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How accurate is preoperative colonoscopic localization of colonic neoplasia?

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Abstract

Introduction Preoperative colonoscopic localization for resection of colonic neoplasia, with or without tattooing for guidance, has been extensively used with variable accuracy. Difficulty in intraoperative identification of the lesion may lead to resection of an incorrect segment or to a more extensive resection than originally planned. The aim of this study was to evaluate the accuracy of preoperative colonoscopy in determining the site of the lesion.

Methods A prospectively collected IRB-approved institutional database was retrospectively queried for all consecutive patients who underwent an elective colon resection for neoplasia between 2013 and 2016. Excluded were patients without preoperative colonoscopy reports available for comparison or who underwent emergency surgery. Surgical plan based on preoperative colonoscopic localization with or without tattooing was compared to the final surgery and pathology reports.

Results 203 patients were included [mean age 68 (35–92) years; 102 males (50.2%)]. Preoperative colonoscopy was inaccurate in 16.7% (34 patients) leading to a change in the surgical plan. Patients with transverse or distal lesions were more likely to have a change in final surgical management compared to proximal sided lesions (29.7% vs. 3.9%, respectively; $p < 0.001$). Only 3.8% of the tattooed lesions could not be identified during surgery. Additional intraoperative colonoscopy was needed in 11 patients (5.5%) to verify exact lesion location. Average length of the resected segment was longer in patients who required a change in surgical plan (26.44 cm vs. 22.47 cm; $p = 0.02$).

Conclusion Inaccurate preoperative colonoscopic localization led to a change in surgical management in 16.7% of cases, especially in transverse or left sided lesions. Surgeons should consider these findings when planning colonic resections.

Keywords Preoperative colonoscopy · Colorectal neoplasia · Localization · Management · Left sided lesions · Colonic resection

Colonoscopy is an essential tool in the colorectal surgeon's armamentarium, not only for screening and diagnostic purposes, but also as a tool for treatment planning. Estimation of tumor site during colonoscopy with or without marking (endoscopic tattooing) as a guide for resection has been extensively used with variable accuracy in precise anatomical identification of the primary lesion of interest [1–3].

Intraoperative identification of lesions previously detected by colonoscopy may be difficult, particularly during laparoscopic surgery where the lack of tactile sensation may prevent adequate primary tumor localization [4]. The absence of intraoperative identification of the primary tumor and inaccurate anatomical site determination by preoperative colonoscopy may lead to more extensive colorectal resections than originally planned or, even worse, resection of a normal segment of colon leaving the primary tumor in situ.

Some studies have shown discrepancies between the intended area of resection and the actual resected segment even after endoscopic tattooing of the primary lesions [5, 6]. Reasons for such discrepancies may include difficult or impossible visualization of the tattooed segment, inconsistency of ink injection, poor injection technique, or even the presence of multiple marked sites [6–8]. These inaccuracies during the surgical procedure may ultimately require an additional intraoperative colonoscopy to evaluate the correct location of the primary tumor, resulting in a significant increase in operative time, staff and equipment requirement, and overall costs.

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The aim of this study was to compare the preoperative colonoscopy reports with the intraoperative findings of patients undergoing elective surgical treatment for colonic neoplasia in an attempt to estimate the rates and identify potential risk factors for significant discrepancies, resulting in changes in the final surgical management.

Patients and methods

Patients who underwent an elective colon resection for colonic neoplasia in a single institution between 2013 and 2016 were retrospectively reviewed from a prospectively collected database after Institutional Review Board approval.

All consecutive patients undergoing surgical resection (open or laparoscopic) for colon neoplasia were eligible for the study, provided there was a preoperative colonoscopy available for review. In the absence of a preoperative colonoscopy, patients were excluded from the study. Patients with rectal lesions, defined as located within 15 cm from the anal verge by endoscopic examination, were also excluded from the study.

Colonoscopy information

Data obtained from preoperative endoscopic/colonoscopic reports were compared to intraoperative location and final pathological findings in an attempt to find predictive factors for the presence of any discrepancy in tumor location, leading to a change in the originally planned surgical procedure.

Possible sites of the primary lesion were divided into proximal (cecum to hepatic flexure), transverse, and left (from splenic flexure to rectosigmoid junction) for comparison purposes, based on operative notes and reported endoscopic findings. In cases of multiple preoperative colonoscopies, only the one prior to surgical resection was used as reference in each patient. In cases where more than one lesion was identified during colonoscopy, only the lesion that required surgical resection was analyzed as reference. A complete colonoscopy was considered when cecal intubation was achieved, defined as passage of the scope beyond the ileocecal valve into the cecal pole or terminal ileum [9]. The decision for tattooing and its specific technical details were left at the discretion of the endoscopist.

Surgical procedure

The planned surgical procedure was obtained from informed consent notes prior to the date of the planned surgery. In cases where the informed consent was unavailable, the surgeon's notes were reviewed to determine the intended surgical procedure. Operative notes were used to define the final location of the neoplasms. Differences in location between preoperative and intraoperative findings were considered as a discrepancy if a change in the final surgical approach was needed. The need for an extended surgical approach was defined as the inclusion of one or more colonic segments within the resected specimen compared to the originally planned surgical strategy. The decision for intraoperative colonoscopy was left at the discretion of the surgeon.

Pathology reports were reviewed for all patients. The length of surgical specimen was routinely measured and obtained from final pathology report.

Statistical analysis

Patients were compared according to the presence of discrepancy in preoperative and intraoperative tumor location leading to any change in the surgical plan. Univariate analysis was performed to identify factors associated with change in the surgical plan. Categorical variables were compared using χ^2 and Fisher exact tests, when appropriate, whereas for numerical variables, the student t test was used. Multivariate analysis using Cox's logistic regression including variables identified to be significant ($p \leq 0.05$) at univariate analysis. A p value of less than 0.05 was considered statistically significant.

Results

During the study period, 203 patients [mean age 68 (35–92 years); 102 (50.2% males)] with available preoperative colonoscopic localization and subsequent colonic resection were reviewed. The majority of the lesions were malignant (70%; T1:12%, T2: 33%, T3: 66%, T4: 26%) and 30% were benign. The surgical approach was laparoscopic in 87.2% (177) and open in 12.8% (26) of cases.

Preoperative colonoscopy & tattooing

Table 1 shows preoperative colonoscopic findings and tattooing details. A total of 114 (56.2%) patients had their colonoscopy performed at our institution and a gastroenterologist (instead of a surgeon) performed 145 (71.4%) of all the procedures. The majority of lesions were right-sided (proximal location) and most of the patients (87.7%) had a complete colonoscopy. One hundred thirty-one (64.5%) were endoscopically tattooed in order to facilitate intraoperative identification of the lesion. Among patients undergoing preoperative endoscopic tattooing, the tattoo could not be identified intraoperatively in 3.8%. Additional intraoperative colonoscopy was needed in 11 patients (5.5%) to verify definitive lesion location due to the inability to identify the primary lesion, all during the laparoscopic approach.

Table 1 Preoperative colonoscopy and tattooing characteristics

Variable	No. (%) ($n=203$)
Complete colonoscopy	178 (87.7)
Colonoscopic lesion location	
Proximal	102 (50.2)
Transverse	22 (10.8)
Distal	79 (39)
Colonoscopy performed by	
Colorectal surgeon	58 (28.6)
Gastroenterologist	145 (71.4)
Colonoscopy performed at	
Our institution	114 (56.2%)
Outside institution	89 (43.8%)
Tattoo during procedure	
Yes	131 (64.5)
No	72 (35.5)
Tattooing agent	
India Ink	103 (78.6)
Spot	10 (7.6)
Non-specified	18 (13.8)
Tattooing technique	
1 quadrant	7 (5.3)
2 quadrants	–
3 quadrants	11 (8.4)
4 quadrants	3 (2.3)
Non-specified	110 (84)
Tattooing location	
Proximal to lesion	11 (8.4)
Distal to lesion	32 (24.4)
Non-specified	88 (67.2)

Discrepancies between preoperative and intraoperative findings

There was a discrepancy between pre- and intraoperative location of the primary lesion in 34 (16.7%) patients, leading to a change in the final surgical procedure (Tables 2, 3). Ultimately, more than half of the patients (19/34; 55.9%) who had a significant discrepancy underwent a more extensive resection than originally planned. Nearly a third of these patients (12 patients; 35.3%) underwent a completely different resection than originally planned. In 4 patients, the resection was more distal requiring TME, one with ileostomy. Overall, the average length of the resected segment was longer in patients who required any change in the surgical plan (26.44 cm vs. 22.47 cm, respectively; $p=0.02$) (Table 3).

Patients with transverse and distal lesions were more likely to have a significant discrepancy compared to proximal-sided lesions (29.7% vs. 3.9%; $p<0.001$). In addition, patients undergoing preoperative tattooing were more likely to have a discrepancy between colonoscopic description of localization of the lesion and the operative findings (22.9 vs. 5.5%; $p<0.001$). However, multivariate analysis showed that only transverse/distal location remained a statistically significant independent predictor for change in a significant discrepancy in primary lesion location, leading to a change in the surgical management ($p<0.001$) (Tables 4, 5).

Table 2 Discrepancies between preoperative colonoscopic and intraoperative findings

Location based on colonoscopy	Actual location	No.
Right colon (n-3)	Hepatic flexure	1
	Transverse	1
	Sigmoid	1
Hepatic flexure ($n=1$)	Transverse	1
Transverse ($n=8$)	Right colon	3
	Hepatic flexure	1
	Splenic flexure	2
	Left colon	1
	Sigmoid	1
Splenic flexure ($n=8$)	Cecum	1
	Hepatic flexure	1
	Transverse	4
	Sigmoid	2
Left colon ($n=5$)	Transverse	4
	Splenic flexure	1
Sigmoid colon ($n=9$)	Transverse	1
	Splenic flexure	3
	Left colon	1
	Rectum	4

Discussion

Colonoscopy is a crucial tool in the surgical treatment plan of patients with colonic tumors. Accurate preoperative identification of the primary tumor site may allow for safe segmental colonic resection, even during minimally invasive approaches with inherent absence of tactile/palpation sensation. Frequently, however, discrepancies between colonoscopic estimation and the actual tumor site may lead to changes in the planned surgical procedure. This may result in significant clinical consequences, including the need for intraoperative colonoscopy, inappropriate oncological surgical resection margins, or even removal of an unaffected segment of large bowel leaving diseased bowel in situ. Ultimately, failure to accurately identify primary disease location will almost inevitably result in increased operative time and operating room-related costs.

Our study shows that 17% of patients undergoing elective segmental colectomy had a change in their planned approach

Table 3 Change in surgical procedure

Planned surgery	Final procedure	No.
Right hemicolectomy ($n=6$)	Extended right colectomy (+)	5
	Sigmoid colectomy	1
Extended right colectomy ($n=3$)	Right hemicolectomy	2
	Transverse colectomy	1
Transverse colectomy ($n=2$)	Left hemicolectomy	2
Left hemicolectomy ($n=13$)	Right hemicolectomy	2
	Extended right colectomy (+)	4
	Transverse colectomy	3
	Sigmoid colectomy	3
	Subtotal colectomy	1
Sigmoid colectomy ($n=9$)	Transverse colectomy	2
	Left hemicolectomy	3
	Anterior Resection*	3
	Total mesorectal excision + ileostomy*	1
Subtotal colectomy ($n=1$)	Extended right colectomy	1

+ Represents extended right colectomy: includes cecum, right colon, hepatic flexure, and proximal transverse

*Four patients with colonoscopic diagnosis of sigmoid lesions and final diagnosis of rectal tumor

Table 4 Comparison between nonconcordant and concordant lesions groups

	No change ($N=168$)		Change ($N=34$)		p Value
	N	Statistics	n	Statistics	
Anatomical site	168		34		<0.001[c]
Proximal		97 (96.0)		4 (4.0)	
Transverse		14 (63.6)		8 (36.4)	
Distal		57 (72.2)		22 (27.8)	
Right vs transverse + distal	168	97 (96.0)	34	4 (4.0)	<0.001[c]
		71 (70.3)		30 (29.7)	
Tattoo	168		34		0.002[c]
Yes		101 (77.1)		30 (22.9)	
No		67 (94.4)		4 (5.6)	
Colonoscopy complete	168		34		0.98[c]
Yes		148 (83.1)		30 (16.9)	
No		20 (83.3)		4 (16.7)	
Operator	168		34		0.46[c]
Gastroenterologist		118 (81.9)		26 (18.1)	
Colorectal surgeon		50 (86.2)		8 (13.8)	
Pathology	168		34		0.080[c]
Cancer		55 (90.2)		6 (9.8)	
Benign		113 (80.1)		28 (19.9)	
Type of surgery	165		33		0.85[c]
Laparoscopy		143 (83.1)		29 (16.9)	
Open		22 (84.6)		4 (15.4)	
Size of specimen (cm)	165	23.8 ± 13.4	34	26.4 ± 13.9	0.30[a]

Statistics presented as mean ± SD or N (row %); p Values: a = ANOVA, or c = Pearson's Chi square test

Table 5 Multivariate analysis

Effect	Odds ratio (95% CI)	p Value
Anatomical site		<0.001
Proximal	1.00 (REF)	
Transverse	10.4 (2.7, 40.2)	
Distal	7.6 (2.5, 23.5)	
Tattoo	0.33 (0.11, 1.04)	0.059

due to discrepancies between the preoperative (endoscopic) and actual primary tumor location. These changes in surgical management more frequently resulted in a more extensive surgical resection and even completely different (than planned) segmental resections.

Similar rates of discrepancies have been previously reported, although this has not always resulted in a change in the originally planned surgical procedure [10–14]. A few studies have even reported superior outcomes of accurate preoperative endoscopic primary tumor location. In a series of 374 patients over a period of 17 years, Saleh et al. [13] reported 96% accuracy when preoperative colonoscopy was performed by a single observer who was also the single primary surgeon performing all procedures. However, as impressive as these results may be, one could argue that this would likely be impossible in a high-volume center. One interesting study reported that patients undergoing repeat endoscopy for surgical planning by the operating surgeon was associated with a lower risk for any discrepancy in the anatomical primary tumor site ($p=0.04$) [13]. In our series, the inclusion of

patients undergoing preoperative colonoscopy at multiple institutions and by endoscopists with variable expertise may have contributed to the slightly inferior accuracy in precise tumor site estimation [15]. Interestingly, one prospective study reported a perfect (100%) accuracy rate in a 4-step protocol to identify the location of the primary lesion. This included conventional colonoscopy, followed by CT scan endoscopic clip placement, followed by abdominal radiograph, and finally intraoperative colonoscopy. Conversely, when only conventional colonoscopy was considered, the overall accuracy was reduced to 87%, which is very similar to our findings.

Another feature that may have influenced accuracy of preoperative colonoscopy in previously reported studies is the inclusion of primary rectal lesions. Additional staging modalities frequently used for primary rectal cancer staging such as digital rectal examination, proctoscopy, and even magnetic resonance imaging (MRI) may further influence accuracy and confirm the exact site of primary tumor location. In fact, in all previous studies, at least 40% of lesions were primary rectal tumors and reported accuracy for these lesions was (as expected) 100%. For these reasons, we decided to exclude primary rectal lesions and ultimately decreased overall accuracy of preoperative colonoscopy tumor site estimation.

Identification of risk factors for anatomical discrepancies and ultimate change in surgical management may be useful in clinical practice. High-risk patients may require additional preoperative diagnostic tools or even anticipation for the need of intraoperative colonoscopy. In our series, patients with transverse and distal lesions were more likely to have a change in their surgical plan due to anatomical discrepancies ($p < 0.001$). Distal tumor location was the only independent risk factor for anatomical discrepancies. Although this was the most common anatomic location in the majority of studies, only one found left-side lesions to be a risk factor of inaccurate tumor location ($p = 0.012$) [13].

Our study has several limitations. First, not all patients undergoing elective colorectal resection had a preoperative endoscopic report available for review. Second, considering the retrospective nature of our study, it becomes impossible to rule out inherent selection bias. Ultimately, more experienced surgeons may have anticipated the need for more extensive surgery (and included in consent/notes) more frequently than junior surgeons. Regardless, the nearly 17% of discrepancies requiring change in management remains quite significant. Also, inclusion of colonoscopy reports from multiple observers with variable expertise and different institutions may also have been a source of bias. Conversely, this may also have reflected "real-world" practice data.

Conclusion

Preoperative colonoscopy correctly identifies the site of primary colonic lesions in 83% of patients. In 17%, there is a change in the planned surgical resection due to discrepancies between preoperative colonoscopy and intraoperative findings. More frequently, this will lead to more extensive resections and an increased length of the surgical specimen. Left-sided lesions are more likely to need a change in final surgical management and should be considered for routine endoscopic tattooing in order to avoid the need for intraoperative colonoscopy and ultimate change in the final surgical management.

Compliance with ethical standards

Disclosures Laura Fernandez, Rowaa Ibrahim, Ido Mizrahi, Giovanna Dasilva, and Steven D. Wexner have no relevant conflicts of interest or financial ties to disclose.

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