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TECHNICAL

Strategies for improving colorectal cancer detection with routine computed tomography

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Abstract

Purpose To report the detection rate of colorectal tumors with computed tomography (CT) performed within 1 year before diagnosis for indications other than colon abnormalities. Strategies to improve cancer detection are reported.

Methods Two board-certified, subspecialty-trained abdominal radiologists retrospectively reviewed patient health records and CT images with knowledge of tumor location/size. Patients were classified into 3 groups: *prospective* (colon abnormality suggesting neoplasm documented in radiologic report), *retrospective* (not documented in radiologic report but detected in our retrospective review of CT images), and *undetected* (neither prospectively nor retrospectively detected). Retrospective detection confidence and morphologic characteristics of each tumor were also recorded.

Results Of 209 included patients, 106 (50.7%) had prospectively detected tumors, 66 (31.6%) had retrospectively detected tumors, and 37 (17.7%) had undetected tumors. Asymmetric bowel wall thickening and polypoid masses were present more often in the retrospective group than in the prospective group (27% vs. 10.5% and 26% vs. 17.1%, respectively). Tumors in the ascending colon were more likely to be detected retrospectively than prospectively (odds ratio, 2.75; 95% CI 1.07–7.08; $P=0.04$). Undetected tumors were smaller on average (2.9 cm) than prospective (6.0 cm) and retrospective (4.9 cm) tumors ($P=0.03$). Detection confidence was lower for retrospectively detected tumors than for prospectively detected tumors ($P=0.03$). Indications other than abdominal pain were most common for retrospectively detected tumors ($P=0.03$). Use of intravenous contrast material was lowest in the undetected group ($P=0.003$). The prospective group had more pericolonic abnormalities, regional/retroperitoneal lymph node involvement ($P<0.001$), and distant metastases than did the retrospective group ($P=0.01$).

Conclusion Half of all colorectal tumors were not detected prospectively. Radiologists should perform meticulous colon tracking regardless of the indication for CT. The right colon merits additional examination. Polypoid and asymmetric morphologic characteristics were most often overlooked, but these characteristics can be learned to improve detection.

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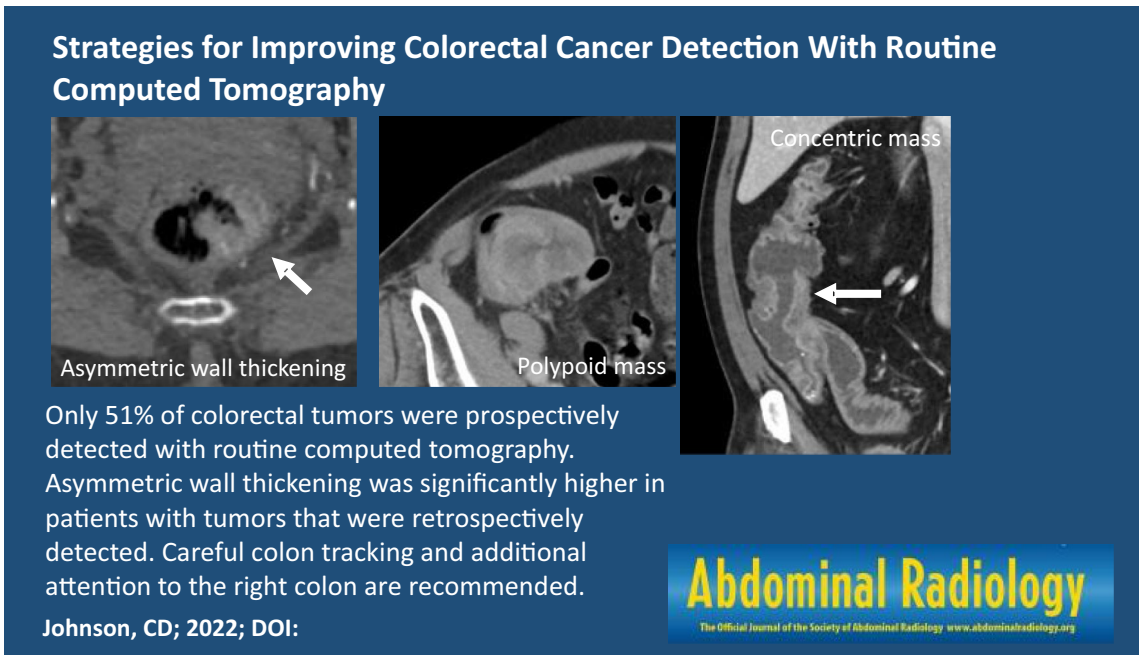
Graphical abstract



Keywords Asymmetric thickening · Colorectal cancer · Computed tomography · Concentric · Detection error · Missed diagnosis

Abbreviations

CT Computed tomography
IV Intravenous
OR Odds ratio

Introduction

Colorectal cancer remains a major public health problem because it is the fourth most common cancer and fourth leading cause of cancer-related deaths in the USA [1]. Data support the use of routine screening for early detection of colorectal cancer to reduce overall incidence and mortality rates; however, only 70% of patients aged 50–75 years are up to date with nationally recommended guidelines for colorectal cancer screening [2]. The 5-year relative survival rate is considerably higher for localized disease (91%) than for colorectal cancer with regional (73%) or distant (15%) metastases [3].

The use of routine computed tomography (CT) in the USA has increased from 204 per 1000 person-years in 2000 to 428 per 1000 person-years in 2016 [4]. This increase provides an opportunity to detect unsuspected colorectal tumors in patients undergoing routine abdominal/pelvic CT for various indications. Detecting such tumors at an earlier stage would improve both morbidity and mortality rates.

Previous studies of the use of routine abdominal CT to prospectively detect colorectal cancer have reported missed cancer diagnosis rates ranging from 9.4 to 27.6% [5–7]. The largest study by Klang et al. [5] in 2017 reported that 19.7% of colorectal tumors were prospectively missed and that only 4% were not detected on retrospective review. Most of the cases in which tumors were detected included both routine oral (3 h before CT) and intravenous (IV) administration of contrast material. Whether all of these cases were confirmed by histopathologic analysis is unclear, and whether the colorectal cancer diagnoses were known or suspected before CT is unknown.

The purpose of our study was to report the prospective detection rate of colorectal tumors with routine CT conducted within 1 year before confirmed histopathologic diagnosis of colorectal cancer in patients without a known colon abnormality. In addition, the study aimed to report the percentage of tumors that were prospectively missed but detected retrospectively and the radiologic characteristics associated with retrospectively detected tumors versus those detected prospectively. Strategies to improve detection of colorectal cancer with routine CT are also described.

Methods

This study was considered exempt by the Mayo Clinic Institutional Review Board. A retrospective search of the electronic health records of Mayo Clinic academic and community practices identified consecutive adult (≥ 18 years) patients who had histopathologically confirmed colorectal adenocarcinoma (including signet ring cell and mucinous tumors) from April 28, 2011, through April 28, 2021, and routine abdominal/pelvic CT performed within 1 year before diagnosis. The search was conducted using 13 *International Classification of Diseases*, *Ninth Revision*, *Clinical Modification* codes; 13 *International Classification of Diseases*, *Tenth Revision*, *Clinical Modification* codes; and 38 CT procedure codes. Health records and CT images for each patient were reviewed to determine whether the imaging data were diagnostic and the histopathologic data supported diagnosis of a colorectal primary tumor. Patients were excluded from the study if the indication for CT was a suspected or known colorectal mass, histopathologic data were unavailable, tissues were inadequate for a histopathologically based diagnosis, or the primary adenocarcinoma did not arise from the colon or rectum.

Confirmed diagnoses were based on colonoscopic biopsy or surgical specimen histopathologic findings. When both a colonoscopic biopsy and a surgical specimen report were available, the surgical specimen report was used for data collection. Abstracted patient and clinical data included sex, age, affected colon segment, maximum tumor diameter, tumor cell type (adenocarcinoma or mucinous adenocarcinoma/signet ring cell carcinoma), tumor grade, T category (if available), lymph node involvement (if available), and use of IV or oral contrast material.

Two board-certified, subspecialty-trained abdominal radiologists (K.T.F. and C.D.J.), with 3 years and 30 years of experience, retrospectively reviewed the health records and CT images with knowledge of the tumor location and size. Patients were classified into 3 groups according to the time of tumor detection in CT images: *prospective* (colon abnormality suggesting neoplasm in the original radiologic report), *retrospective* (neoplasm not included in the original radiologic report but detected in our retrospective CT image review), and *undetected* (neither prospectively nor retrospectively detected). In addition, the radiologist reviewers recorded their confidence in diagnosing colorectal cancers during retrospective review in each group (i.e., both prospectively and retrospectively detected tumors) and the morphologic characteristics of each tumor according to those reported by Klang et al. [5] (i.e., asymmetric bowel wall thickening and concentric, polypoid, or exophytic masses) (Fig. 1). During the retrospective CT review, the following radiologic findings were also noted: pericolonic abnormality, presence of regional lymph node involvement, retroperitoneal adenopathy, and distant metastases. For cases with discrepant findings (i.e., undetected by one reviewer and retrospectively detected by another reviewer), consensus reviews were performed.

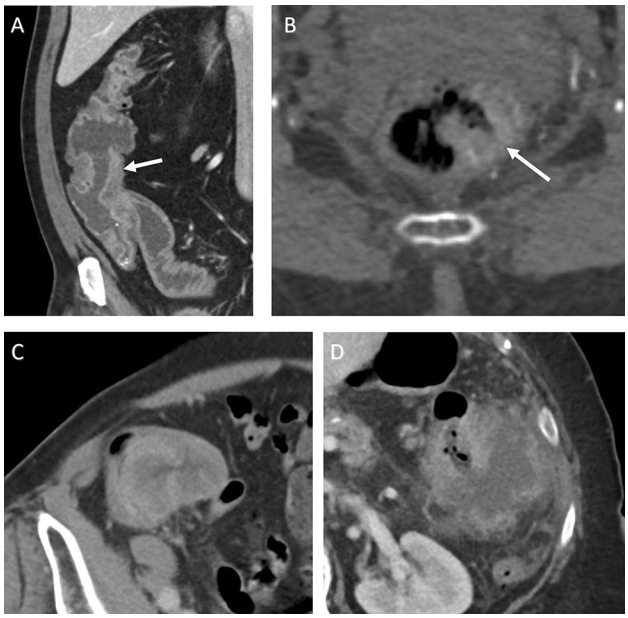


Fig. 1 Four morphologic characteristics of colorectal cancers. **a** Concentric or annular appearance of a tumor that encompasses the colon lumen with bowel wall thickening and luminal narrowing (arrow). **b** Asymmetric bowel wall thickening from a tumor arising from the left side of the rectum (arrow). **c** Polypoid tumor filling the lumen of the ascending colon. **d** Exophytic tumor extending predominantly beyond the colon wall

Continuous variables are summarized as mean (SD), and differences were tested with a linear model analysis of variance and Tukey post hoc tests. Categorical variables are summarized as frequency (%), and differences in distribution across all levels were tested with Fisher exact tests. Multivariable logistic regression was used to test the association of morphologic characteristics with detection group, adjusting for tumor size. Univariate logistic regression was used to estimate odds ratios (ORs) for levels of tumor location. Statistical analyses were performed with R v4.1.2 (The R Foundation) and SAS v9.4 (SAS Institute Inc.). P values < 0.05 were considered statistically significant.

Results

Initially, 680 patients with colorectal adenocarcinoma who had routine abdominal/pelvic CT performed within 1 year before diagnosis during the study period were identified. CT images were considered nondiagnostic in 12 cases because

of insufficient coverage in 4, metallic artifacts in 6, and other factors in 2. Patients had an indication of a suspected or known colorectal mass recorded at the time of CT in 44 cases. An additional 415 patients were excluded. Most of these patients were excluded for 1 of 3 reasons: (1) The patient had a previous personal history of colorectal cancer (often many years prior) and were seeking care for another reason. (2) The patient had untreatable metastatic cancer suspicious for a colorectal primary tumor, but no further search for a primary mass was performed and therefore not confirmed. Often these patients were discharged home or were admitted to hospice. (3) The diagnosis of adenocarcinoma was confirmed, but the cancer arose from a site other than the colon or rectum. Therefore, a total of 471 patients were excluded from analysis, and 209 patients were included in the final analysis groups. Confirmed diagnoses were based on colonoscopic biopsy findings in 74 cases (35.4%) and surgical specimen findings in 133 cases (63.6%). Two additional patients (1.0%) had biopsies of identified pelvic masses that confirmed the diagnosis of colon adenocarcinoma.

Of 209 included patients, only 106 (50.7%) were included in the prospectively detected group. Retrospective review with knowledge of the tumor location and size identified 66 (31.6%) patients who were included in the retrospectively detected group and 37 (17.7%) patients who were included in the undetected group. Six tumors were initially undetected by one reviewer but were subsequently detected by the second reviewer. These tumors were confirmed to be present after consensus review and were subsequently reclassified to the retrospectively detected group.

Patient demographics and indications for CT for each of the 3 detection groups are summarized in Table 1. The mean age for all patients was 71 years, which did not significantly differ among groups ($P=0.29$). The undetected (54%) and retrospective (58%) groups had a higher percentage of men than women, but the prospective group had fewer men than women (43.4% vs. 56.6%). However, patient sex did not significantly differ among detection groups ($P=0.16$). Abdominal pain was the most common indication for CT examination in the prospective group (57.5%). The indications for CT significantly differed between the prospective and retrospective groups ($P=0.03$). Indications other than abdominal pain, constipation, bleeding, or anemia were the most frequent indication in the undetected (73%) and retrospective (45%) groups. Such *other* indications included hematuria, kidney stone, trauma, pelvic mass, and prostate cancer.

Histopathologic characteristics of the colorectal tumors in each detection group are shown in Table 2. Tumor locations significantly differed among the detection groups ($P=0.02$, all groups; $P=0.01$, prospective vs. retrospective). The highest percentage of tumors in the undetected group were in the ascending colon (24%), followed by the transverse colon (22%) and rectum (22%). Tumors in the retrospective group were located primarily in the ascending colon (36%) and rectum (18%). Tumors in the prospective group were predominantly in the cecum (26.4%), sigmoid colon (21.7%), and rectum (20.8%). Tumors in the ascending colon were more likely to be in the retrospective group than in the prospective group in univariate logistic regression analysis (OR, 2.75; 95% CI 1.07–7.08; $P=0.04$).

The mean tumor diameter in the undetected group was smaller (2.9 cm) than that in the prospective (6.0 cm) and retrospective (4.9 cm) groups ($P<0.001$) (Table 2). Tumor diameter was also significantly smaller in the retrospective group than in the prospective group ($P=0.03$). Tumor size

Table 1 Patient demographics and indications for computed tomography examination

Demographic/indication	Prospective ($n=106$)	Retrospective ($n=66$)	Undetected ($n=37$)	P (all groups)	P (prospective vs. retrospective)
Age at diagnosis, y	69.2 (16.7)	72.9 (14.2)	71.9 (14.1)	0.29[a]	0.28[b]
Sex					
Men	46 (43.4)	38 (58)	20 (54)	0.16[c]	0.09[c]
Women	60 (56.6)	28 (42)	17 (46)		
Indication				<0.001[c]	0.03[c]
Abdominal pain	61 (57.5)	27 (41)	8 (22)		
Constipation	1 (0.9)	2 (3)	0 (0)		
Bleeding	6 (5.7)	5 (8)	1 (3)		
Anemia	10 (9.4)	2 (3)	1 (3)		
Other	28 (26.4)	30 (45)	27 (73)		

Categorical data are summarized as no. (%) of patients, and patient age data are summarized as mean (SD)

[a] P value determined with linear model analysis of variance

[b] P value determined with Tukey post hoc test

[c] P value determined with Fisher exact test

Table 2 Histopathologic findings according to detection group

Histopathologic finding	Prospective ($n=106$)	Retrospective ($n=66$)	Undetected ($n=37$)	P (all groups)	P (prospective vs. retrospective)
Affected colon segment				0.02[a]	0.01[a]
Cecum	28 (26.4)	8 (12)	4 (11)		
Ascending	16 (15.1)	24 (36)	9 (24)		
Transverse	9 (8.5)	7 (11)	8 (22)		
Descending	8 (7.5)	7 (11)	1 (3)		
Sigmoid	23 (21.7)	8 (12)	7 (19)		
Rectum	22 (20.8)	12 (18)	8 (22)		
Tumor diameter, cm	6.0 (3.1) ($n=86$)	4.9 (2.5) ($n=58$)	2.9 (1.9) ($n=32$)	<0.001[b]	0.03[c]
Range	0.3–19.0	1.0–12.0	0.8–8.4		
Signet ring cell carcinoma or mucinous adenocarcinoma	15 (14.2)	8 (12)	1 (3)	0.16[a]	0.82[a]
Tumor grade	($n=93$)	($n=63$)	($n=31$)	0.47[a]	0.28[a]
1/2	72 (77)	48 (76)	27 (87)		
3/4	21 (23)	15 (24)	4 (13)		
Invasiveness	($n=71$)	($n=43$)	($n=16$)		
T stage	71 (100)	43 (100)	16 (100)		
Venous invasion	0 (0)	0 (0)	0 (0)		
Tumor category	($n=71$)	($n=43$)	($n=16$)	0.12[a]	0.28[a]
T1/2	8 (11)	8 (19)	5 (31)		
T3/4	63 (89)	35 (81)	11 (69)		
Lymph node involvement	42 (55) ($n=77$)	18 (36) ($n=50$)	6 (29) ($n=21$)	0.03[a]	0.47[a]

Categorical data are summarized as no. (%) of patients, and tumor diameter data are summarized as mean (SD)

[a] P value determined with Fisher exact test

[b] P value determined with linear model analysis of variance

[c] P value determined with Tukey post hoc test

did not significantly increase with increased confidence in making a retrospective diagnosis for either the prospective or retrospective groups (Fig. 2). Most colorectal tumors were adenocarcinomas, and 11.5% were either mucinous adenocarcinomas or signet ring cell carcinomas. Tumor grade (1/2 vs. 3/4, $P=0.28$) and T category (T1/2 vs. T3/4, $P=0.28$) did not differ between the prospective and retrospective groups.

IV contrast material was administered in 181 of 209 (86.6%) patients, whereas oral contrast material was administered in 16 (7.7%) patients and neither IV nor oral contrast material was administered in 12 (5.7%) patients. Two patients (1.0%), both in the prospective group, underwent routine CT colonography with colorectal cleansing. Use of IV contrast material was significantly higher in the prospective group ($n=99$, 93.4%) than in the retrospective ($n=56$, 85%) and the undetected groups ($n=26$, 70%) ($P=0.002$). Only 16 (7.7%) patients received oral contrast material, but oral contrast material frequency did not differ among the detection groups ($P=0.51$).

Reviewer confidence ratings in diagnosing colorectal tumors at the time of retrospective image review are summarized in Table 3. Reviewers reported a significantly higher frequency of very confident ratings for detecting tumors in the prospective group (79.2%) than in the retrospective group (26%) ($P<0.001$).

The radiologic findings identified during the retrospective CT image review are summarized in Table 4. The frequency of bowel wall thickening did not significantly differ between the prospective and retrospective groups ($P=0.54$). The prospective group had a significantly higher frequency of luminal narrowing ($P=0.01$), pericolonic abnormalities (soft-tissue stranding and/or localized lymph node involvement) ($P<0.001$), regional and retroperitoneal lymph node involvement ($P<0.001$), and distant metastases ($P=0.01$) than did the retrospective group.

The 4 morphologic characteristics of colorectal cancer reported by Klang et al. [5] (Fig. 1) were compared between the prospective and retrospective groups (Table 4), which were significantly different ($P=0.006$). Concentric (annular) masses were present in 64.8% of the prospective group and in 46% of the retrospective group. Only 1 exophytic mass was present in the retrospective group. Asymmetric bowel wall thickening was more frequent in the retrospective group

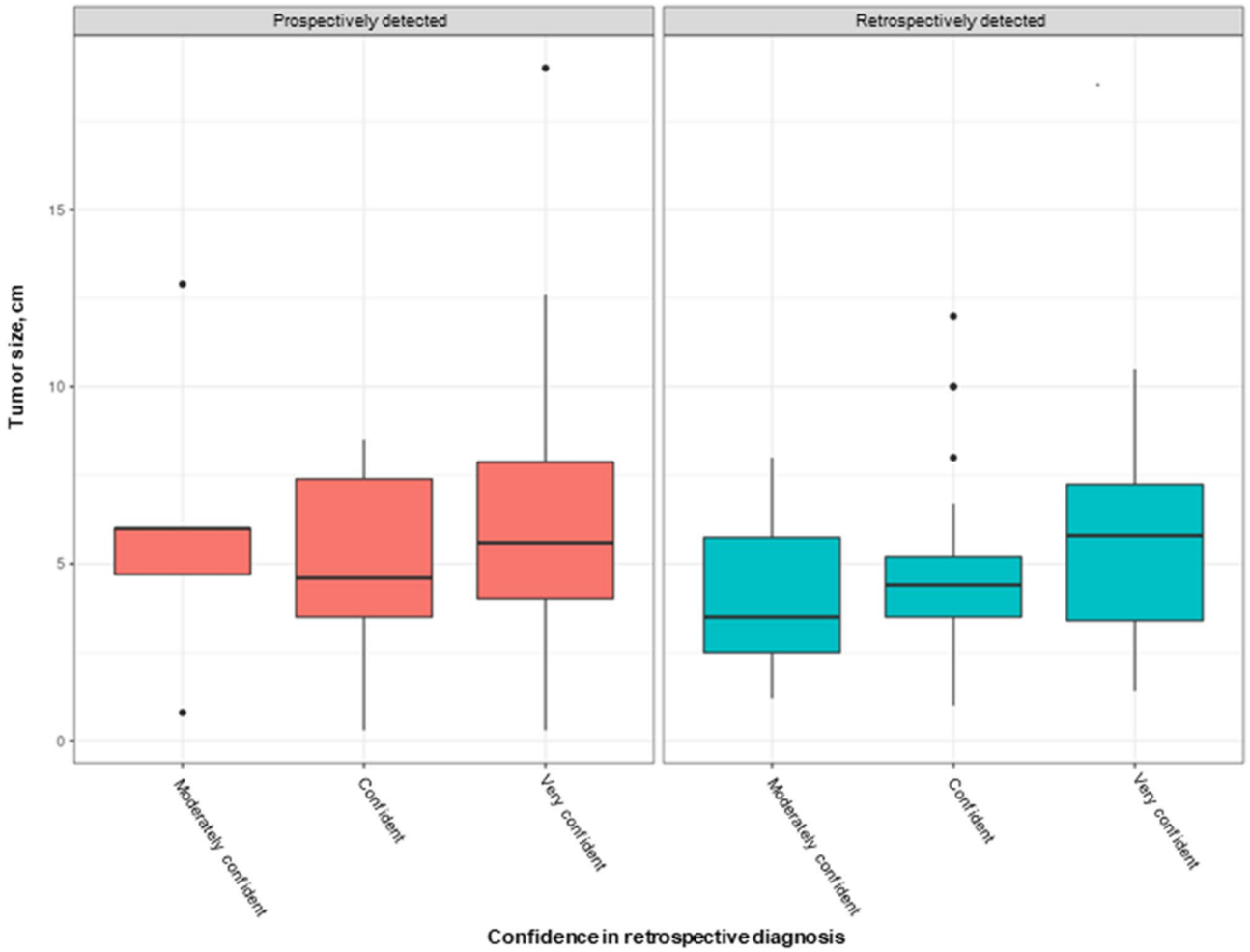


Fig. 2 Distribution of tumor size according to confidence in retrospective diagnosis of colorectal tumors. Box plots show median tumor size according to radiologist-rated confidence level in the retrospective diagnosis of prospectively and retrospectively detected tumors

Table 3 Confidence for diagnosing colorectal tumors during retrospective review of computed tomography images

Rating	No. of cases (%)		*P*
	Prospective ($n=106$)	Retrospective ($n=66$)	
Detection confidence			<0.001[a]
Not at all confident	0 (0)	0 (0)	
Moderately confident	5 (4.7)	14 (21)	
Confident	17 (16.0)	35 (53)	
Very confident	84 (79.2)	17 (26)	

[a]*P* value determined with Fisher exact test

than in the prospective group (27% vs. 10.5%). Polypoid masses were also more common in the retrospective group than in the prospective group (26% vs. 17.1%). Multivariable logistic regression analysis showed that morphologic characteristics remained associated with detection group after adjusting for tumor size ($P=0.01$). Asymmetric bowel wall thickening was 3.91 times more likely to be present in the retrospective group than were concentric masses (95% CI 1.52–10.04; $P=0.005$). The presence of polypoid masses did not differ from that of concentric masses for each detection group ($P=0.08$). Representative CT images of tumors with morphologic characteristics are shown in Figs. 3, 4, 5, and 6.

Discussion

The importance of early detection of colorectal cancer is well established [1, 3, 8]. Opportunities to identify colorectal tumors, in addition to recommended screening examinations, include cross-sectional imaging performed for other clinical indications. To our knowledge, this the largest study to date to determine whether histopathologically confirmed

Table 4 Radiologic findings on retrospective review of computed tomography images

Radiologic finding	No. of cases (%)		P^a
	Prospective ($n=106$)	Retrospective ($n=66$)	
Bowel wall thickening	100 (94.3)	60 (91)	0.54
Luminal narrowing	94 (88.7)	48 (73)	0.01
Pericolonic abnormality	77 (72.6)	23 (35)	< 0.001
Normal regional lymph nodes	49 (46.2)	52 (79)	< 0.001
Distant metastases	28 (26.4)	7 (11)	0.01
Morphologic appearance	($n=105$)		0.003
Asymmetric bowel wall thickening	11 (10.5)	18 (27)	
Concentric (annular) mass	68 (64.8)	30 (45)	
Polypoid mass	18 (17.1)	17 (26)	
Exophytic mass	8 (7.6)	1 (2)	

[a] P values determined with Fisher exact test

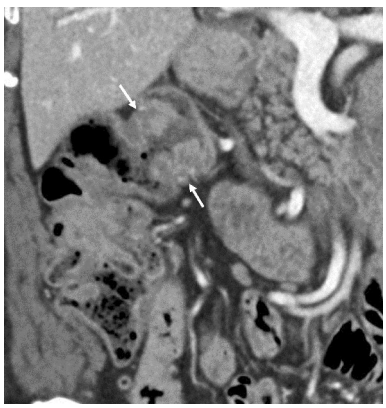


Fig. 3 Retrospectively detected tumor near the hepatic flexure. Concentric mass (arrows) narrows the caliber of the colon lumen

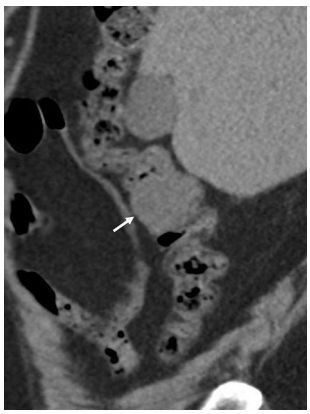


Fig. 4 Retrospectively detected polypoid mass in the ascending colon. A soft-tissue mass (arrow) fills the lumen of the ascending colon

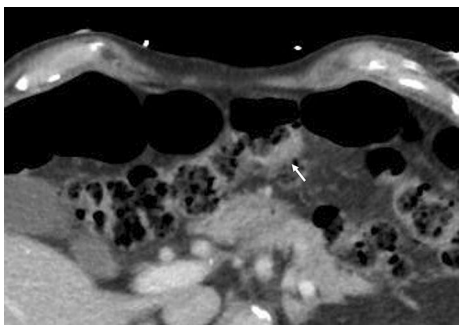


Fig. 5 An initially undetected tumor in the transverse colon that was retrospectively detected after consensus review. Asymmetric soft-tissue thickening is present along the inferior border of the mid transverse colon (arrow). This tumor was initially undetected on retrospective review by one reviewer but was detected by a second independent reviewer, and it was agreed by consensus to be present

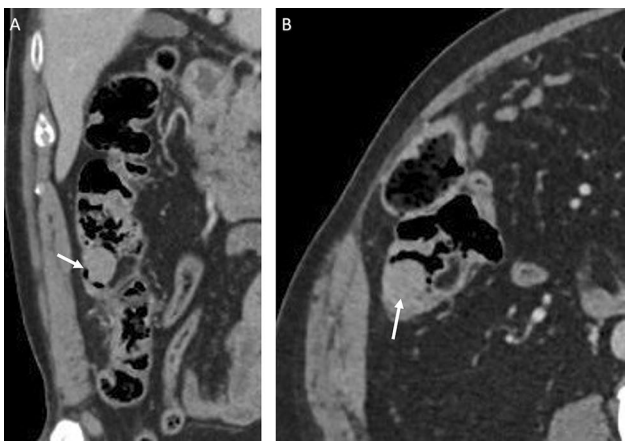


Fig. 6 Retrospectively detected polypoid tumor in the ascending colon. **a** Coronal view of the ascending colon showing a round, polypoid mass (arrow) in the ascending colon. **b** Axial view of the same mass (arrow). Note that the soft-tissue tumor attenuation can be easily distinguished from typical stool that contains air

colorectal cancer can be detected with routine CT examination in patients without a known or suspected colorectal mass. Only 51.2% of confirmed colorectal tumors were prospectively detected. Retrospective review with knowledge of tumor location and size detected an additional 32.1% of tumors. Therefore, approximately 83% of these tumors have the potential for detection with routine CT.

Our overall prospective detection rate was lower than that reported by others. Klang et al. [5] reported detection of 80% of tumors, but higher error rates occurred without the use of IV or oral contrast material. Than et al. [6] reported a 9.4% false-negative rate for CT-based detection of colorectal tumors, which included both symptomatic patients and those undergoing screening. Ozel et al. [7] reported 65–85% sensitivity among 3 observers for the detection of colorectal tumors with routine CT in 29 patients. The detection rate of large polyps in 16 patients was much lower, with a sensitivity of 15%.

Cases of known or suspected colorectal tumors were specifically excluded in our study because radiologists generally apply additional scrutiny to images when a tumor is known or suspected. CT colonographic examinations also receive more scrutiny than do routine CT examinations performed for other indications. Our results are most likely representative of most practices in the USA because they were obtained from both academic and community practices across a large geographic region (Mayo Clinic campuses in Arizona, Florida, and Minnesota). Because many more tumors than expected were not prospectively detected, this should prompt radiologists to inspect CT images of the colon more carefully. The differences between prospectively and retrospectively detected tumors should be understood because they are important for improving radiologic detection.

The morphologic characteristics of retrospectively detected tumors merit attention. Concentric/annular masses were present most often among the tumors in the retrospective group, despite this common and expected pattern of malignant growth. This finding suggests that routine colon tracking (i.e., slice-by-slice image examination of the colon throughout its length) was not performed adequately. However, factors other than a lack of careful colon tracking may have contributed to the inability to prospectively detect some tumors. Retrospectively detected tumors were smaller on average than those detected prospectively. Furthermore, confidence ratings were consistently lower for retrospectively detected tumors than for those detected prospectively. A lack of awareness of the full spectrum of morphologic patterns is most likely an important contributor to errors, especially for tumors with asymmetric and polypoid growth patterns. A higher level of suspicion should be prompted when these morphologic characteristics are identified. The 17.7% of tumors that remained undetected despite knowledge of tumor size and location were most likely not detected because they were small and hidden in colonic contents and collapsed colonic segments.

The prospectively detected tumors had a higher frequency of advanced tumor stage characteristics, which included pericolonic soft-tissue stranding, prominent/enlarged lymph nodes, regional or retroperitoneal lymphadenopathy, and distant metastases. Although these characteristics were less frequently observed in the retrospective group, they should prompt a search for a colorectal tumor when present.

Clinical indications for CT included abdominal pain for most patients with prospectively detected tumors. Retrospectively detected tumors had various indications other than abdominal pain, constipation, bleeding, or anemia. The most commonly noted indications in these patients were hematuria, kidney stone, trauma, pelvic mass, and prostate cancer. Satisfaction of search may have contributed to the number of tumors in the retrospective group [2]. If a specific condition is listed in the clinical indication for CT examination, radiologists often focus their search for that condition or problem. This could lead to a failure to search as thoroughly in other organs. Radiologic findings that could explain the indication (e.g., finding of ureteral calculi in a patient with abdominal pain) may also lead to diminished effort and focus when evaluating other abdominal organs. Other common findings in our patients included small bowel obstruction, constipation, Crohn disease, kidney mass, and diverticulitis. Regardless of the indication, a thorough search of the colon should be performed for every patient.

In an effort to improve colorectal cancer detection, radiologists may increase the number of false-negative results and unnecessarily recommended colon examinations, which increases medical costs and patient risk and anxiety. Equivocal findings could be further evaluated with reformatted views in multiple planes and in consultation with colleagues for second opinions. Nearly all tumors enhance after administration of IV contrast material. Enhancement can be helpful to confirm findings.

Most patients in our study had IV contrast material administered, whereas only 7.7% of patients had oral contrast material administered. Because our study reviewed data collected between 2011 and 2020, COVID-19 contrast administration protocols most likely did not affect the rate of oral contrast material administration in this patient population. Many of these patients were sent for CT from the emergency department, in which rapid turnaround times are important and oral contrast administration is not routine. Furthermore, waiting time after administration of oral contrast material in our practice is usually 45–60 min, which is most likely insufficient for adequate labeling of colonic contents in most patients.

Patient sex and age considerations did not appear to account for detection errors. In the retrospective group, most colorectal tumors were located either in the ascending colon

(36.4%) or cecum (12.1%). Therefore, special attention to the right colon should be considered at the time of colon tracking.

This study was limited by its retrospective nature and data collection from a single health care system with multiple different CT instruments and different faculty readers at many sites. Routine CT protocols are standardized across these varied locations, and image quality was considered high because only 12 cases were deemed nondiagnostic. Further study of the added value of oral contrast material, requirement for IV contrast material, and amount and quality of colon tracking with eye-tracking systems are warranted. The radiologists performing the retrospective review were aware that a tumor was present in each case and had knowledge of the tumor location and size. Therefore, the retrospective detection rate most likely overestimates the number of tumors that would be detected even after careful review.

Conclusion

Routine CT of the abdomen and pelvis is commonly ordered for various conditions. The key take-home message of this study is that half of all colorectal tumors were not prospectively detected, which indicates that radiologists should consider several practice changes to improve their overall detection rate. These changes include meticulous colon tracking with a careful search pattern, regardless of the indication for CT. The right colon merits special attention and inspection. Findings of pericolonic stranding and adjacent, regional, or retroperitoneal lymph node involvement should prompt suspicion and a search for a primary colorectal tumor. Polypoid asymmetric and concentric tumors were often overlooked, but these morphologic characteristics can be learned to improve detection.

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Code availability Not applicable.

Declarations

Conflict of interest All authors declare that they have no conflict of interest.

Consent to participate Not applicable.

Consent for publication Not applicable.

Ethics approval Exempt.

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