

# Tattooing or not? A review of current practice and outcomes for laparoscopic colonic resection following endoscopy at a tertiary care centre

François Letarte, MD  
 Mitch Webb, MD  
 Manoj Raval, MD, MSc  
 Ahmer Karimuddin, MD, MSc  
 Carl J. Brown, MD, MSc  
 P. Terry Phang, MD, MSc

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## Correspondence to:

P.T. Phang  
 St. Paul's Hospital  
 1081 Burrard St  
 Vancouver BC V6Z 1Y6  
 tphang@providencehealth.bc.ca

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**Background:** Because small colonic tumours may not be visualized or palpated during laparoscopy, location of the lesion must be identified before surgery. The aim of this study was to evaluate the effectiveness of the current recommendation of endoscopic tattooing of lesions prior to laparoscopic colonic resections.

**Methods:** All consecutive patients who underwent elective laparoscopic resection for a colonic lesion at a single tertiary institution between 2013 and 2015 were identified for chart review.

**Results:** In total, 224 patients underwent laparoscopic resection for a benign or malignant colonic lesion during the study period. All patients had a complete colonoscopy preoperatively. In all, 148 patients (66%) had their lesion tattooed at endoscopy. Most lesions were tattooed distally, but 15% were tattooed either proximally, both proximally and distally, or tattooed without specifying location as proximal or distal. Tattoo localization was accurate in 69% of cases. Tattooed lesions were not visible during surgery 21.5% of time; 2 cases were converted to open surgery to identify the lesion. Inaccuracy in endoscopic localization led to change in surgical plan in 16% of surgeries. In the nontattooed group, 1 case was converted to open surgery to localize the lesion, 3 required intraoperative colonoscopy and 1 had positive margins on final pathology.

**Conclusion:** To improve surgical planning, we recommend the practice of endoscopic tattooing of all colon lesions at a location just distal to the lesion using multiple injections to cover the circumference of the bowel wall.

**Contexte :** Comme il n'est pas toujours possible de voir ou de palper les petites tumeurs du côlon durant la laparoscopie, le siège de la lésion doit être localisé avant la chirurgie. Le but de cette étude était d'évaluer l'efficacité de la recommandation actuelle, qui consiste à tatouer les lésions au cours de l'endoscopie, avant les colectomies laparoscopiques.

**Méthodes :** Nous avons recensé tous les patients consécutifs ayant subi une résection laparoscopique non urgente d'une lésion du côlon dans un même établissement de soins tertiaires entre 2013 et 2015 afin d'analyser leurs dossiers.

**Résultats :** En tout, 224 patients ont subi la résection laparoscopique d'une lésion bénigne ou maligne du côlon durant la période visée. Tous les patients ont passé une coloscopie totale avant la chirurgie. Le tatouage endoscopique de la lésion a été effectué pour 148 patients (66 %). La plupart des lésions ont été tatouées au point distal, mais 15 % l'ont été soit au point proximal, soit au point proximal et au point distal, soit sans précision quant à l'emplacement. La localisation par tatouage était exacte dans 69 % des cas. Les lésions tatouées n'étaient pas visibles durant la chirurgie dans 21,5 % des cas; 2 cas ont été convertis en chirurgies effractives afin qu'on puisse repérer la lésion. L'inexactitude de la localisation endoscopique a entraîné la modification du plan chirurgical dans 16 % des chirurgies. Dans le groupe non tatoué, 1 cas a été converti en chirurgie effractive afin qu'on puisse repérer la lésion, 3 cas ont nécessité une coloscopie péroopératoire et 1 cas présentait des marges positives à l'examen pathologique final.

**Conclusion :** Afin d'améliorer la planification chirurgicale, nous recommandons le tatouage endoscopique de toutes les lésions du côlon, au point distal de la lésion, et de procéder par injections multiples en vue de couvrir la circonférence de la paroi intestinale.

About 100 000 cases of colon cancer are now diagnosed each year in the United States, and most are amenable to resection with curative intent.<sup>1</sup> In the past decade, there has been a dramatic shift in practice toward minimally invasive surgery, with an increasing number of laparoscopic colon resections being performed. Since laparoscopic surgery is associated with decreased tactile feedback,<sup>2</sup> small colon lesions may not be detectable intraoperatively. Failure to accurately localize a tumour may lead to adverse outcomes, including resection of a wrong segment of bowel, positive resection margins, conversion to open surgery, on-table colonoscopy, or on-table alteration in planned surgical resection. In fact, according to a survey conducted by the American Society of Colon and Rectal Surgeons, 6.5% of surgeons who perform routine laparoscopic colonic resection have admitted to removing the wrong segment of bowel at least once.<sup>3</sup>

Colonoscopy is firmly established as the gold standard both for diagnosis and preoperative localization of malignant colonic lesions. However, even colonoscopic tumour localization is inaccurate in 11.3%–21% of cases.<sup>4–6</sup> As such, colonoscopic tattooing is now considered to be standard practice for tumour localization before laparoscopic colorectal excision.<sup>7,8</sup> Several medical and surgical associations and societies recommend tattooing of suspicious-looking lesions without reference to their size.<sup>9,10</sup> However, there is no established guideline as to when and how to tattoo colonic lesions, resulting in varied practices among physicians and hospitals.

The aim of the present study was to evaluate the effectiveness of the current practice of endoscopic tattooing of lesions before laparoscopic colonic resection at a tertiary care centre.

## METHODS

We performed a retrospective cohort study on all consecutive patients who underwent elective laparoscopic resection for a colonic tumour in the period January 2013 to January 2015 at St. Paul's hospital, Vancouver, which is affiliated with the University of British Columbia. We excluded patients with rectal lesions below the peritoneal reflection, as they would be accurately localized by routine magnetic resonance imaging scan. Also excluded were patients who had more than 1 lesion in the colon or who had emergency surgery. No institutional guideline or protocol regarding tattooing existed at the time of the study.

Data on baseline patient demographic and clinical characteristics were obtained. We collected details regarding endoscopic localization of the tumour, tattooing and endoscopic documentation. Charts were reviewed to collect data on operative visualization and localization of lesions and tattoos, planned and performed surgical procedures, changes in surgical plan and operative and postoperative outcomes. We compared patients with and without tat-

tooled lesions. Visibility and accuracy of the position of the tattoo at surgery was compared with the position stated in the endoscopy report. The research ethics boards of St. Paul's Hospital and the University of British Columbia approved our study.

## Statistical analysis

Descriptive statistics are reported, including means, medians, standard deviations and ranges. We used the Student *t* test or the Mann–Whitney *U* test to compare means. Categorical variables were compared using the  $\chi^2$  test. All statistics were 2-tailed, and we considered results to be significant at  $p < 0.05$ . Statistical analysis was done with the software package R Studio.

## RESULTS

During the study period, 276 patients underwent laparoscopic colonic resection for malignant lesions. We excluded 41 patients because the lesion was localized in the rectum, and we excluded 11 patients because they had more than 1 lesion. Of the 224 patients included in the study analysis, 148 (66.1%) had their lesion tattooed preoperatively and 76 (33.9%) did not. Patients' baseline demographic and clinical characteristics are shown in Table 1.

Table 2 summarizes differences associated with tattooing. The greatest proportion of tattooed lesions (45.5%) was in the left colon, whereas most nontattooed lesions (82.9%) were in the right colon. Most preoperative endoscopies were performed by gastroenterologists (86.6%), of which 88.7% were done by staff at our tertiary care centre. The remaining endoscopies were performed by surgeons (13.4%). Surgeons were more likely to tattoo the lesion than gastroenterologists (80% v. 63.9%,  $p = 0.10$ ). There was no statistically significant difference in the tattoo rate between local gastroenterologists and referring gastroenterologists (62.8% v. 72.7%,  $p = 0.48$ ). For 8 patients,

**Table 1. Baseline demographic and clinical characteristics of the study sample**

| Characteristic | Group; mean $\pm$ SD or no. (%) |                            |                              |
|----------------|---------------------------------|----------------------------|------------------------------|
|                | Overall<br><i>n</i> = 224       | Tattooed<br><i>n</i> = 148 | Nontattooed<br><i>n</i> = 76 |
| Age, yr        | 69.5 $\pm$ 13.0                 | 69.4 $\pm$ 12.6            | 69.7 $\pm$ 12.4              |
| Male sex       | 134 (60.7)                      | 93 (62.8)                  | 43 (56.6)                    |
| BMI            | 25.5 $\pm$ 4.7                  | 25.4 $\pm$ 5.1             | 25.6 $\pm$ 4.0               |
| ASA score      |                                 |                            |                              |
| 1              | 16 (7.1)                        | 13 (8.8)                   | 3 (3.9)                      |
| 2              | 120 (53.6)                      | 71 (48.0)                  | 49 (64.5)                    |
| 3              | 87 (38.8)                       | 63 (42.6)                  | 24 (31.6)                    |
| 4              | 1 (0.4)                         | 1 (0.7)                    | 0 (0)                        |

ASA = American Society of Anesthesiologists; BMI = body mass index; SD = standard deviation.

tattoos were carried out during a second endoscopy, as they had not been tattooed on the first endoscopy and it was deemed necessary by the surgeon preoperatively. The endoscopy reports of 44 (19.6%) patients were missing information regarding tattooing and localization of the lesion. There was no difference in the percentage of lesions seen on computed tomography (CT) scan between the 2 groups. Twenty-three (15.5%) patients had their lesions tattooed at a site other than distal to the lesion; 16 were tattooed proximally, and 7 were tattooed both proximally and distally.

Table 3 shows the operative outcomes. Overall, endoscopic localization was accurate in 68.8% of tumours. Of the 70 lesions inaccurately localized by endoscopy, 8 were in the upper rectum (described as sigmoid), 8 were in the sigmoid (described as descending colon), 7 were in the descending colon (described as sigmoid), 6 were in the splenic flexure (described as hepatic flexure), 16 were in the transverse colon (4 described as right colon, 4 as descending colon and 8 as splenic flexure), 12 were at the hepatic flexure (described as cecum) and 13 were in the cecum (described as hepatic flexure). Endoscopic localization was more accurate in the nontattooed group than in the tattooed group (82.9% v. 61.5%,  $p = 0.002$ ). Of the tattooed lesions, 116 (78.5%) were visualized intraoperatively. Of

the 32 tattoos that were not visualized, 16 were in the right colon, 1 in the hepatic flexure, 2 in the transverse colon, 3 in the splenic flexure, 3 in the descending colon, 5 in the sigmoid and 2 in the rectosigmoid.

These inaccurate endoscopic localizations led to intraoperative changes in surgical plan in 15.2% of patients. The majority of these occurred in the tattooed group (19.6% v. 6.6%,  $p = 0.018$ ). Of the 34 patients with an on-table alteration in surgical plan, 8 had an anterior resection instead of a planned left hemicolectomy, 1 had an anterior resection instead of a planned low anterior resection, 11 had a left hemicolectomy instead of a planned anterior resection, 5 had a right hemicolectomy instead of a planned extended right hemicolectomy, 7 had an extended right hemicolectomy instead of a planned right hemicolectomy and 2 had a subtotal colectomy instead of a right hemicolectomy ( $n = 1$ ) or left hemicolectomy ( $n = 1$ ).

Conversion to open surgery owing to inability to locate or feel the lesion occurred in 3 patients. One patient had a hepatic flexure lesion that was not tattooed and was described as localized in the transverse colon at endoscopy. Two patients had tattooed lesions that were not visualized at surgery: 1 in the descending colon and 1 in the sigmoid. Intraoperative endoscopy was needed in 7 patients, including 5 patients whose tattoos could not be

**Table 2. Endoscopic localization, tattooing and imaging data**

| Characteristic                             | Group; no. (%)            |                            |                              | <i>p</i> value |
|--|---------------------------|----------------------------|------------------------------|----------------|
|  | Overall<br><i>n</i> = 224 | Tattooed<br><i>n</i> = 148 | Nontattooed<br><i>n</i> = 76 |                |
| Localization at endoscopy                  |                           |                            |                              | < 0.001        |
| Right colon                                | 121 (53.9)                | 58 (39.3)                  | 63 (82.9)                    |                |
| Transverse colon                           | 17 (7.6)                  | 15 (10.1)                  | 2 (2.6)                      |                |
| Left colon                                 | 77 (34.5)                 | 67 (45.5)                  | 9 (11.9)                     |                |
| Rectosigmoid                               | 9 (4.0)                   | 7 (4.9)                    | 2 (2.6)                      |                |
| Endoscopy performed by                     |                           |                            |                              | 0.10           |
| Gastroenterologist                         | 194 (86.6)                | 124 (63.9)                 | 70 (36.1)                    |                |
| Surgeon                                    | 30 (13.4)                 | 24 (80)                    | 6 (20)                       |                |
| Second endoscopy necessary                 | —                         | 8 (5.4)                    | —                            | —              |
| Missing information on tattooing in report | 44 (19.6)                 | 15 (10.1)                  | 29 (38.2)                    | < 0.001        |
| Lesion seen on CT                          | 115 (51.3)                | 74 (50.0)                  | 41 (53.9)                    | 0.14           |
| Tattoo site other than distal              | —                         | 23 (15.5)                  | —                            | —              |

CT = computed tomography.

**Table 3. Perioperative outcomes**

| Outcome   | Group; no. (%)            |                            |                              | <i>p</i> value |
|---|---------------------------|----------------------------|------------------------------|----------------|
|   | Overall<br><i>n</i> = 224 | Tattooed<br><i>n</i> = 148 | Nontattooed<br><i>n</i> = 76 |                |
| Accurate endoscopic localization                                | 154 (68.8)                | 91 (61.5)                  | 63 (82.9)                    | 0.002          |
| Tattoo visualized at surgery                                    | —                         | 116 (78.5)                 | —                            | —              |
| On-table change in surgical plan                                | 34 (15.2)                 | 29 (19.6)                  | 5 (6.6)                      | 0.018          |
| Conversion to open surgery or need for intraoperative endoscopy | 10 (4.5)                  | 6 (4.1)                    | 4 (5.3)                      | 0.94           |

seen and 2 patients who did not have their lesions tattooed. All 7 lesions were located in the sigmoid, and the 2 lesions not tattooed were described as being in the descending colon at endoscopy. Only 1 patient had a microscopic positive distal margin. The lesion was located in the sigmoid and had not been tattooed before surgery.

There was no significant difference between the tattooed and nontattooed groups in intraoperative complications (1.4% v. 1.3%,  $p > 0.99$ ), median estimated blood loss (100 mL v. 100 mL,  $p > 0.99$ ), mean lymph nodes retrieved (20.4 v. 20.0,  $p = 0.96$ ) and median length of hospital stay (5 d v. 5 d,  $p > 0.99$ ). However, the median duration of surgery was significantly longer in the tattooed than in the nontattooed group (120 min v. 97.5 min,  $p = 0.002$ ).

## DISCUSSION

Colorectal cancer screening has led to a decrease in colorectal cancer mortality and has been adopted in most economically developed countries. Increased use of fecal occult blood testing (FOBT) and fecal immunochemical tests for hemoglobin (FIT) has led to the detection of early and smaller lesions.<sup>11,12</sup> In our series, just 50% of the lesions were visible on CT scan. With laparoscopic surgery for colonic resection, accurate preoperative and intraoperative localization of the tumour is mandatory. Tattooing is an appropriate way to assure accurate localization for small lesions not identified on CT scan. Although a few studies have recommended tattooing the lesion distally and at multiple circumferential sites,<sup>13,14</sup> no universal guideline has been adopted to ensure standardized and effective tattooing.

Our study reports an inaccuracy rate of endoscopic localization of lesions of 31.2%. This rate exceeds others reported in the literature (11%–21%).<sup>4–6</sup> Our higher inaccuracy may be explained by our categorical distinction of the hepatic flexure, ascending colon and cecum as different segments rather than including them all as the right colon. Also, we excluded distal rectal lesions that are accurately localized preoperatively by digital rectal examination and rigid sigmoidoscopy.

Additionally, there is variability in the way tattooing is performed: single versus multiple circumferential, and proximal versus distal versus both. In our study, 72.4% of tattoos were placed at a single spot. There was a significant difference in tattoo visibility rate if the tattoo was placed at a single spot versus multiple spots (70.8% v. 88.6%,  $p = 0.030$ ). The high rate of single-spot tattoos can, in part, account for the large proportion of tattoos (21.5%) that were not visible at surgery. Also, 23 patients had lesions tattooed at a site other than distally, which could lead to confusion as to lesion location during surgery, with potential removal of the wrong segment of bowel or positive margin. Furthermore, in our study there was missing information in regards to tattooing for

43 patients, indicating the need for standardized documentation of tattooing.

Adverse outcomes resulted from inaccurate lesion localization in 45 of 224 (20%) patients in our study: 34 patients had an on-table alteration in surgical plan, 3 patients needed conversion to open surgery to localize the lesion, 7 patients required intraoperative endoscopy to confirm location of the tumour and 1 patient whose lesion was not tattooed had a positive microscopic margin. Adverse outcomes may be avoidable with accurate tattooing at the preoperative endoscopy.

In our study, 33.9% of the tumours were not tattooed. This number is similar to rates of tattooing reported in the literature.<sup>15</sup> In our study, 80% of the lesions that were not tattooed were localized in the right colon at endoscopy. Likely, endoscopists did not feel that tattooing was needed if the lesion was visualized in proximity to the landmarks of the ileocecal valve and appendiceal orifice. However, in our study, 25 of the 70 inaccurately localized lesions were described as being in the right colon at endoscopy. We recommend that all potentially significant lesions are tattooed, even those located in the right colon or rectum. Also, if the lesion is not tattooed, we recommend a second colonoscopy be performed to tattoo the lesion if it is not visible on CT scan.

Arguments supporting the recommendation of tattooing all cancers and suspicious polyps include safety and low cost.<sup>16</sup> In our series, no complications resulted from endoscopic tattooing. There was also no difference in the number of lymph nodes retrieved or in intraoperative complication rates from tattooing. Shorter duration of surgery in our nontattooed group was explained by the higher number of right-sided lesions that were not tattooed.

## Limitations

Our study was limited by its retrospective design and single-institution experience. The decision to tattoo or not tattoo the lesion was at the discretion of the endoscopist, which introduced potential selection bias. Additionally, absence of standardized endoscopy reporting on tattooing resulted in missing or incomplete data. Finally, there were no data on the use of a scope guide, which can help with localization of the lesion.

## CONCLUSION

To improve surgical planning and outcomes, we recommend endoscopic tattooing of all cancers and suspicious polyps just distal to the lesion using multiple injections to cover the circumference of the bowel wall as well as recording all pertinent information in the endoscopy report. Every institution should establish clear guidelines to ensure standard practice among endoscopists and to increase accuracy rates.

**Affiliations:** From the Department of Surgery, Faculty of Medicine, University of British Columbia, Vancouver, BC (Letarte, Webb, Raval, Karimuddin, Brown, Phang); and the Department of Colorectal Surgery, St. Paul's Hospital, Vancouver, BC (Letarte, Raval, Karimuddin, Brown, Phang).

**Competing interests:** P.T. Phang is a consultant with Servier. No other competing interests declared.

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## References

1. National Cancer Institute. Surveillance, Epidemiology, and End-Results Program. Available: <http://seer.cancer.gov/data/> (Accessed 2016 May 10).
2. Hospital Episode Statistics. Proportion of colorectal resections undertaken laparoscopically in England. Available: [www.lapco.nhs.uk/activity-latest-HES-data.php](http://www.lapco.nhs.uk/activity-latest-HES-data.php) (accessed 2016 May 12).
3. Wexner SD, Cohen SM, Ulrich A, et al. Laparoscopic colorectal surgery—are we being honest with our patients? *Dis Colon Rectum* 1995;38:723-7.
4. Vignati P, Welch JO, Cohen L. Endoscopic localization of colon cancers. *Surg Endosc* 1994;8:1085-7.
5. Cho YB, Lee WY, Yun HR, et al. Tumor localization for laparoscopic colorectal surgery. *World J Surg* 2007;31:1491-5.
6. Piscatelli N, Hyman N, Osler T. Localizing colorectal cancer by colonoscopy. *Arch Surg* 2005;140:932-5.
7. Beretvas RI, Ponsky J. Endoscopic marking: an adjunct to laparoscopic gastrointestinal surgery. *Surg Endosc* 2001;15:1202-3.
8. Ellis KK, Fennerty MB. Marking and identifying colon lesions. Tattoos, clips, and radiology in imaging the colon. *Gastrointest Endosc Clin N Am* 1997;7:401-11.
9. European Commission. European guidelines for quality assurance in colorectal cancer screening and diagnosis; 2011. Available: [www.europacol.com](http://www.europacol.com) (accessed 2016 May 11).
10. Atkin WS, Saunders BP. Surveillance guidelines after removal of colorectal adenomatous polyps. *Gut* 2002;51:V6-9.
11. Van Rossum LG, Van Rijn AF, Laheij RJ, et al. Random comparison of guaiac and immunochemical fecal occult blood tests for colorectal cancer in a screening population. *Gastroenterology* 2008;135:82-90.
12. UK Colorectal Cancer Screening Pilot Group. Results of the first round of a demonstration pilot of screening for colorectal cancer in the United Kingdom. *BMJ* 2004;329:133.
13. Jenkins IJ, Kennedy R. Laparoscopic surgery and enhanced recovery programs in colorectal disease. In: *Colorectal Surgery*; 2009. New York (NY): Elsevier. p.282.
14. Yeung JM, Maxwell-Armstrong C, Acheson AG. Colonic tattooing in laparoscopic surgery — making the mark? *Colorectal Dis* 2009;11:527-30.
15. Conaghan PJ, Maxwell-Armstrong CA, Garrioch MV, et al. Leaving a mark: the frequency and accuracy of tattooing prior to laparoscopic colorectal surgery. *Colorectal Dis* 2011;13:1184-7.
16. Park JW, Sohn DK, Hong CW, et al. The usefulness of preoperative colonoscopic tattooing using a saline test injection method with pre-packaged sterile India ink for localization in laparoscopic colorectal surgery. *Surg Endosc* 2008;22:501-5.