

# The importance of preoperative tattooing before laparoscopic surgery

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## Abstract

**Background.** Laparoscopically assisted resections in patients with colorectal cancer have been established since randomized studies ascertained that early post-operative results after laparoscopic surgery were comparable to the results after open surgery.

**Methods.** We reviewed the literature for the currently most valid method of preoperative tumor marking and our experience.

**Conclusion.** In the case of laparoscopic resections, oncological principles must be followed, which, in addition to the removal of the primary tumor, also require radical ligation of the blood vessels, thus removing the regional lymph nodes. However, identification of tumors during surgery can be difficult. The use of preoperative endoscopic tattooing can enable identification of the tumor and facilitate laparoscopic resection.

## Introduction

The treatment method for colorectal cancer depends on the localization and size of the primary tumor, possible regional and/or distant metastases, and the patient's general condition. Radical resection (R0) is the only curative treatment. When radical resection is no longer possible, palliative resection of the tumor (R2) is preferred over non-resectional surgery.

Specific oncological therapy (neoadjuvant, adjuvant, or palliative), chemotherapy, and/or radiotherapy is important in the treatment of colorectal cancer patients [1–5]. In the last decade, neoadjuvant treatment of cancer of the middle and lower third of the rectum has gained in importance. Effective treatment planning is based on accurate estimation of the local and distant extent of the tumor [6]. Preoperative staging requires complete colonoscopy with biopsy, abdominal CT scan and chest radiograph, histological type of the tumor, differentiation grade (G1, G2, G3), and levels of tumor markers (CEA, CA 19-9). In the case of rectal cancer, MRI, urography, and cystoscopy are sometimes also required for proper preoperative evaluation [7–10].

Before the surgery, local preparation of the bowel is required. Orthograde cleansing is currently still recommended only before a low anterior resection. The concept of accelerated recovery (“fast-track” surgery) is gaining ground. Perioperative antibiotic and antithrombotic prophylaxis remain standard. The latter is also extended to the time after discharge, for up to 3 weeks after surgery [11, 12].

Standard radical operations for colon cancer are: right and extended right hemicolectomy, transverse resection, left and extended left hemicolectomy, sigmoid resection, and subtotal and total colectomy. Every standard resection includes interruption and ligation of lymphovascular pedicles for the area of the colon where the tumor is located and removal of the entire section of the intestine with the attached mesentery (lymphadenectomy). Standard radical surgeries for rectal cancer are anterior resection and low anterior resection with total mesorectal excision, abdominoperineal resection of the rectum, extended abdominoperineal resection of the rectum with removal of the uterus, the posterior vaginal wall, and/or the posterior wall of the bladder, and, exceptionally, the evisceration of the lesser pelvis [13–15]. For a well-differentiated (G1) T1 rectal tumor with a diameter of up to 2 cm, a radical as well as a transanal local excision of the tumor can be performed [16].

Laparoscopic surgery of colorectal cancer in the lower stages is becoming increasingly popular worldwide. The laparoscopic approach has some advantages over standard open surgery; apart from improved cosmesis, the postoperative ileus after laparoscopic surgery is shorter, normal pulmonary function is restored faster, and less morbidity and shorter postoperative hospitalization are observed [17–19].

The potential benefit of a laparoscopic approach for cancer patients is that it lessens surgical trauma and the impact on the immune system, which potentially reduces the number of recurrences of the disease and also benefits operated patients’ quality of life. A number of randomized studies were carried out that did not indicate any differences in survival between laparoscopically assisted resections and conventional surgery in colorectal cancer patients [20].

Colonoscopy is a well-established gold standard for diagnosing and preoperative localization of malignant lesions in colorectal cancer. However, with colonoscopy inaccurate tumor localization occurs in 11.3 to 21% of cases [21–23]. Colorectal

tumors are increasingly discovered in the early stage through the SVIT screening program, which was implemented over a decade ago. Small tumors are often poorly visible on the serosa, whereas tactile feedback is reduced during laparoscopy. Hence, it is particularly difficult to determine the exact location of smaller flat lesions.

The location of tumors can be determined with preoperative colonoscopy, but in some locations, such as in the transverse colon, it is completely inaccurate, with a reliable tumor site found in only 37.5% [24]. Even lesions that during endoscopy seem to lie in the cecum often proved to be incorrectly located [25]. In one series, the intraluminal measurements from the anocutaneous line onward were incorrect in most patients [26].

Correctly performed preoperative endoscopic tattooing is a safe and effective way of identifying tumors before a laparoscopic resection [27]. Among several methods for preoperative localization of tumors, endoscopic labeling is the most reliable [28]. Placement of endoscopic clips on the mucosa of the colon is also described, followed by X-ray imaging to show the lesion site [29]. However, it has been shown that the clips detach after about 10 days [30]. In a study of 63 patients, it was found that, with preoperative tattooing, tumor localization was successful in 62 (98.4%) patients [31]. Intraoperative colonoscopy as another option significantly extends the surgery time and may reduce visibility during surgery [32]. Preoperative marking is not always successful, and it can make the search for the marked lesions very difficult when done incorrectly. Abbosy reported difficulties with intraoperative identification of pathological changes in 31.5% of patients during a laparoscopic procedure. During histological examinations of the resected tissue, no dye was found in 26.4% of the samples [33].

## Preoperative tattooing techniques

Various tattooing techniques are described, among them marking the proximal and distal parts of the lesion, or both. A special challenge arises when a lesion is marked both proximal and distal. If only one marked spot is visible during laparoscopy, the surgeon would assume that the distal part of the lesion is marked, which would lead to inadequate resection. Standard marking with a tattoo 1 to 2 cm distal from the tumor is appropriate for cases where the tumor completely closes the lumen [34,

35]. The lesion must be marked on at least two of the four bowel quadrants because a single tattoo is not always visible during laparoscopy if it lies on the retroperitoneal or on the mesenteric side of the intestine. Marking two or more of the four quadrants ensures that at least one tattoo is visible during surgery. First, 0.5 to 1 ml of saline is injected into the submucosa, and then the infiltrate is injected with the same amount of Spot dye. This technique typically reduces the possibility of intraperitoneal spillage, which may cause difficulties in identifying the tumor, blur the anatomical layers, and consequently hinder the laparoscopic resection. The needle can be left in place while the syringes are changed, avoiding numerous punctures in the gut wall [34, 36, 37].

### Which lesions should be marked?

There is no need to mark lesions that have the appearance of benign lesions and benign lesions that are endoscopically removed to healthy tissue. Over-intense marking may cause problems during laparoscopic surgery. The marking decision can be left to the endoscopist, who must mark all lesions with a suspicious appearance. Marking is also important for later endoscopies, when one cannot completely excise small lesions endoscopically, but an additional endoscopic resection is planned [38]. It is not necessary to mark lesions in the cecum if anatomical characteristics such as the entrance to the appendix and the terminal ileum are clearly visible. However, they must be marked if there is any doubt about the localization of the lesion in the right colon [24]. Lesions in the rectum are usually not marked by tattooing during the initial diagnostic endoscopy because most lesions are identified and marked, if necessary, in later rectoscopy. Excessive amounts of dye may reduce the success of planned transanal excision and may lead to resection problems [38]. In the Bretagne study, based on the French screening program, high levels of dysplasia with incidence at 2.8%, 15.5%, and 46.8% with polyp sizes of 5 mm, 6 to 9 mm, and less than 10 mm were found, respectively [39]. Zafar describes a malignant polyp incidence of 0.7%, 2.4%, and 13% for polyp sizes less than 10 mm, 10 to 19 mm, and greater than 19 mm, respectively [40]. Based on these results, it is reasonable to mark all lesions larger than 10 mm. Moreover, it is necessary to consider marking suspicious lesions that are smaller than 10 mm and were not removed completely [38].

### Types of ink and potential pitfalls

Ponski and King first described the use of commercial India ink to mark colon lesions in 1975 [41]. Commercial India ink contains stabilization additives to facilitate smooth flow. The additives are propylene glycol, ethylene glycol, sodium tetraborate decahydrate, ammonium hydroxide, surfactant, and gelatin [27]. The most common problem, due to awkward injection, is ink spillage along the abdominal cavity. Botoman described a patient that became febrile after injection of ink, with tension of the abdominal wall and leukocytosis. The patient was treated intravenously with antibiotics. During the procedure, a perforation of the intestine was not found; however, ulcers were found at the site of the biopsy, due to which India ink was not a reliable cause of the patient's problems [42]. Spot dye is a substance approved by the Food and Drug Administration (FDA) and is suitable for marking mucosa. It is a dilute form of India ink that is sterile and does not contain phenol or ethylene glycol. It has been confirmed to be safe and effective both by endoscopy and laparoscopy. No side effects, necrosis, or abscesses caused by the dye have been detected [41]. The most common problems arise when the Spot dye spills across the abdominal cavity. This usually happens when the dye is injected perpendicularly into the wall of the intestine, which can cause adhesion and darkening of the site of the predicted resection. Other dyes such as indocyanine green (ICG) and toluidine blue (TB) are known. Unfortunately, these coloring agents stain the colon only for a few days and are not suitable for patients when the marking and surgery are more than a week apart. The literature also describes individual examples of fat necrosis with the formation of inflammatory pseudotumors, colon abscesses, and localized peritonitis with the use of these dyes [43, 44].

### Clinical pathway for endoscopic tattooing

Based on the current literature review, the following advice could be given regarding preoperative endoscopic tattooing:

- Mark only distally from the tumor.
- Mark at least in two places distally from the tumor, 180° apart so as to avoid locations that are not seen during surgery (retroperitoneal or mesenteric).

- The standard marking technique is to first inject saline solution into the submucosa, and then replace the syringes and inject 0.5 to 1 ml of Spot dye into the infiltrate on each side. The needle should be inserted at an angle of 45° and to a depth of 5 mm to ensure infiltration into the submucosa. If the needle is inserted perpendicularly to a depth of 8 mm, it is enough to penetrate the wall of the intestine and cause dye spillage.
- If the anatomical features of the cecum are clearly visible and the endoscopist is certain that they are in the cecum, there is no need for marking with a tattoo. If there is any doubt about the accuracy of the location, the lesion should be marked distally.
- Do not mark the rectum at the initial endoscopy. The surgeon will mark the lesion later, during rectoscopy.
- Avoid over-marking in numerous places during the screening program when polyps are found. Not all benign lesions should be marked, especially small polyps, which are removed completely.
- It is important to record every tattoo.

## Conclusion

The standard procedure for endoscopic tattooing prevents confusion during laparoscopic surgery. The key is to enable optimum resection according to all oncological principles by means of marking. Although marking with a tattoo is relatively easy, it can cause problems if done incorrectly.

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