

## Accuracy of colon tumor localization: Computed tomography scanning as a complement to colonoscopy

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### Abstract

**AIM:** To determine the utility of computed tomography (CT) scanning in localizing colon tumors.

**METHODS:** At a single tertiary care teaching hospital, a retrospective chart review was conducted on patients who underwent surgery for colon malignancies between January 2004 and May 2006. One hundred and four charts containing all of the following data were reviewed: preoperative colonoscopy report, preoperative CT report, surgical operative report, tumor pathology report. The colon was divided into five segments from the cecum to the sigmoid and the location of the lesions was categorized into one of these areas. The tumor location was considered "erroneous" if its location determined during surgery differed from the location determined by colonoscopy or CT.

**RESULTS:** Over all, tumor location was accurately determined *via* colonoscopy in 83/104 cases (79.8%) and erroneously in 21/104 (20.2%) of cases. CT scan accurately localized colon tumors in 52/104 (50.0%) of cases, incorrectly localized tumors in 18/104 (17.3%) of cases, and did not detect known tumors in 34/104

(32.7%) of cases. Of the 21 tumors erroneously located by colonoscopy, 11 (52.4%) were accurately localized by CT scan. The average tumor size for all patients in this study was 5.72 (+/- 3.11) cm. The average size of tumors properly located by colonoscopy and CT was 5.39 (+/- 3.34) cm and 6.79 (+/- 3.48) cm, respectively. The average size of the tumors not detected by CT was 3.98 (+/- 1.75) cm.

**CONCLUSION:** CT scanning may be used in concert with colonoscopy to help localize colon tumors.

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**Key words:** Colon; Colonoscopy; Colon cancer; Computed tomography scan; Colectomy

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### INTRODUCTION

Mislocalization of colon tumors during preoperative colonoscopy can result in serious difficulty in the operating room, particularly in laparoscopic cases. The error rate of 11%-21%<sup>[1-4]</sup> reported in the literature implies that this is a significant problem. Hilliard *et al*<sup>[5]</sup> stated that endoscopy is frequently unable to obtain precise distance measurements from the anal verge, thus making localization of lesions during surgery difficult. Piscatelli *et al*<sup>[4]</sup> found that colonoscopic localization of colorectal carcinoma is frequently

inaccurate and that errors resulted in a different surgical procedure than originally planned in 11% of cases, and modification of the surgical approach in an additional 4% of cases. Even when tumors have been tattooed during colonoscopy, their location may remain elusive intraoperatively<sup>[1,6,7]</sup>.

A tumor mislocalized by colonoscopy can create great difficulty. In the rectum, it is the precise distance from the dentate line that is important regarding the distal resection margin. In the colon, however, mislocalization may lead to resection of the wrong segment. Confirmation of tumor or polyp location can necessitate intraoperative colonoscopy which prolongs the operative time and/or results in intestinal distension with gas, precluding laparoscopic resection<sup>[7]</sup>.

Repeating colonoscopy prior to surgery in all patients has been recommended based on the discovery that many patients may be spared operation by completion of colonoscopic polypectomy<sup>[8,9]</sup>. Repeat colonoscopy is invasive, time consuming, expensive, and is often met with resistance by both the patient and the referring endoscopist<sup>[8]</sup>. Most oncologists and many surgeons require a preoperative computed tomography (CT) for clinical staging and determination of metastatic disease. Some studies support routine pre-op CT scans in colon cancer cases<sup>[10,11]</sup>. Others recommend only selective use of pre-op CT<sup>[12]</sup>. Thus it is worth investigating whether the scan can serve an additional purpose, specifically, can CT scanning be used in concert with colonoscopy to verify the location of the colon tumor and possibly correct colonoscopic errors?

## MATERIALS AND METHODS

All patients listed in the Cancer Registry at St. Francis Hospital and Medical Center, a tertiary care teaching hospital affiliated with the University of Connecticut School of Medicine, who were diagnosed with colon cancer between January 2004 and May 2006 were reviewed for inclusion in this study. It should be noted that a preoperative CT scan was not routinely performed on all patients. Of the 305 patients who fit this initial criterion, 104 charts contained all of the following data: preoperative colonoscopy report, preoperative CT report, surgical operative report, and tumor pathology report. Only these charts were included in the study. Patients with appendiceal or rectal cancer were excluded from this study.

Tumor location determined by endoscopy and abdominal CT reports were recorded and compared with the exact location stated in the operative report. The operative description was considered the "gold standard". The colon was divided into five segments from the cecum to the sigmoid, corresponding to common surgical resections. The location of the lesions was categorized into one of these areas. The largest measurement of any one dimension of the tumor as reported in the pathology report was used as the size.

All patient information was coded without identifying

data, in compliance with Health Insurance Portability and Accountability Act confidentiality requirements. Institutional Review Board approval was granted by the University of Connecticut Health Center and St. Francis Hospital and Medical Center.

The statistical analyses used include  $\chi^2$  test to compare tumor sizes as well as a student *t*-test to compare tumor locations.

## RESULTS

Between January 2004 and May 2006, 104 patients were diagnosed with colon cancer and met criteria to be included in this study. As shown in Table 1, overall tumor location was accurately determined *via* colonoscopy in 83/104 cases (79.8%) and erroneously in 21/104 (20.2%) of cases. CT scan accurately localized colon tumors in 52/104 (50.0%) of cases, incorrectly localized tumors in 18/104 (17.3%) of cases, and did not detect known tumors in 34/104 (32.7%) of cases. It is noteworthy that of the 21 tumors erroneously located by colonoscopy, 11 were accurately localized by CT scan, thus correcting the colonoscopic error 52.4% of the time.

As shown in Table 2, the average tumor size for all patients in this study was 5.72 (+/- 3.11) cm. The average size tumor properly located by colonoscopy and CT was 5.39 (+/- 3.34) cm and 6.79 (+/- 3.48) cm, respectively and erroneously localized was 7.09 (+/- 1.49) cm and 5.87 (+/- 2.62) cm, respectively. The average size of the tumors not detected by CT was 3.98 (+/- 1.75) cm.

## DISCUSSION

Colonoscopy erroneously localized colon tumors in 20.2% of the cases reviewed, where as CT scan erroneously localized 17.3% of the tumors and failed to detect 32.7% of known tumors. The inaccuracy of tumor localization in our study is in the range cited in the literature (12%-21%). It is well established that colonoscopy is very accurate for localization up to 20 cm from the anal verge. Therefore, it was not surprising to find that colonoscopy accurately identified the location of 100% of tumors in the sigmoid colon.

Tumors correctly localized by colonoscopy were smaller than those erroneously localized. Accurate localization is probably more dependent on knowledge of colonic geography and anatomic landmarks rather than tumor size. As expected, tumors correctly localized by CT scan were larger than those incorrectly localized or not detected. The average tumor size properly localized by CT scan was approximately 1.4 cm larger than that properly localized by colonoscopy.

Different techniques have been used to facilitate the localization of colon tumors at the time of surgery. Tattooing of tumors during colonoscopy will often increase the ease of locating tumors intraoperatively<sup>[13]</sup> particularly for laparoscopic cases. The technique does have limitations. If the ink injection is placed in the

**Table 1** Number and percent (%) of tumors per colon segment that were correctly or incorrectly localized by colonoscopy, and correctly, incorrectly or not localized by CT scan

Surgical location	Colonoscope		CT			Total
	Right	Wrong	Right	Wrong	Not detected	
Cecum	22 (64.7)	12 (35.3)	19 (55.9)	8 (23.5)	7 (20.6)	34
Ascending colon	21 (84.0)	4 (16.0)	12 (48.0)	7 (28.0)	6 (24.0)	25
Transverse	4 (80.0)	1 (20.0)	2 (40.0)	0	3 (60.0)	5
Descending colon	9 (69.2)	4 (30.8)	7 (53.8)	0	6 (46.1)	13
Sigmoid	27 (100.0)	0	12 (44.4)	3 (11.1)	12 (44.4)	27
Total	83	21	52	18	34	104
Percentage (%)	79.80	20.20	50.00	17.30	32.70	

**Table 2** Mean tumor size in centimeters per colon segment (C: correct, I: Incorrect), as detected by colonoscopy or CT scanning

Surgical location	Colonoscope		CT			Mean	Standard deviation
	C: mean size	I: mean size	C: mean size	I: mean size	Not detected		
Cecum	5.67	6.35	7.02	5.29	3.69	5.89	3.23
Ascending colon	6.4	5.75	7.25	6.27	4.43	6.3	3.79
Transverse colon	3.86	6	4.5	0	4.17	4.5	1.85
Descending colon	3.95	10.75	8.76	0	2.22	4.64	2.83
Sigmoid	5.01	0	5.21	6.5	4.44	5.01	1.47
Mean	5.39	7.09	6.79	5.87	3.98	5.72	
Standard deviation	3.34	1.49	3.48	2.62	1.75	3.11	

mesentery and not in four quadrants, the tumor may not be visualized during surgery. In obese patients, exuberant pericolic fat may preclude visualization. The application of clips to polyp sites is another feasible method by which the polyp can be marked preoperatively<sup>[14]</sup>. This method requires the use of intraoperative ultrasound and runs the risk of accidental detachment of the clips. Others have used magnetic endoscopic imaging to guide localization<sup>[15]</sup>. Hand assisted laparoscopy adds the ability to palpate for the tumor.

Errors in preoperative localization of colonic tumors may result in considerable problems. These include improper positioning on the table (supine *vs* lithotomy), the need for intraoperative colonoscopy and the need to convert a laparoscopic resection to an open operation. At worst, such an error could result in resection of the wrong colon segment. Due to variability in surgeon's dictation habits, we were unable to discern the number of operations altered by mislocalization in this study.

The data collected in this study have clear implications for quality improvement in the care of our patients. This data demonstrates that for 100 colon tumor resections, 20 cases would have a tumor in a segment other than what was determined during colonoscopy. If these patients had undergone preoperative CT scanning, 52.4% of these 20 patients (11 patients) would have had the errors corrected. It is possible that there was selection bias towards obtaining preoperative CT scans in patients with larger tumors. This might overestimate the value of preoperative CT scans in correcting colonoscopic errors. However, it is more likely that most CT scans were done to rule out liver metastases. In the future, CT colonography may prove to further improve preoperative

tumor localization. In one recent study, CT colonography correctly localized 94.7% of colon tumors<sup>[11]</sup>.

## CONCLUSION

Colonoscopy should remain the gold standard for localizing colon tumors. Conventional CT scanning alone is not an optimal study for colon tumor localization. Preoperative CT scanning is a beneficial complement to and may be used in concert with colonoscopy for the localization of colon tumors.

## COMMENTS

### Background

In this laparoscopic era, it is more important than ever for surgeons to be aware of the precise location of colon tumors, prior to operation. Errors in colon tumor localization may result in difficulty during the operation. Colonoscopy, while being the gold-standard, is still associated with a significant error rate. This study investigates whether pre-operative computed tomography (CT)-scanning of the abdomen can correct some colonoscopic errors.

### Research frontiers

Colonoscopy and CT scanning are commonly available in most health care organizations. Careful pre-operative review of results of these studies may minimize errors.

### Innovations and breakthroughs

While oncologists and surgeons may utilize pre-operative CT scanning in these cases, it is usually used to rule-out liver metastases. Attention should also be paid to tumor localization. In the future, CT-colonography may further improve localization rates.

### Applications

Pre-operative CT scanning is not routine in patients with colon tumors. While adding this test would add to the cost of care, error prevention results in cost savings and reduces the risk of litigation.

### Terminology

Colonoscopy is a diagnostic test involving the study of the colon mucosa utilizing

a flexible scope. CT scanning is a radiographic study, whereby computers can reconstruct human anatomy. CT-colonography, is a CT-scan study developed to vastly improve the resolution of images of the colon lumen.

### Peer review

This study adds to our knowledge regarding surgery for colon tumors. In this era of increased scrutiny on patient safety, such research designed to minimize errors is timely.

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