

# Preoperative Localization of Colorectal Tumors with Endoscopic Tattooing for Laparoscopic Surgery

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## Abstract

**Background:** Effective localization of colorectal tumors with a visible marker is necessary for adequate resection in laparoscopic surgery. Tattooing of these tumors by endoscopy is a widely utilized method for proper localization.

**Methods:** A retrospective study of 50 patients who underwent tattooing with colonoscopy prior to colorectal surgery over a 12-year period was conducted. One patient was excluded from analysis due to incomplete data. Tattooing was performed using SPOT endoscopic marker (GI Supply, Camp Hill, PA), which is a prepackaged biocompatible agent containing highly purified, very fine carbon particles.

**Results:** 49 patients received endoscopic tattooing with colonoscopy. Of these 49 patients, 37 patients had tattooing identified in either surgery and/or surgical pathology specimens. 12 lesions were not identified on both surgery and pathology. No tattoo related complications were noted. There were no conversions from laparoscopic to open surgical resection due to poorly visualized tattooed lesions. No patients underwent intra-operative colonoscopy to confirm accurate tattoo placement.

**Conclusions:** All colonic lesions that appear to be malignant should be tattooed during endoscopy to improve surgical localization. Tattoo endoscopy is a safe and effective method for preoperative tumor localization.

**Keywords:** Colorectal cancer; Colorectal tattooing; Laparoscopic surgery

## Introduction

Colorectal cancer is the second leading cause of cancer-related deaths in the United States and the third most common cancer in men and women. Survival has significantly increased due to early diagnosis, adjuvant therapies, and better outcomes with surgical resection. Laparoscopic surgery has shown a decrease in peri-operative complications and has led to more rapid recovery postoperatively [1].

Localization of colorectal tumors during laparoscopic surgery can be difficult due to the lack of palpation of these tumors, the small size of some lesions, and inability to locate a previous polypectomy site. Unlike open laparotomy, the surgeon cannot palpate the bowel during laparoscopic surgery. Thus, effective localization of these tumors with a visible marker is necessary for adequate resection. Without precise preoperative localization, there is an increased risk for conversion to open surgery to find the lesion.

Saunty and Knudtson first described colorectal tattooing with the use of blue dye to track rectal polypectomy sites in 1958 [2]. Ponsky and King then published a case report in 1975 describing a patient in whom they used India ink to localize a sigmoid polyp prior to colectomy [3]. Tattooing of colorectal tumors and other colonic pathology by endoscopy is now widely utilized for proper localization.

The only landmarks that can be definitively identified with colonoscopy are the rectum and the cecum. Thus, lesions that are not in the rectum or cecum are harder to localize without the use of a visible marker.

## Patients and Methods

Between January 1, 2000 to May 10, 2012, a total of 50 patients who received tattooing with colonoscopy prior to colorectal surgery at MedStar Georgetown University Hospital were identified. A retrospective chart review was performed on these patients with approval by the institutional review board at Georgetown University. One patient was excluded from analysis due to incomplete data. Patients' records were reviewed to determine rates of accurate identification of endoscopic tattooing during colorectal surgery and surgical pathology. Data regarding indication for colonoscopy, endoscopic findings, endoscopic and surgical pathology were collected and analyzed. Gastroenterologists carried out all the endoscopies and colorectal surgeons performed all the surgeries. Patients underwent a mechanical bowel preparation prior to endoscopic tattooing. Tattooing was performed using SPOT endoscopic marker (GI Supply, Camp Hill, PA), in all cases. The injection needle caused a submucosal bleb and dye was injected as the needle was pulled back. Multiple injections were made circumferentially in the wall around the lesion. The endoscopists documented the site of the tattooing and the

surgeons were informed if the tattooing was done at multiple sites and if the injections were proximal or distal to the site.

## Results

Fifty patients underwent tattooing with colonoscopy prior to colorectal surgery over a 12-year period one of whom was excluded from analysis due to incomplete data. The series included 23 males (46%) and 27 females (54%) with an average age of 64.86 years (Table 1).

Baseline Characteristics	N=50
Average Age	64.86 years
Male	23 (46%)
Female	27 (54%)

**Table 1:** Patient demographics

Indication for endoscopy include hematochezia, screening for colon cancer, diverticulitis, history of colon polyps, iron deficiency anemia, abnormal imaging, surgical marking, a known mass, change in bowel habits, history of colorectal cancer, Crohn's disease, weight loss, and abdominal pain (Table 2). Endoscopic location of the mass is described in (Table 3), and endoscopic location of other colonic pathology is described in (Table 4).

Indication for Endoscopy	N=50
Hematochezia	8 (16%)
Screening	8 (16%)
Diverticulitis	7 (14%)
History of Colon Polyps	7 (14%)
Iron Deficiency Anemia	6 (12%)
Abnormal Imaging	4 (8%)
Surgical Marking	3 (6%)
Known Mass	2 (4%)
Change in Bowel Habits	1 (2%)
History of Colon/Rectal Cancer	1 (2%)
Crohn's	1 (2%)
Weight Loss	1 (2%)
Abdominal Pain	1 (2%)

**Table 2:** Indication for endoscopy

Endoscopic Location of Mass	N=40
Right Colon	15 (37.5%)
Transverse Colon	2 (5%)
Left Colon	5 (12.5%)
Sigmoid Colon	15 (37.5%)

Rectum	3 (7.5%)
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**Table 3:** Endoscopic location of mass

Endoscopic Location of Other Colonic Pathology	N=10
Transverse Stricture	1 (10%)
Descending Colon Stricture	1 (10%)
Sigmoid Stricture	1 (10%)
Sigmoid Diverticulosis	6 (60%)
Sigmoid Inflammation	1 (10%)

**Table 4:** Endoscopic location of other colonic pathology

Of the 49 patients studied who received endoscopic tattooing with colonoscopy, tattooing was visualized intra-operatively in 32 (65%) surgeries and 29 (59%) surgical pathology specimens. Endoscopic tattooing was identified both during surgery and on pathology in 24 (49%) patients. Tattooing was not identified in 17 (34%) surgeries, but 5 out those 17 (10%) were identified on the pathology specimens. There were 12 lesions that were not identified on both surgery and pathology (Table 5).

Endoscopic Visualized	Tattoo	N=49
Surgery	Pathology	
yes	yes	24 (49%)
yes	no	8 (16%)
no	yes	5 (10%)
no	no	12 (24%)

**Table 5:** Endoscopic tattoo visualization

The pathology results of endoscopic biopsy showed that 32 (65%) of the biopsy specimens were adenocarcinoma, 7 (14%) were adenomas, 1 (2%) was metastatic cancer, 1 (2%) was a gastrointestinal stromal tumor, and 8 (16%) was diverticular disease with inflammation and abscess formation (Table 6). Comparatively, in the surgical pathology specimens, 28 (57%) were adenocarcinomas. 9 (18%) of these 28 adenocarcinomas had positive lymph nodes in the surgical specimens. 6 (12%) were benign lesions, 5 (10%) were adenomas, 1 (2%) was metastatic cancer, 1 (2%) was a lipoma, and 8 (16%) were diverticular disease with inflammation and abscess formation (Table 6).

Pathology (N=49)	Endoscopic	Surgical
Adenocarcinoma	32 (65%)	28 (57%)
Adenoma	7 (14%)	5 (10%)
Metastatic Cancer	1 (2%)	1 (2%)
Gist	1 (2%)	0
Diverticulosis/Inflammation/Abscess	8 (16%)	8 (16%)

Benign	0	6 (12%)
Lipoma	0	1 (2%)

**Table 6:** Endoscopic and surgical pathology

No tattoo related complications were noted. There were no conversions from laparoscopic to open surgical resection due to poorly visualized tattooed lesions. No patients underwent intra-operative colonoscopy to confirm accurate tattoo placement.

## Discussion

Laparoscopic surgery for colorectal cancer resection has shown an improvement in morbidity and mortality as compared to open surgical resection. In a randomized controlled trial in 2002, Lacy et al. showed that postoperative recovery is faster and complications are fewer in laparoscopic surgery for colorectal cancer resection than with open surgical resection and that long-term outcomes in these patients were improved. In this trial by Lacy et al., patients with non-metastatic cancer had a significantly lower probability of tumor recurrence and a higher probability of overall and cancer-related survival in the laparoscopic surgical group as compared to the open surgical group [1].

Identification of colonic tumors during laparoscopic surgery is difficult without the assistance of preoperative endoscopic tattoo localization. These lesions are difficult for the surgeon to identify for a number of reasons. This includes removal of a malignant polyp during colonoscopy without gross evidence of the previous site of the polyp after mucosal healing, the inability to palpate small, flat, or soft tumors, and the lack of tactile sensation by the surgeon in laparoscopic procedures. Also in patients with adhesions, localization of a tumor would be more challenging. The surgeon lacks the ability to palpate the colon with the fingers which without tattooing would compromise surgical resection. Visible marking must be used for precise localization in laparoscopic colon resections. Endoscopic tattooing is the most reliable method of localization and has been widely used.

Several methods have been proposed for localization of tumors in the colon many of which can be highly inaccurate. These methods include barium enema, computed tomography colonography, placement of mucosal clips, and intra-operative colonoscopy [4]. The barium enema historically has been the modality used to localize lesions for surgery but is increasingly unreliable [5]. While it is a good method for localizing exophytic and stenosing lesions, it is less effective for localizing early or flat tumors [6]. Preoperative location of a lesion by measuring centimeters of instrument introduced into the rectum is a poor method due to variability in length of colon and looping of the scope within the colon [5]. Localization with computed tomography colonography is useful for detecting not only the primary tumor but also synchronous colon lesions, provides additional information about regional and distant metastatic disease, the depth of wall invasion, and the precise location of the lesion in the colon prior to surgery [6]. Its performance exceeds that of barium enema procedure, but not as effective at detection of lesions as optical colonoscopy [6]. Intra-operative colonoscopy is another method used for localization of a tumor during laparoscopic surgery which is a complex procedure that requires an experienced endoscopist to prevent intestinal distension due to the air insufflated for the procedure [6].

Colonoscopic tattooing is now considered the gold standard for tumor localization prior to laparoscopic colorectal resection. Different dyes such as methylene blue, indigo carmine, and indocyanine green all successfully stain the bowel wall but usually disappear within days as they are rapidly absorbed making for inappropriate techniques for localization [5]. These agents are less useful compared with India ink with respect to safety, efficacy, and ease of use. Animal studies have shown that only India ink and indocyanine green (ICG) are visible at the injection site longer than 48 hours, whereas other dyes are reabsorbed within 24 hours [7]. India ink is superior because it doesn't diffuse through the mesentery and is thus permanent [4]. It is effective and safe. It is a permanent marker demonstrated to persist for at least 10 years in patients [5]. Its permanence may be due to the lack of local lymphatics to remove these inert particles [8]. Many endoscopists use SPOT® endoscopic marker (GI Supply, Camp Hill, PA), which is a prepackaged biocompatible agent containing highly purified, very fine carbon particles [8]. These particles remain in the submucosal injection site creating a permanent mark. The tattoo is seen on surgery as a blue staining of the serosal layer of the colon. Even if there is spillage of the tattoo in the peritoneum, the marked location on the colon is darker than the staining in the peritoneum and can be localized accurately. It is approved by the United States Food and Drug Administration and comes packaged in sterilized syringes containing 5cc of the marker. It is used to endoscopically mark lesions that will be surgically removed within 30 days [9]. In this series, the cases in which the tattoo was not identified during surgery or on the surgical specimen may be because the tattoos in those cases were not injected properly into the submucosal layer of the colonic wall.

There is little evidence of long-term complications of India ink for colonic tattooing. In one study of 113 patients, follow up after SPOT tattoo placement did not have any report of fever, abdominal pain, or other clinically significant complication [10]. Carbon from the India ink is mainly located in the macrophages of the submucosa and lamina propria. There is evidence to suggest that carbon exposure to other organs such as the lungs has no association with the development of cancer [8]. According to a large review of 447 cases by Nizam et al, the risk of clinical complications was only 0.22% with the use of India ink in colonic tattooing [11]. This review also showed that India ink is not a culture medium and there was no evidence linking it to infection [11].

In conclusion, a strong number of tattooed lesions were visualized during laparoscopic surgery and surgical pathology, therefore establishing a strong correlation between tattooing and accurate resection. The tattoos that were not identified during surgery, or on the surgical specimen, indicates that improvement in the technique is necessary for a higher yield. The majority of tattooed lesions were adenocarcinomas, confirming the importance of tattooing in colorectal cancer resection. All colonic lesions that appear to be malignant should be tattooed during endoscopy to improve surgical localization. Tattoo endoscopy is a safe and effective method for preoperative tumor localization. While it is a useful technique, it needs improvement to increase the yield of localization of colonic tumors. The positive outcome of this series emphasizes the need for further randomized controlled trials evaluating the effectiveness of tumor localization with endoscopic tattoo placement.

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