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Tattooing or Metallic Clip Placement? A Review of the Outcome Surrounding Preoperative Localization Methods in Minimally Invasive Anterior Resection Performed at a Single Center

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Background: For minimally invasive colorectal surgery, preoperative localization is a typical procedure. We here aimed to analyze compared 2 different localization methods in terms of short-term outcomes, like the operative outcome and postoperative complication rates based on real-world data.

Materials and Methods: This was a retrospective analysis study conducted at a medical center. We enrolled patients who were presented with colonic tumor between January 1, 2016, and December 31, 2019, and they had undergone laparoscopic anterior resection in a single institution. Data included patient characteristics, operative outcome, length of hospital stay, and postoperative complications.

Results: The preoperative localization group had a better resection margin (4 vs. 3 cm; $P < 0.001$) and fewer procedures of intraoperative colonoscopy (4.67% vs. 18.22%; $P = 0.002$). Lymph node harvest occurred more in patients with endoscopic tattooing procedures than with metallic clip procedures (25 vs. 20; $P = 0.031$). No significant difference was found regarding postoperative complications and the length of hospital stay.

Conclusions: Preoperative localization in a laparoscopic anterior resection led to better surgical planning and resection margin. The metallic clip placement was helpful in the preoperative localization and setting. The endoscopic tattooing method had a larger lymph node harvest and with fewer intraoperative colonoscopy.

Key Words: tattooing, metallic clip, colorectal surgery, laparoscopy, localization, colorectal neoplasm

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Within the past 2 decades, minimally invasive surgery is becoming the global gold-standard method to treat colorectal diseases.[1] Different from a traditional laparotomy procedure, surgeons do not directly touch intra-abdominal tissues of patients. Hence colon lesions cannot be localized preoperatively through manual palpation.[2] Although an intraoperative colonoscopy can localized perioperatively, surgical time is extended, with greater perioperative challenges and complications.[3] Also, it would consume manpower with material resources. Therefore, preoperative lesion localization is more valuable when compared with a traditional laparotomy, particularly in patients with small lesions. Since small colonic lesions often do not cause serosa changes, surgeons cannot visually identify them. These lesions' intraluminal size cannot be easily determined, even when invading the colonic serosa. Therefore, for colorectal surgery, preoperative colonoscopic localization is recommended in the National Comprehensive Cancer Network clinical guidelines.[4]

There are a number of localization methods, endoscopic tattooing or metallic clip placement, colonoscopy, colon computed tomography, barium enema, and intraoperative colonoscopy.[5,6] Currently, the most popular methods are endoscopic tattooing and metallic clip placement. Both methods are recommended in the American Society for Gastrointestinal Endoscopy clinical guidelines.[7] However, no guidelines exist to assist surgeons in choosing between tattooing and metallic clip placement. Therefore, we here compared the short-term outcomes of these 2 localization methods.

MATERIALS AND METHODS

Patients

Between January 2016 and December 2019, a total of 332 patients underwent laparoscopic anterior resection for colon tumor in our hospital. The procedure was a resection of the sigmoid colon with anastomosis beyond peritoneal reflection. Lesions were all located at the distal descending colon to the upper rectum. Those surgeries that converted to the open method were not included for this study. We initially divided these patients into 2 groups: those receiving preoperative localization and those not (ie, receiving colonoscopy only). Subsequently, patients receiving preoperative localization were further subdivided into 2 groups: a tattooing group and a metallic clip group. Data on patients were collected regarding patient characteristics, operative outcome (operative time, resection margin, lymph node

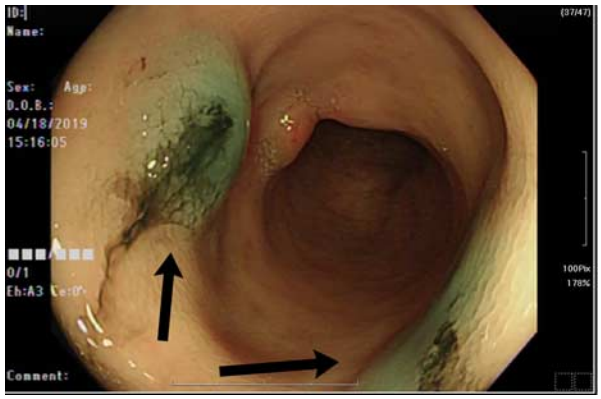

FIGURE 1. Endoscopic tattooing on proximal colonic mucosa.

harvest, intraoperative colonoscopy usage rates, inadequate resection margin during the first attempt and later requiring a second colonic resection), length of hospital stay, and postoperative complications (wound infection, delayed weaning, anastomosis leakage, ileus, pneumonia, chylous leak, stroke, urinary tract infection).

Preoperative Localization Methods

The 2 methods used were: endoscopic tattooing and metallic clip placement. The tattooing method was performed using sterilized ink and is typically done with a standard puncture needle inserted in the colonic submucosa distal to the lesion circumferentially at 2 or more locations (Fig. 1, black arrows). The metallic clip method was performed using an endoscopic hemoclip. The clip was placed at the mucosa near the lesion and followed through using abdominal radiography or computed tomography (Figs. 2, 3, white arrows). The indication for use of preoperative localization is when the surgeon supposes that the lesion's location cannot be confirmed during the perioperative period. The choice of localization method was at the surgeon's discretion.

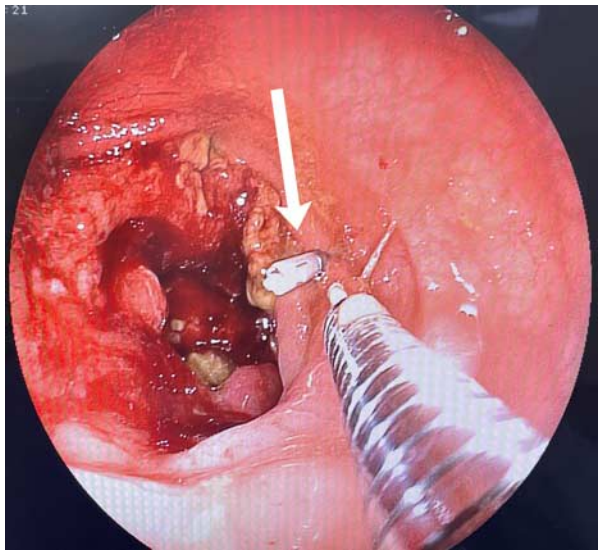

FIGURE 2. Metallic clip placement on proximal colonic mucosa.

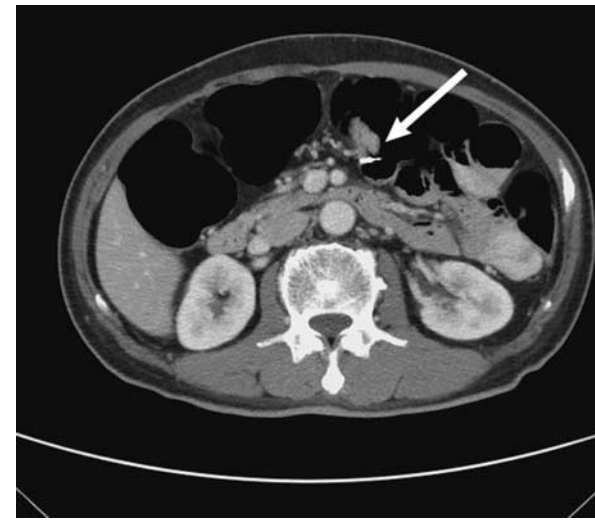

FIGURE 3. Preoperative abdominal computed tomography. The metallic clip was enhanced at the sigmoid colon.

Statistical Analyses

Clinical data were retrospectively collected from the hospital's database. Continuous data were presented as medians and compared with the Mann-Whitney test. Categorical data were presented in both numbers and percentages and evaluated with the χ^2 test and Fisher exact test. All statistical comparisons were 2 tailed, and P-value < 0.05 was considered significant. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS).

TABLE 1. All Patient's Baseline Characteristics

	Nonlocalization Group (N = 225)	Localization Group (N = 107)	*P*
Age‡	62.00 (53-71)	65.00 (57-77)	0.022*
Sex‡			0.161
Female	104 (46.22)	40 (37.38)	
Male	121 (53.78)	67 (62.62)	
BMI†	24.02 (21.56-27.03)	24.61 (22.27-27.47)	0.099
ASA†	2.00 (2-2)	2.00 (2-3)	0.002**
Stage			0.026*
0	11 (4.89)	12 (11.21)	
I	55 (24.44)	37 (34.58)	
II	51 (22.67)	22 (20.56)	
III	83 (36.89)	30 (28.04)	
IV	25 (11.11)	6 (5.61)	
Pathologic T stage‡			0.002**
I	37 (16.44)	34 (31.78)	
II	40 (17.78)	10 (9.35)	
III	112 (49.78)	43 (40.19)	
IV	25 (11.11)	8 (7.48)	
TIS	11 (4.89)	12 (11.21)	

Continuous data were expressed as median (interquartile range).
Categorical data were expressed as n (%).
ASA indicates American Society of Anesthesiologists; BMI, body mass index.
†χ^2 test.
‡Mann-Whitney test.
*$P < 0.05$.
**$P < 0.01$.

TABLE 2. Localization Group Patient's Baseline Characteristics

	Tattooing Subgroup (N = 69)	Clip Subgroup (N = 38)	*P*
Age†	65.00 (56-79)	65.00 (57.75-72.25)	0.663
Sex‡			0.027*
Female	20 (28.99)	20 (52.63)	
Male	49 (71.01)	18 (47.37)	
BMI†	24.73 (23.03-28.21)	24.46 (21.6-27.15)	0.327
ASA†	2.00 (2-3)	2.00 (2-2.25)	0.215
Stage‡			0.041*
0	4 (5.80)	8 (21.05)	
I	22 (31.88)	15 (39.47)	
II	15 (21.74)	7 (18.42)	
III	22 (31.88)	8 (21.05)	
IV	6 (8.70)	0 (0)	
Pathologic T stage‡			0.036*
I	22 (31.88)	12 (31.58)	
II	5 (7.25)	5 (13.16)	
III	32 (46.38)	11 (28.95)	
IV	6 (8.70)	2 (5.26)	
TIS	4 (5.80)	8 (21.05)	

Continuous data were expressed as median (interquartile range).
Categorical data were expressed as n (%).
ASA indicates American Society of Anesthesiologists; BMI, body mass index.
†χ^2 test.
‡Mann-Whitney test.
*$P < 0.05$.

TABLE 3. Surgical Outcome of Nonlocalization and Localization Groups

	Nonlocalization Group (N = 225)	Localization Group (N = 107)	*P*
Resection margin (cm)§	3.00 (2-4)	4.00 (2.8-4.5)	< 0.001*
Operative time (min)§	164.00 (129.75-198)	169.00 (144.75-184)	0.750
Lymph node harvest§	22.00 (18-29.5)	24.00 (18-29)	0.719
Intraoperative colonoscopy‡	41 (18.22)	5 (4.67)	0.002*
Another colonic resection†	6 (2.67)	1 (0.93)	0.436
Hospital stay (d)§	7.00 (6-9)	7.00 (6-9)	0.662
Postoperative complication			
Wound infection†	5 (2.22)	2 (1.87)	1.000
Delayed weaning (> 48 h)†	4 (1.78)	1 (0.93)	1.000
Anastomosis leakage†	2 (0.89)	0 (0)	1.000
Ileus‡	17 (7.56)	5 (4.67)	0.453
Pneumonia†	1 (0.44)	3 (2.80)	0.100
Chylous leak†	2 (0.89)	4 (3.74)	0.088
Stroke†	1 (0.44)	0 (0)	1.000
Urinary tract infection†	3 (1.33)	0 (0)	0.554

Continuous data were expressed as median (interquartile range).
Categorical data were expressed as n (%).
Note: Another colonic resection: inadequate resection margin during first attempt.
†Fisher exact test.
‡χ^2 test.
§Mann-Whitney test.
*$P < 0.01$.

RESULTS

There were 332 patients receiving laparoscopic anterior resection during our study period. Among them, 107 received preoperative localization, and 225 received an only preoperative colonoscopy. Of the 107 patients with preoperative localization, 38 metallic clip placements, while 69 had the tattoo method. All patients' baseline characteristics are shown in Tables 1 and 2.

Between the preoperative localization and colonoscopy alone groups (Table 3), we found a statistical difference in the resection margin and the usage of intraoperative colonoscopy. No statistical difference was found between postoperative complications and the length of hospital stay.

Between the tattooing subgroup and metallic clip subgroup (Table 4), while we found no significant differences in resection margin, we found a statistical difference in the number of lymph node harvest. The tattooing subgroup had more lymph node harvests than the metallic clip subgroup (25 vs. 20, $P = 0.031$). Also, we found more postoperative chylous leakage between subgroups, but the difference was statistically insignificant (5.8% vs. 0%, $P = 0.295$). The intraoperative colonoscopy usage rate was lower in the tattooing subgroup (10.53% vs. 1.45%, $P = 0.053$). No differences were found regarding postoperative complications and the length of hospital stay.

DISCUSSION

In our article, we only included patients with laparoscopic anterior resection. Previous studies suggested that for lesions at the right side of the colon or rectum, preoperative localization is unnecessary.[3,8] We were able to identify right

TABLE 4. Surgical Outcome of Tattoo and Clip Groups

	Tattoo Subgroup (N = 69)	Clip Subgroup (N = 38)	*P*
Resection margin (cm)§	3.50 (2.75-4.5)	4.00 (3-5)	0.421
Operative time (min)§	171.00 (149.75-181)	158.00 (124-184.75)	0.172
Lymph node harvest§	25.00 (18-31.5)	20.00 (16.75-27)	0.031*
Intraoperative colonoscopy†	1 (1.45)	4 (10.53)	0.053
Another colonic resection†	1 (1.45)	0 (0)	1.000
Hospital stay (d)	7.00 (6-9)	7.50 (7-9)	0.323
Postoperative complications			
Wound infection†	1 (1.45)	1 (2.63)	1.000
Delayed weaning (> 48 h)†	0 (0)	1 (2.63)	0.355
Anastomosis leakage‡	0 (0)	0 (0)	—
Ileus†	3 (4.35)	2 (5.26)	1.000
Pneumonia†	2 (2.90)	1 (2.63)	1.000
Chylous leak‡	4 (5.80)	0 (0)	0.295
Stroke‡	0 (0)	0 (0)	—
Urinary tract infection‡	0 (0)	0 (0)	—

Continuous data were expressed as median (interquartile range).
Categorical data were expressed as n (%).
Note: Another colonic resection: inadequate resection margin during first attempt.
†Fisher exact test.
‡χ^2 test.
§Mann-Whitney test.
*$P < 0.05$.

side colonic lesions through the use of an ileocecal valve. When located at the rectum, these lesions could be identified by the use of a Huston valve. For the above reason, we believed that limiting the procedure to only an anterior resection likely reduced bias.

A systematic review in 2016 found a higher accuracy for colonic localization in the endoscopic tattooing method when compared with the preoperative conventional colonoscopy alone.[9] Also, there is no consensus as to which method is better, that is, between endoscopic tattooing and other localization methods. According to our present findings, the localization group showed a better resection margin and surgical plan by having more accurate lesion localization. The more accurate resections in the localization group are reflected in the boxplots (Fig. 4). As for the tattooing and metallic clip subgroups, the only statistical difference was lymph node harvest. Dye-containing lymph nodes were likely better detected during surgery. Adequate numbers of lymph nodes in the specimen are known to be critically important for patients with colorectal cancer.[10,11] Adequate harvests of lymph nodes (eg, >12) help avoid understaging and are strongly associated with better outcomes.[12–14] Most specialists consider the benefits of endoscopic tattooing in lymph node retrieval,[15–17] while others disagree.[18] In our present study, tattooing led to more lymph node harvest than metallic clip placement (25 vs. 20, $P=0.031$), although both subgroups had adequate numbers of dissected lymph nodes (>12). The usage of intraoperative colonoscopy was higher in the metallic clip subgroup, a result that is consistent with expectation. As the proportion of early cancer staging was also higher in the metallic clip subgroup, we cannot exclude the likely existence of some bias. The tattooing technique has been discussed for >20 years.[19,20] One study in 2017 reported that an intraluminal circumferential multiple spot injection improves localization accuracy.[21] This can avoid having a tattoo located retroperitoneally or colonic serosa being covered by omentum, a condition which cannot be easily seen. Endoscopic tattooing with localized accuracy is dependent on the surgeon's skills and may fail due to insufficient injections of the submucosal dye. If the puncture needle perforates the colonic wall, the dye may cause peritonitis or abscesses, making the operation more challenging.[22] In our study, only 1 patient in the tattooing group required an additional colonic resection due to poor localization. In the case, the error was due to dye spreading to the proximal colonic serosa, misleading the surgeon in performing the correct segmental resection of the colon (Fig. 5). Few cases in the tattooing subgroup showed unsatisfied resection margins (only about 1 cm) (Fig. 6). One possibility of such error may be due to the fact that the tattoo procedure was not performed by the chief surgeon. Also, distances between the tattooing site and the lesion site were inconsistent across patients. All these factors should be considered when performing the endoscopic tattoo.

Metallic clip placement has been used by gastrointestinal tract endoscopists for a long time. It was described as a method to evaluate the depths of the colonoscopy tip in the colon[23] and has also been used for precise localization of colon lesions in laparoscopic surgery.[24] Accurate placement

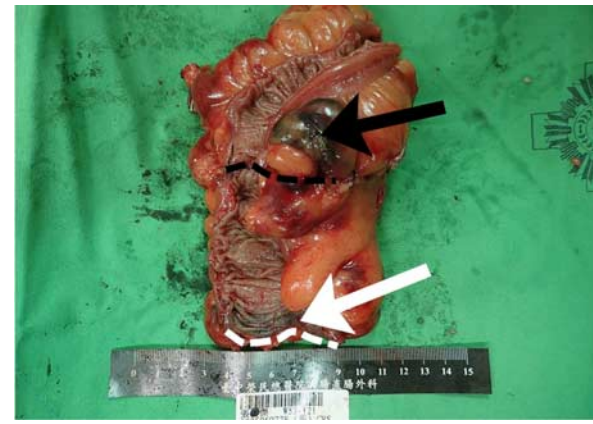

FIGURE 5. Surgical specimen. Black arrow: Tattoo on wrong colonic segment serosa. White arrow: True lesion proximal colonic mucosa been tattooed. Black dotted line: Inadequate colonic resection at first attempted (this specimen was repaired with simple suture). White dotted line: Another colonic resection with adequate resection margin.

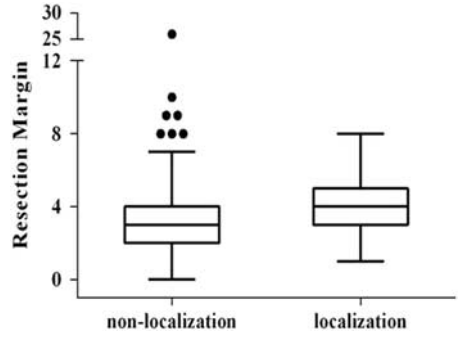

FIGURE 4. Boxplot of resection margin between localization and nonlocalization groups.

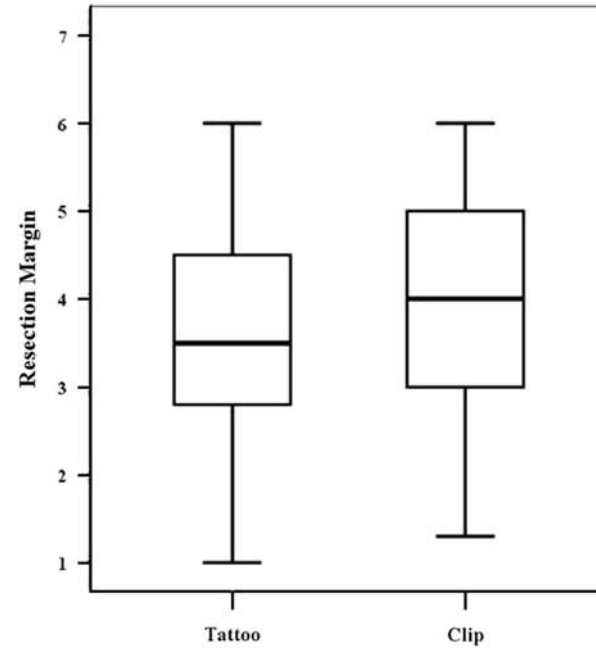

FIGURE 6. Boxplot of resection margin between tattooing and metallic clip groups.

of the metallic clip is known to cover a wide range. Error localization rates range from 0% to 40%.[25,26] Interestingly, one 2016 study a 100% accurate level even without using the tattooing method. In that study, only the method of metallic clip or colonoscopy was applied.[27] The benefit of this method is that a surgeon knows the lesion's relative location before surgery. Furthermore, surgeons can decide in advance on the port site, patients' position, and endovideosurgery monitor placement. After a selected colon segment is dissected retroperitoneally, the surgeon can pull it through and check the colonic lesion by manual palpation. If the lesion is too small to be palpable, an intraoperative colonoscopy may be needed. Clip migration may lead to erroneous localization and other complications such as perforation or colonic ulcer.[28]

This observational study is limited by its retrospective nature. Our laparoscopic anterior resections were carried out by different surgeons, with surgeon-dependent choices of the localization method. Different surgeons with different experiences could have well influenced the number and the quality of lymphadenectomy. The intraoperative colonoscopy usage rate was statistically lower in the localization group, but that also required longer surgical time. Selection bias could have contributed different results.

Each of the 2 methods has different features. Tattooing is aimed to facilitate intraoperative localization, but this is not possible with clip placement, which is not visible intraoperatively. Tattooing methods also can map the surgical field for better surgical outcomes. Metallic clip placement is helpful in the preoperative setting based on imaging results, especially for difficult lesions localized in the transverse colon/splenic flexure. It is noteworthy that a case series study describing new marking methods like fluorescent clips may have advantages of both methods.[29]

In conclusion, preoperative localization produced better resection margins and surgical plans. Metallic clip placement is a simple method for preoperative localization and setting. The endoscopic tattooing method offered more lymph node harvest and less usage of an intraoperative colonoscopy. If you can only choose one of these 2 methods, we would recommend the endoscopic tattooing method. However, we believe the usage of both techniques would create the best surgical plan.

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