virtual double-contrast display showing the 'apple-core' lesion (arrow) in the transverse colon; and (c) endoluminal image showing the irregular annular stricture in the transverse colon.

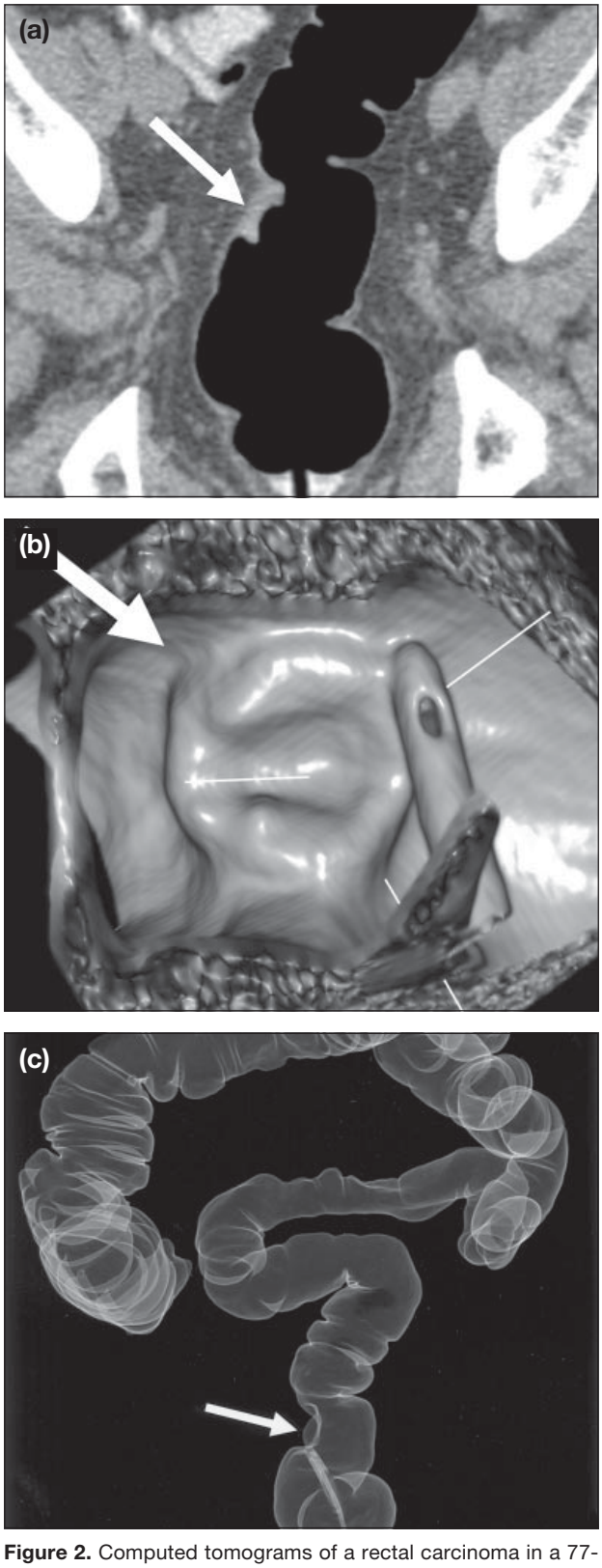

Figure 2. Computed tomograms of a rectal carcinoma in a 77-year-old man: (a) curved reformatted image showing the sessile lesion (arrow) with its centre in the lateral wall of the rectum; (b) 3-dimensional volume–rendered endoluminal image showing the ulcerated lesion (arrow) with elevated edges; and (c) virtual double-contrast view showing the same lesion (arrow). Histological examination showed this lesion to be an adenocarcinoma.

Good, homogeneous tagging of the colonic fluid was obtained in 42 (82%) patients. The tagging of the residual fluid failed in 9 patients. The density of the residual fluid was less than that of the psoas muscle (mean, 51.5 HU; SD, 12.1 HU). The mean density of the tagged fluid in the patients with successful tagging was 225.5 HU (SD, 90.3 HU) in the ascending colon and 226.9 HU (SD, 104.2 HU) in the descending colon. Seven patients had inadequate bowel distension or poor bowel preparation.

The results of colonoscopy were normal in 27 patients. In 21 patients, colonoscopy depicted 22 polyps and 6 infiltrative or annular masses. In 3 patients, colonoscopy depicted colitis. Nineteen adenomas and 6 carcinomas were confirmed at histological examination. The remaining polyps that were identified at colonoscopy were 1 hyperplastic polyp and 2 normal mucosa. One polyp did not undergo biopsy examination.

CT colonoscopy had a 100% sensitivity for the detection of carcinoma. For direct by-lesion matching (Table 1), the sensitivity of CT colonoscopy for polyp or carcinoma detection was 68% for all lesions and 59% for all polyps. When polyps were grouped according to their diameter, the sensitivity for the detection of polyps of 5 mm or larger was 86%. The sensitivity for the detection of histologically confirmed adenomas and carcinoma was 75%; and for all adenomas, it was 67%. When lesions were stratified according to size, the sensitivity for adenoma detection of lesions 5 mm or larger was 85%. All these results had p values of less than 0.05 by Fisher's exact test. However, the sensitivity for detection of polyps smaller than 5 mm was 13% and the sensitivity for detection of adenomas smaller than 5 mm was 20%; the p values for these were greater than 0.05.

In by-patient matching analysis (Table 2), the sensitivity of CT colonoscopy for lesion detection was 74% for

Table 1. Sensitivity of computed tomography colonoscopy for lesion detection, using by-lesion comparison.

Lesion	Sensitivity for polyps or carcinomas (%)	Sensitivity for adenomas or carcinomas (%)
Overall	68 (19/28)*	75 (18/24)*
All polyps	59 (13/22)*	67 (12/18)*
Polyps <5 mm	13 (1/8)	20 (1/5)
Polyps ≥5 mm	86 (12/14)*	85 (11/13)*
Carcinomas	100 (6/6)*	na

*$p < 0.05$. *Note:* Numbers in parentheses are raw data used to calculate percentages.
Abbreviation: na = not applicable.

Table 2. Sensitivity and specificity of computed tomography colonoscopy for lesion detection, using by-patient comparison.

Lesion	Sensitivity (%)		Specificity for polyps or carcinomas
	Polyps or carcinomas	Adenomas or carcinomas	
Overall	74 (14/19)*	81 (13/16)*	94 (30/32)
All polyps	64 (9/14)*	73 (8/11)*	95 (35/37)
Polyps <5 mm	17 (1/6)	25 (1/4)	100 (45/45)
Polyps ≥5 mm	100 (8/8)*	100 (8/8)*	95 (41/43)
Carcinomas	100 (5/5)*	na	100 (46/46)

*$p < 0.05$. *Note:* Numbers in parentheses are raw data used to calculate percentages.
Abbreviation: na = not applicable.

all lesions and 64% for all polyps. When lesions were grouped according to polyp diameter, the sensitivity for the detection of polyps of 5 mm or larger was 100%. The sensitivity for the detection of histologically confirmed cases of adenoma and carcinoma was 81%, and that for the detection of all adenomas was 73%. When lesions were stratified according to size, the sensitivity for adenoma detection for polyps of 5 mm or larger was 100%. The calculated p values by Fisher's exact test were less than 0.05. The overall specificity for the detection of polyps or carcinomas was 94%. However, the sensitivity for detection of polyps smaller than 5 mm was only 17%. Similarly, the sensitivity for detection of adenomas smaller than 5 mm was only 25%. These results had p values of greater than 0.05.

CT colonoscopy demonstrated 2 false-positive polyps in 2 patients. The lesions were present in poorly distended or poorly prepared segments. CT colonoscopy did not produce any false-positive carcinomatous detection.

DISCUSSION

CT colonoscopy is a new radiological modality for detecting colorectal polyps and other tumours. Colonoscopy can differentiate between stool, polyps, and other tumours on the basis of the colour and the morphology of the object being viewed. CT colonoscopy has a potential role in differentiating between the three because of their differences in Hounsfield units, morphology, and the relative positions in supine and prone scans.[15] Small polyps are homogeneous in attenuation, and faecal material often contains areas of low attenuation (due to trapped gas) or high attenuation (due to high-density food particles).[16] Colorectal polyps are round, oval, or lobulated. They do not contain geometric borders or sharp angles, whereas faecal material often contains angled borders or geometric morphology. Faecal material tends to remain on the dependent surface when the patient is moved from the supine to prone position. However, it is important to realise that several segments of colon are mobile owing to long, attached mesentery. Hence, it is important to distinguish whether the colon itself or the filling defect has changed position. A polyp also may appear mobile if it is pedunculated and has a long stalk (Figures 3 and 4).[16] At the Ruttonjee Hospital, we also add a contrasting agent in the bowel preparation fluid to tag the stool and the residual fluid. This procedure helps us to detect submerged polyps. It also increases the confidence in characterisation of the lesion. The polyps are not tagged and therefore isodense, while the residual fluid or faeces are tagged and appear hyperdense.

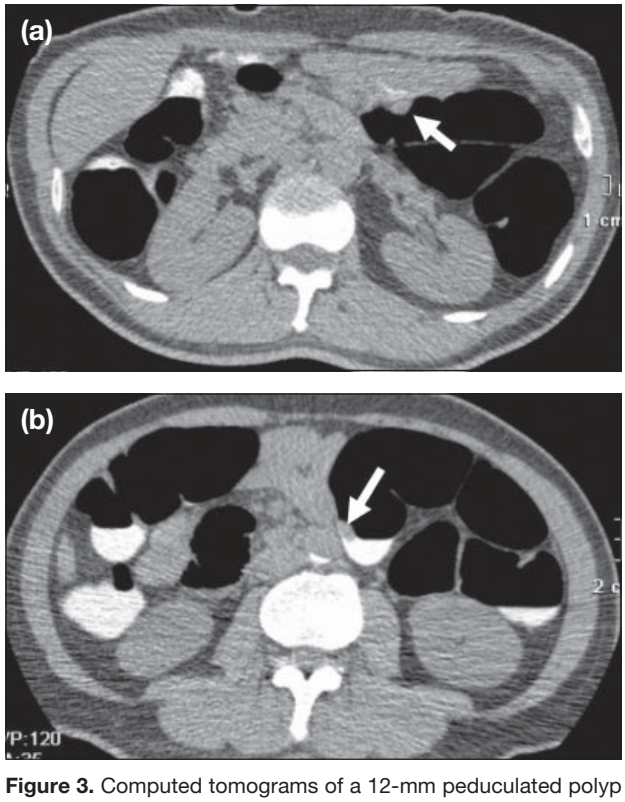

Figure 3. Computed tomograms of a 12-mm peduculated polyp in a 55-year-old man: (a) transverse image obtained in the prone position showing the lesion (arrow) on the ventral surface of the transverse colon; and (b) transverse image obtained in the supine position showing the same filling defect (arrow) on the dependent surface of the transverse colon. At colonoscopy, a 12-mm peduculated tubulovillous adenoma was identified; the apparent change in position was mainly due to a change in colon position.

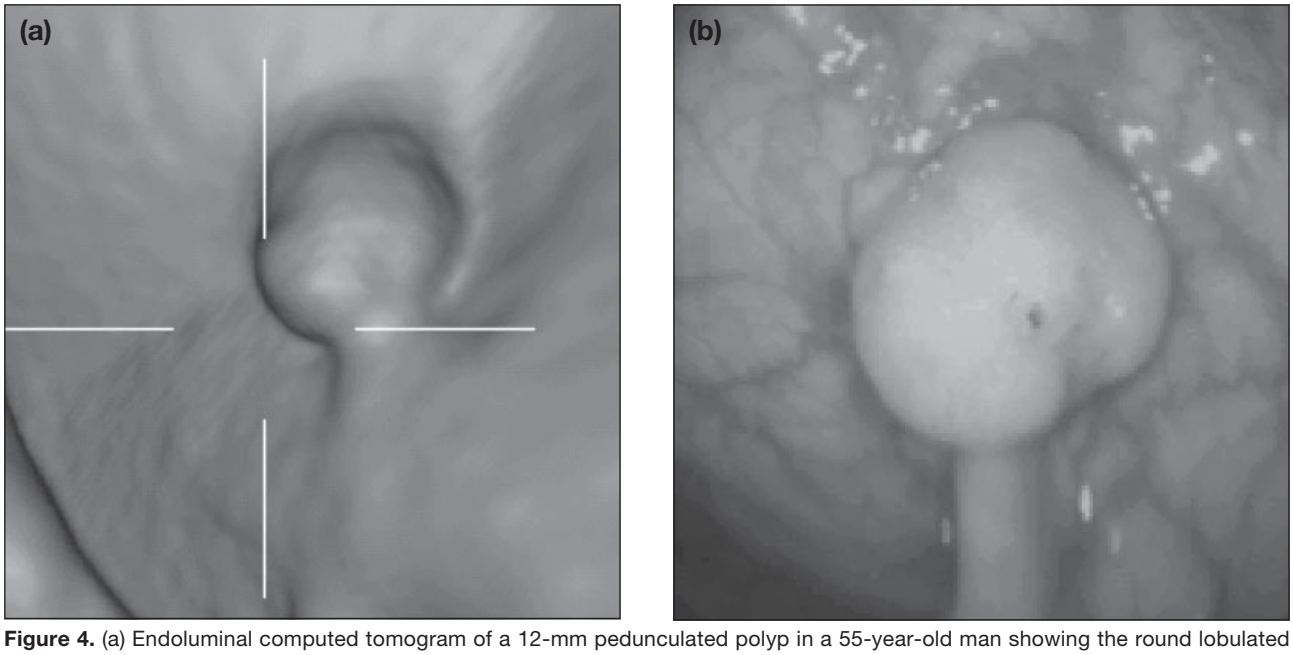

Figure 4. (a) Endoluminal computed tomogram of a 12-mm pedunculated polyp in a 55-year-old man showing the round lobulated morphology of the lesion with a stalk; (b) conventional colonoscopic image showing the same lesion. Histological evaluation showed this lesion to be a tubulovillous adenoma.

To yield a high test sensitivity and specificity, the colon must be free from faecal residue in CT colonoscopy and a good bowel preparation should be obtained. Bowel cleansing can be achieved either by wet-bowel preparation using laxative products orally, together with a rectal suppository to 'wash away' the faeces[14]; or by dry-bowel preparation, using multiple small doses of oral administration of contrast agents to label or tag the stool. Some authors[15,17] add a contrast agent to the bowel-cleansing solution to improve the sensitivity and specificity of the wet-bowel preparation. In our study, we used the same bowel preparation as the colonoscopy, with the addition of a single small dose of oral contrast agent. This approach improved the performance of CT colonoscopy by reducing the rate of false-positive results. At the same time, these steps did not increase the burden on patients and hospital facilities and facilitate the participation and compliance of the patients in the study.

Several prospective studies have been performed to evaluate CT colonoscopy. Sosna et al[18] performed a meta-analysis of 14 studies and 1324 patients to assess the reported accuracy of CT colonoscopy versus conventional colonoscopy for colorectal polyps detection. Overall, 1411 polyps were detected. The pooled by-patient sensitivity for polyps 10 mm or larger was 88%; for polyps of 6 to 9 mm, it was 84%; and for polyps of 5 mm or smaller, it was 65% ($p < 0.05$). The pooled by-lesion sensitivity was 81%for polyps of 10 mm or larger, 62% for polyps of 6 to 9 mm, and 43% for polyps 5 mm or smaller ($p < 0.05$). The sensitivity for the detection of polyps increased as the polyp size increased ($p < 0.05$). The pooled overall specificity for detection of polyps larger than 10 mm was 95%. It is important to differentiate between sensitivity by patient and by polyp. In by-patient analysis, a need for colonoscopy versus no need for colonoscopy is differentiated.[18] Most trials have demonstrated a sensitivity of 75% to 100%; but the 2 largest series have reported 100% sensitivity for polyps of 1 cm or larger.[14,19] For by-lesion sensitivity, the range quoted in the literature is 50% to 100%; but in the 2 largest trials, the sensitivity was 90% and 89%.[14,19,20]

Our study of CT colonoscopy demonstrates comparable results for lesions of 5 mm or larger. The by-lesion sensitivity for polyps of 5 mm or larger was 86%; for adenomas of 5 mm or larger, it was 85%. The by-patient sensitivity for the detection of polyps of 5 mm or larger was 100%; and for adenomas 5 mm or larger, it was 100%. The overall specificity for polyp or carcinoma detection was 94%. Assuming that all the patients with polyps of 5 mm or larger would proceed to conventional colonoscopy and biopsies, the by-patient sensitivity of 100% for the detection of histologically confirmed adenomas larger than 5 mm and colorectal carcinoma means that no clinically important polyps or carcinomas were missed. However, by-lesion and by-patient sensitivity for the detection of polyps smaller

than 5 mm were only 13% and 17%, respectively. These results were poorer than previous studies of 43%.[18] The probable reason was that our bowel preparation was given in the morning of the CT colonoscopy examination, so that the residual fluid was increased, which would obscure small lesions.

There were several limitations in our study. Firstly, we used a relatively small data set. Only 51 patients were included in the study, and a total of 22 polyps and 6 carcinomas were detected in 21 patients (37%). Secondly, bowel preparation was not optimal. The cleansing solution and the contrast agent for faecal tagging were given on the morning of the CT colonoscopy examination. As a result, some patients had an excess amount of residual fluid, which may have obscured the colonic polyps. In fact, 14% of patients (7 of 51) were considered to have poor distension or poor bowel preparation. Bowel cleansing solution given on the night before the CT examination should result in a drier colon the following day, which would favour image interpretation. Moreover, 9 patients had unsuccessful tagging, mostly due to errors in the preparation and mixing of the cleansing solution with the contrast agent. These problems would be improved with experience and additional instruction. Thirdly, the 6 radiologists in this study each interpreted the CT colonoscopic examinations independently, but they probably had variable previous experience in CT colonoscopy. Because of the small sample size, the interobserver variability of the CT readings was not evaluated in this study. Still, a consensus judgement was made to reduce the likelihood of false-positive or false-negative results. Fourthly, complete colonoscopy to the caecum was achieved in 48 patients. Of the 3 patients with incomplete colonoscopy, the missed colonic segments were not included in the comparison.

In conclusion, CT colonoscopy is excellent in detecting clinically important colorectal polyps and other tumours. With the help of faecal tagging, a filling defect should be characterised by all its characteristics, including mobility, attenuation, and morphology.

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