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Preoperative re-endoscopy in colorectal cancer patients: an institutional experience and analysis of influencing factors

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Abstract
Background This study serves to establish the re-endoscopy rate in patients undergoing surgery for colorectal cancer (CRC) at a tertiary academic center and to identify significant factors that may influence the decision for preoperative re-endoscopy.
Methods A retrospective review of 341 consecutive patients undergoing elective surgical resection for CRC was performed from January 2008 to December 2011. Descriptive statistics were used to define the patient population and to establish the institutional re-endoscopy rate. In order to identify factors associated with re-endoscopy, univariate and multivariate analysis was performed using the chi square test and logistic regression modeling.
Results Patients within the two comparison groups had similar demographic profiles. Excluding patients where the primary endoscopist was the operating surgeon, 121 of 299 patients (40.5 %) underwent re-endoscopy. The most common reasons for re-endoscopy included tattooing of the lesion in 55 patients (45.5 %), surgical planning in 43 (35.5 %), and repeated therapeutic attempts in 11 (9 %). Significant factors associated with re-endoscopy included left-sided colon cancers (compared to right-sided lesions, $P < 0.001$), planned laparoscopic procedures ($P = 0.011$), and the absence of a tattoo on the first colonoscopy ($P = 0.010$). There was also a trend toward a reduction in re-endoscopy if the operating surgeon was consulted at the time of the initial endoscopy ($P = 0.085$). There was a clear trend toward increased laparoscopic procedures over the duration of the study ($P < 0.001$). Although this did not correlate with an increase in re-endoscopy, it did coincide with a significant increase in preoperative tattooing at the first colonoscopy ($P < 0.001$).
Conclusions The repeat preoperative endoscopy rate in CRC patients was 40.5 %. Re-endoscopy was associated with an initial failure to tattoo the lesion, left-sided colonic neoplasms, and a planned laparoscopic resection. Further research is needed to help identify which patients would benefit from re-endoscopy and where this may be safely omitted.

Keywords General < endoscopy · Colorectal < cancer · Repeat endoscopy · Tattoo localization

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During 2012, the American Cancer Society estimated 103,170 cases of colon cancer and 40,290 cases of rectal cancer, resulting in 51,690 total deaths [1]. Colonoscopy remains the gold standard in surveillance, as well as the diagnosis and localization of colorectal lesions. However, colonoscopic tumor localization has its limitations with a reported error rate of 14 % [2]. Therefore, preoperative re-endoscopy has been perceived as an integral component in surgical planning, particularly when the operating surgeon did not perform the initial colonoscopy. Although

commonplace, repetition of this procedure is associated with an average cost ranging from $352 to $467 [3]; discomfort to the patient; and an estimated 0.08 % risk of colonic perforation [4].

With a shift in practice from open to laparoscopic colon resections, preoperative localization is essential in avoiding surgical errors, preventing conversion to open procedures to identify the tumor, and reducing the rate of intraoperative colonoscopy. Certain interventions, such as colonoscopic tattooing, are considered to be standard practice with regard to preoperative tumor localization [5], particularly in the laparoscopic era.

There is a paucity of evidence in the literature regarding the indications for re-endoscopy in the preoperative setting, and the actual rate of this practice is not well established. Our primary objectives were to establish the re-endoscopy rate in patients undergoing elective surgery for colorectal cancer (CRC) at a tertiary academic center and to identify significant factors that may influence the decision for preoperative re-endoscopy. Our secondary objective was to evaluate the change in the proportion of laparoscopic colectomies over the study period and its relationship to both endoscopic tattooing and re-endoscopy rates.

Methods

A retrospective cohort study was performed on 341 consecutive patients undergoing elective surgical resection for CRC diagnosed on colonoscopy between January 2008 and December 2011. All patients were treated at the University Health Network which is comprised four teaching hospitals affiliated with the University of Toronto. Patients undergoing emergency resection, palliative diversion, or surgery for anal cancer were not included. Patients were excluded from the analysis if the surgeon performing the elective resection was the initial endoscopist. Our institutional Research Ethics Board approved the study protocol.

Data on baseline patient characteristics and the surgical procedure performed were collected on all patients. Charts were reviewed with attention drawn to both the initial as well as the repeated (when performed) colonoscopy reports. Preoperative localization of lesions was documented, as well as whether or not the lesion was tattooed, the completeness of the procedure (defined as visualization of the ileocecal valve and appendiceal orifice), whether a general surgeon was called for intraoperative consultation during the primary colonoscopy, and the indication for re-endoscopy. Data were also collected on the primary colonoscopist, which included the colonoscopist's specialty (general surgeon vs gastroenterologist) and whether they were from within the institution or an external, non-academic referral center. In addition, we ascertained the years of experience of the endoscopist based on the time from completion of specialty training. While data on endoscopy characteristics were primarily extracted from endoscopy reports, because reporting was not uniform, patients' electronic medical records were also used to collect relevant data. Missing data were uncommon and are reported where relevant.

Descriptive statistics were used to define the patient population and to establish our institutional re-endoscopy rate. While the initial endoscopy was a colonoscopy in all

Table 1 Patient demographics and primary endoscopy characteristics

Variable	No. (%)[d]
Mean age (±SD)	64.7 (SD 12.5)
Male	163 (54.5)
Site of primary colonoscopy[a]	
External institution	128 (44.7)
Internal institution	158 (55.2)
Colonoscopist specialty[b]	
General surgeon	105 (36.6)
Gastroenterologist	180 (63.4)
Operating surgeon consulted on primary colonoscopy	25 (8.4)
Colonoscopist experience[c]	
≤5 years	34 (12.2)
6–15 years	56 (20.1)
16–25 years	91 (32.7)
≥26 years	97 (34.9)
Previous colon resection	7 (2.3)
Location of lesion on primary colonoscopy	
Rectum	63 (21.1)
Left colon	108 (36.1)
Transverse colon	10 (3.3)
Right colon	118 (39.5)
Tattoo on primary colonoscopy	64 (21.4)
Complete primary colonoscopy achieved	236 (85.5)
Planned laparoscopic surgery	188 (62.9)
Abdominoperineal resection	10 (3.3)
Anterior resection	102 (34.1)
Sigmoid colectomy	19 (6.6)
Left hemicolectomy	32 (10.7)
Transverse colectomy	1 (0.3)
Right hemicolectomy	128 (42.8)
Subtotal colectomy	5 (1.7)
Total proctocolectomy	2 (0.7)

[a] Missing data on 13 patients

[b] Of colonoscopists performing primary colonoscopy, missing data on 15 patients

[c] Missing data on 21 patients

[d] Unless otherwise specified as mean (±standard deviation)

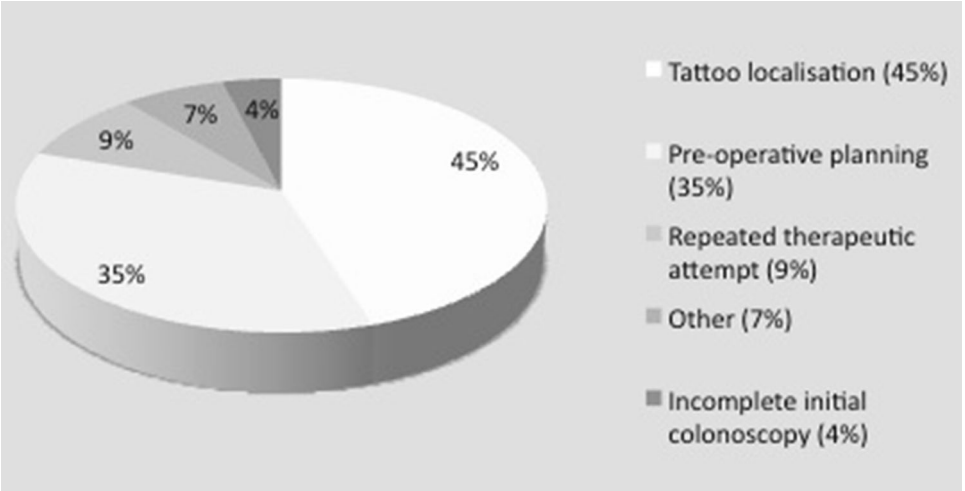

Fig. 1 Indications for re-endoscopy ($N = 121$)

patients, preoperative re-endoscopy was defined as either a colonoscopy or flexible sigmoidoscopy. In order to identify factors associated with re-endoscopy, a univariate analysis was performed using the Chi square test to compare categorical variables and the student *t* test to compare continuous variables. Multivariate logistic regression analysis was used to identify independent predictors of re-endoscopy. Variables thought to be relevant to re-endoscopy were included in the model using a step-wise elimination (cut-off $P < 0.25$). Statistical significance was set at $P < 0.05$. In addition, a test for trend over the study period was performed for proportion of laparoscopic colectomies, the tattoo rate during initial endoscopy, and re-endoscopy rates. All statistical analyses were performed using Stata/IC (version 12.1, Statacorp, College Station, Texas).

Results

341 Patients underwent elective surgical resection for CRC detected by colonoscopy during the study period. After the exclusion of 42 patients who underwent initial colonoscopy by the operating surgeon, 299 patients were included in the analysis. There were a total of 23 patients who had data missing on one or more variables. These patients were not excluded and are identified where relevant in the accompanying tables. There were no significant complications associated with either the initial or repeated endoscopic examination during the study period.

Patient demographic and endoscopic characteristics are detailed in Table 1. The mean age of our patient population was 64.7 (SD 12.5) and included 163 (54.5 %) males. 236 (85.5 %) primary colonoscopies were complete examinations, with detailed description of the ileocecal valve and appendiceal orifice. 128 (44.7 %) of the initial colonoscopies were performed at external referral institutions. 180 (63.4 %) were performed by gastroenterologists.

Of the 299 patients included, 121 (40.5 %) patients underwent a repeat preoperative endoscopic examination. All but one patient had a repeat endoscopy by the operating surgeon. 53 (43.8 %) of these were colonoscopies and 68 (56.2 %) were flexible sigmoidoscopies. 64 patients had rectal lesions, of whom 34 (53.1 %) underwent re-endoscopy. The primary indications for re-endoscopy were lesional localization by means of tattooing ($N = 55$, 45.5 %), surgical planning ($N = 43$, 35.5 %), and repeated therapeutic attempts for polypectomy ($N = 11$, 9.0 %) (Fig. 1). A total of 118 patients underwent lesional tattooing for tumor localization: 64 (52.9 %) underwent tattooing on the primary colonoscopy; and 54 (44.6 %) underwent tattooing on the repeat endoscopy.

Potential predictors of re-endoscopy identified using univariate analysis are listed in Table 2. Patients who underwent an initial colonoscopy at the study institution were less likely to have a re-endoscopy (40.4 %) when compared to external non-academic centers (57.9 %) (OR 0.36; 95 % CI 0.22–0.61; $P < 0.001$). Patients who underwent their initial colonoscopy by a general surgeon were also more likely to undergo a re-endoscopy in comparison to those who had their colonoscopy performed by a gastroenterologist (OR 2.76; 95 % CI 1.62–4.69; $P < 0.001$). There was a trend toward re-endoscopy in patients with anticipated laparoscopic resections (OR 1.74; 95 % CI 0.91–3.42; $P = 0.074$).

Lesional tattooing on the primary colonoscopy was protective against re-endoscopy (OR 0.37; 95 % CI 0.18–0.72; $P = 0.001$). As previously mentioned, tattooing was the most common reason for re-endoscopy. Patients with left-sided colonic lesions (defined as lesions from the splenic flexure to the recto-sigmoid junction) were more likely to undergo re-endoscopy compared to right-sided lesions (from the ileocecal valve to the hepatic flexure) (OR 2.83; CI 1.61–4.95; $P < 0.001$). Surgical consultation

Table 2 Univariate analysis

Variable	No Re-endoscopy[a]	Re-endoscopy[a]	Unadjusted OR (95 % CI)	*P* value
N (%)	178 (59.5)	121 (40.5)	–	–
Mean age (±SD)	64.9 (±12.6)	64.37 (±12.4)	–	0.778
Male	97 (54.5)	66 (54.6)	1.00 (0.61–1.64)	0.993
Site of primary colonoscopy				
External institution	60 (34.9)	68 (59.7)	0.36 (0.22–0.61)	<0.001
Internal institution	112 (65.1)	46 (40.4)	–	–
Colonoscopist specialty				
Gastroenterologist	125 (72.7)	55 (49.1)	2.76 (1.62–4.69)	<0.001
General surgeon	47 (27.3)	57 (50.9)		
Planned laparoscopic surgery (all patients)	108 (60.7)	80 (66.1)	1.26 (0.76–2.11)	0.339
Planned laparoscopic surgery (excluding rectum)	100 (67.6)	69 (78.4)	1.74 (0.91–3.42)	0.074
Tattoo on primary colonoscopy	49 (27.5 %)	15 (12.4 %)	0.37 (0.18–0.73)	0.002
Location of lesion				
Right colon	88 (49.4)	30 (24.8)	1.00	–
Transverse colon	5 (2.8)	5 (4.1)	2.93 (0.79–10.83)	0.107
Left colon	55 (30.9)	53 (43.8)	2.83 (1.61–4.95)	<0.001
Rectum	30 (16.6)	33 (27.3)	3.23 (1.69–6.15)	<0.001
Operating surgeon consulted on primary colonoscopy[b]	22 (19.6)	3 (6.5)	0.29 (0.005–1.04)	0.053
Complete primary colonoscopy achieved	139 (83.2)	97 (89.0)	1.63 (0.76–3.69)	0.184
Colonoscopist experience				
≤5 years	24 (14.12)	10 (9.26)	1.00	–
6–15 years	40 (23.53)	16 (14.81)	0.96 (0.38–2.45)	0.932
15–25 years	55 (32.35)	36 (33.33)	1.57 (0.67–3.67)	0.297
≥26 years	51 (30)	46 (42.59)	2.16 (0.94–5.01)	0.071
Previous colon resection	3 (1.69)	4 (3.31)	1.99 (0.33–13.83)	0.363

CI confidence interval, *OR* odds ratio

[a] Represents number (%) unless otherwise specified

[b] For internal referrals only

Table 3 Multivariate analysis: Re-endoscopy

Covariate	OR	95 % CI	*P* value
Colonoscopist experience[a]	1.02	1.00–1.04	0.099
Operating surgeon consulted on primary colonoscopy	0.32	0.08–1.17	0.085
Planned laparoscopic surgery	2.26	1.21–4.24	0.011
General surgeon as primary endoscopist	1.48	0.81–2.73	0.206
Lesion tattooed on primary colonoscopy	0.36	0.16–0.78	0.010
Lesion location (controlling for right-sided lesions)			
Transverse colon	3.34	0.67–16.69	0.141
Left colon	3.29	1.75–6.19	<0.001
Rectum	4.12	1.86–9.15	<0.001

Multivariate analysis, $N = 276$ (excluding patients with missing variables listed in Table 1 footnote)

OR odds ratio, *CI* Confidence interval

[a] Continuous

at the time of primary colonoscopy to assist in localization was protective against re-endoscopy (OR 0.29; CI 0.005–1.04; $P = 0.053$). No statistically significant difference was found in patients who had undergone a previous colon resection ($P = 0.363$). The number of years of experience of the endoscopist showed an inverse relationship with re-endoscopy; that is, more years of clinical experience resulted in a higher re-endoscopy rate. However, this relationship was not statistically significant.

Results from the multivariate analysis are displayed in Table 3. Lesional tattooing at initial endoscopy (OR 0.36; 95 % CI 0.16–0.788; $P = 0.010$), as well as surgical consultation during initial colonoscopy (OR 0.32; 95 % CI 0.08–1.17; $P = 0.085$), were both protective against re-endoscopy. Statistically significant factors predictive of repeating endoscopy included left-sided colonic lesions as well as anticipated laparoscopic resection. Endoscopist experience and specialty were entered into the model, but neither were statistically significant ($P > 0.05$).

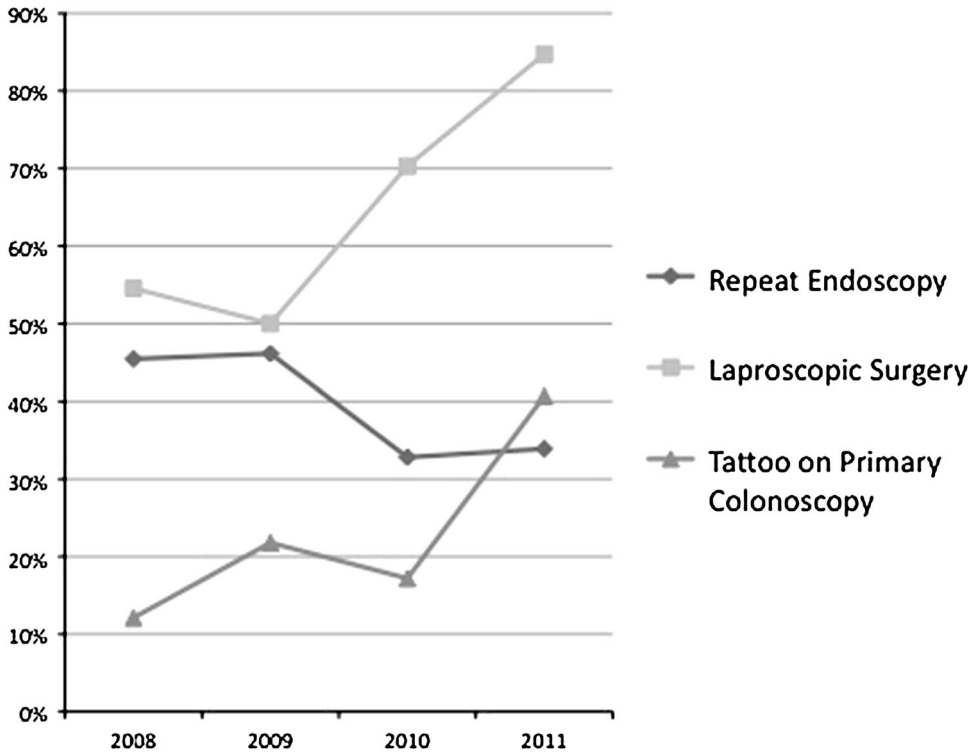

Fig. 2 Rates of re-endoscopy, tattooing, and laparoscopic surgery among patients undergoing resection for CRC. Test for trend over time significant ($P < 0.05$)

Interestingly, the referring center (internal vs external to our institution) for the initial endoscopy, though significant in the univariate analysis, lost significance and did not fulfill criteria to get included in the multivariable model based on our established cut-off value.

Over the 4-year study period, there was a significant increase in the proportion of laparoscopic colon resections at our institution, from 55 % in 2008 to 85 % by 2011 ($P < 0.001$). This did not correspond to an increase in re-endoscopy rates, which, in fact, decreased over the study period ($P = 0.062$). It did, however, correspond to an increase in preoperative lesional tattooing on the initial endoscopic examination ($P < 0.001$) (Fig. 2).

Discussion

This study establishes that the rate of preoperative re-endoscopy at a tertiary academic center is 40.5 %. Left-sided lesions, planned laparoscopic procedures, and failure to tattoo the lesions on the primary colonoscopy, were all associated with a statistically significant increase in the rate of re-endoscopy on multivariate analysis. Given the paucity of the available literature on this topic, these findings provide insight into current practice patterns and highlight the role of re-endoscopy in the management of CRC. Colonoscopic surveillance has led to the detection of earlier and smaller CRCs, as well as pre-cancerous lesions such as endoscopically non-resectable adenomas and serrated polyps. The general trend toward laparoscopic resection means that the ability to manually palpate even larger lesions is hindered. This practice change further increases the necessity for the assimilation of localization techniques into the repertoire of routine surveillance colonoscopy to prevent intraoperative error and unnecessary re-endoscopy.

Piscatelli et al. [6] revealed an error rate of 21 % (11 % of patients requiring a different procedure than initially anticipated) in a 2005 study evaluating the reliability of colonoscopic tumor localization. When comparing this to a similar study establishing the accuracy of colonoscopic localization by Vignati et al. [2] in 1984, which reported an error rate of 14 %, there has been little improvement over the last two decades in tumor localization. Although our study was not meant to establish the accuracy of colonoscopy in tumor localization, this remains the premise driving repeat endoscopic examinations in most patients within our dataset and thus requires specific attention. In analyzing the rate of tattoo localization, Conaghan et al. [7] described a reduced rate of right-sided lesions being tattooed without a significant increase in localization error. Kim et al. [8] also concluded that reliable preoperative identification of a tumor adjacent to the ileocecal valve might permit a right hemicolectomy without tattoo localization. Our study demonstrated that 30 (24.8 %) patients with right-sided lesions underwent a repeat endoscopic examination which was significantly lower than patients

with left-sided lesions on multivariate analysis (OR 3.28; 95 % CI 1.75–6.19; $P < 0.001$). Although error may occur, documentation of ileocecal valve visualization and photographic evidence could potentially decrease this rate even further [8].

The need for accurate preoperative localization is of particular importance when laparoscopic colonic resection is planned. Accurate localization may decrease the incidence of surgical error (e.g., resecting the wrong colonic segment), intraoperative colonoscopy, and conversion to a standard laparotomy. Tattoo localization has been advocated as the standard technique for preoperative tumor localization for non-palpable CRCs and polyps [9, 10]. In particular, tattoo localization has demonstrated utility in the laparoscopic era, and studies have shown a high rate of accuracy with a low rate of complications [5, 7, 8]. Our data support this, with a lower rate of re-endoscopy in the 64 (21.4 %) patients with preoperative tattoo localization at the time of their primary colonoscopy (OR 0.36; CI 0.16–0.78; $P = 0.010$ on multivariate analysis). Furthermore, our results demonstrate that 44 (55 %) patients with planned laparoscopic resection underwent tattoo localization on their second endoscopy compared to 10 (23.81 %) patients designated for open surgery ($P < 0.001$). These findings suggest that re-endoscopy may be safely omitted in select patients undergoing laparoscopic resection if the lesion was tattooed at the time of initial diagnosis.

Our data reflect the growing shift toward a laparoscopic approach in the management of CRC that occurred over the study period. From 2008 to 2011, there was an increase in the proportion of laparoscopic procedures performed. This did not correlate with an increase in the number of preoperative repeat endoscopies performed, as originally anticipated. It did, however, correlate with a statistically significant ($P < 0.001$) increase in the number of lesions tattooed during the primary endoscopic examination. Given that lesional tattooing as a means of tumor localization was the most common reason for repeat endoscopic examination in this study, the decrease in repeat endoscopies over time likely reflects a growing awareness of the importance and utility of tattooing both at our institution as well as referring centers.

Patients referred from independent, non-academic institutions, mainly colonoscopic surveillance clinics, were more likely to undergo repeat endoscopic examination (OR 0.36; 95 % CI 0.22–0.61; $P < 0.001$). Although this likely represents a local phenomenon specific to our institution, the factors associated with this finding may have broader practice-associated implications. Specifically, the higher rate of re-endoscopy may be related to a lack of standardization in the presentation of operative findings, reflecting challenges with communication between the endoscopist and surgeon. In circumstances in which the operating surgeon was consulted at the time of endoscopy, there was a substantial trend toward a reduction in the likelihood of re-endoscopy ($P = 0.085$). This finding further affirms the importance of communication and highlights the need for standardization in endoscopic reports.

A majority of colonoscopists at these outside institutions were general surgeons. This corresponds with our finding of an increased incidence of re-endoscopy in patients whose primary colonoscopy was performed by a general surgeon (OR 2.76; 95 % CI 1.62–4.69; $P < 0.001$). Piscatelli et al. [6] found that colonoscopy performed by surgeons was, in fact, protective against localization error. Our study does not contradict this as colonoscopies performed by the operating surgeon were excluded from the analysis.

Rectal lesions represent a unique subgroup within the study cohort as surgeon-specific practices significantly influenced the primary and secondary outcomes of interest. For example, some surgeons within our institution routinely perform flexible sigmoidoscopy (either preoperatively or at the time of surgery) on all patients with diagnosed rectal cancer regardless of the quality of the primary colonoscopy or the lesional localization techniques employed. Overall, the repeat endoscopy rate for rectal lesions was 53 %. Keller et al. [11] advocated for tattoo localization in all rectal polyps considering a 5–8 % chance of these lesions harboring occult malignancy. This was not substantiated in other studies [8, 12] where the authors felt that this could be safely omitted. Further studies are needed to elucidate the role of localization techniques to increase the accuracy of colonoscopy in rectal lesions.

In conclusion, we have found that preoperative re-endoscopy for CRC is common, and the rate of repeat endoscopic examination is higher in patients with left-sided lesions and patients undergoing laparoscopic colonic resection. Tattoo localization was protective against repeat endoscopic examination. Additionally, communication with the operating surgeon appears to be crucial to the decision for re-endoscopy. Further research is needed to assess the quality of reporting on the re-endoscopy rate and whether standardized records could potentially obviate the need for re-endoscopy in certain circumstances.

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