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WHEN AND HOW TO USE ENDOSCOPIC TATTOOING IN THE COLON: AN INTERNATIONAL DELPHI AGREEMENT

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This manuscript is the result of a cooperative study conducted by 29 experts from different countries. Therefore, different collaborators have participated evaluating the proposed statements in successive rounds which makes the number of authors higher than usual. All authors meet the authorship requirements. Unfortunately, we cannot remove any of the participant authors.

Rodrigo Jover, Cesare Hassan, Evelien Dekker and Raf Bisschops created and designed the project.

Rodrigo Jover, Cesare Hassan, Evelien Dekker and Raf Bisschops, Sergio Alfieri, Pradeep Bhandari, Michael J. Bourke, Raquel Bravo, Marco Bustamante-Balen, Jason Dominitz, Monika Ferlitsch, Paul Fockens, Monique van Leerdam, David Lieberman, Maite Herráiz, Charles Kahi, Michal Kaminski, Takahisa Matsuda, Alan Moss, Maria Pellisé, Heiko Pohl, Colin Rees, Douglas K. Rex, Manuel Romero-Simó, Matthew D. Rutter, Prateek Sharma, Aasma Shaukat, Siwan Thomas-Gibson and Roland Valori reviewed and indicated a level of agreement with each item of the baseline questionnaire developed by the steering committee in successive rounds until consensus was reached.

Rodrigo Jover and Lucía Medina-Prado drafted, reviewed and edited the article. All authors have contributed to critical revision of the article and final approval.

Competing interests:

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ABSTRACT

BACKGROUND: There is a lack of clinical studies to establish indications and methodology for tattooing, therefore technique and practice of tattooing is very variable. We aimed to establish a consensus on indications and appropriate techniques for colonic tattoo through a modified Delphi Process.

METHODS: The baseline questionnaire was classified into 3 areas: where tattooing should not be used (1 domain, 6 questions), where tattooing should be used (4 domains, 20 questions) and how to perform tattooing (1 domain 20 questions). A total of 29 experts participated in the 3 rounds of the Delphi process.

RESULTS: A total of 15 statements were approved. The statements that achieved the highest agreement were: Tattooing should always be used after endoscopic resection of a lesion with suspicion of submucosal invasion. (Agreement score 4.59; degree of consensus 97%). For a colorectal lesion that is left in situ but considered suitable for endoscopic resection, tattooing may be used if the lesion is considered difficult to detect at a subsequent endoscopy. (Agreement score 4.62; degree of consensus 100%). A tattoo should never be injected directly into or underneath a lesion that might be endoscopically removed at a later point in time. (Agreement score 4.79; degree of consensus 97%). Details of the tattoo injection should be clearly stated in the endoscopy report. (Agreement score 4.76; degree of consensus 100%)

CONCLUSION: This expert consensus has developed different statements about where tattooing should not be used, when it should be used and how that

should be done.

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BACKGROUND

Tattooing is a technique that is used to facilitate future localization of malignant and pre-malignant lesions in the digestive tract. The endoscopic orientation within the colon is complicated by the absence of reliable internal anatomic landmarks between the ileocecal valve and anal verge, and numerous reports have stated low accuracy especially in localization of lesions in the left and transverse colon ¹

A significant difference between the location of colorectal cancers reported by gastroenterologists during endoscopy and the actual anatomical location in surgery or surgical specimens at pathology has been reported ². For this reason, tattooing is particularly important for identification of colonic lesions to enable surgical treatment of neoplasia and for future endoscopic localization of lesions and post-treatment scars ^{3,4}.

However, there is a lack of clinical studies to establish indications and methodology for tattooing and the technique and practice of tattooing remains highly variable and largely conducted on an individual basis without clear recommendations or consensus for its use ⁵. Therefore, important inconsistencies between reported and actual practices have been reported ⁶. This uncertainty may lead to unfavourable outcomes, such as misleading guidance from endoscopists to surgeons which may adversely affect surgical outcomes. Alternatively, inappropriate injection of the tattoo too close to a polyp or polypectomy site, may result in fibrosis beneath the polyp ^{7,8}. This may significantly impair the ability to remove the polyp, increases the risk of adverse events during polypectomy and may prevent adequate treatment of possible recurrence at surveillance colonoscopy.

For this reason, we sought to establish a consensus on indications and appropriate techniques for colonic tattoo placement.

METHODS

Study design

This study was based on the Delphi process methodology and was developed through a web application (<http://calite-revista.umh.es/delphi>). The Delphi process is a structured technique designed to build consensus among experts about a topic in which the available scientific evidence may not be robust enough to develop definitive conclusions⁹. In this process, a steering committee developed a baseline questionnaire with multiple statements, and then each member of an expert group reviewed and indicated a level of agreement with each specific item. Successive rounds identify those elements for which a high degree of consensus is achieved.

Steering committee

The steering committee was composed of 4 gastroenterologists with expertise in colonoscopy (RJ, CH, ED and RB). This steering committee developed the baseline questionnaire and its subsequent versions.

Baseline questionnaire

The baseline questionnaire was developed based on literature review. Search terms were: colonoscopy, tattooing, surveillance, polypectomy, laparoscopic surgery identification. Members of the steering committee conducted an extensive literature search for relevant English language articles

on these topics, up to January 2019, in Medline, Scopus and Cochrane databases. This search included relevant polypectomy guidelines^{4,10} and cross-references. The initial questionnaire items were formulated exclusively by the members of the steering committee. After the questionnaire was finalized, the voting process commenced.

The questionnaire included 3 domains and 46 individual statements. The domains were classified into 3 areas: where tattooing should not be used (1 domain, 6 questions), where tattooing should be used (4 domains, 20 questions) and how to use tattooing (1 domain 20 questions).

Expert panel

A total of 33 experts were invited to participate in the successive rounds of the Delphi process, together with the steering committee members, finally 29 experts answered these rounds. The criteria for inclusion in the expert panel was knowledge and expertise demonstrated by previous or current research on colonoscopy technique and quality, peer-reviewed publications in the field, and/or participation in national and international guideline development. For specific questions also 5 experts in abdominal surgery were invited (These questions can be seen in **table 1 and 2**) The expert selection made an effort to ensure representation from Europe, US and Asia-Pacific region.

The Delphi rounds and consensus meeting

The agreement with each statement was scored using a Likert scale with 5 possible answers (strongly disagree: 1 point, disagree: 2 points, neither agree nor disagree: 3 points, agree: 4 points, strongly agree: 5 points). Participants were allowed to include personal opinions as well as to propose revise wording for each item.

A total of 3 voting rounds were performed between May 2019 and February 2020 (**Figure 1**). Participants received feedback about the results after each round (average agreement score and degree of consensus for each statement). Consensus was defined using 2 measures: first, as an average score for the agreement (agreement score) in the range from 1 to 5, with the statement equal or higher than 4 points (agree-strongly agree), or equal or lower than 2 points (disagree-strongly disagree); and second, as a degree of consensus between panellists, defined by the percentage of responses agree and strongly agree. If the agreement score was equal to or higher than 4 points, and the consensus of agree and strongly agree was equal or higher than 80%, the statement was accepted. On the other hand, when the agreement score was equal to or lower than 2 points, the statement was taken out. Statements with an intermediate agreement score (2-4 points) were adapted in the subsequent round. When consensus was not reached, statements were rephrased based on participant comments and panel discussions, and re-submitted for possible consensus in a following voting round. In these successive rounds, decision on statements that scored close to the threshold for acceptance, was adopted after discussion by the steering committee.

RESULTS

Accepted and non-accepted statements are summarized in **table 1 and 2** respectively, including their corresponding agreement scores and degree of consensus. Successive rounds of questions were performed as can be seen in **Figure 1**.

Below we summarize the findings and conclusions of the Delphi process.

1. CONTRAINDICATIONS AND INDICATIONS FOR TATTOOING

Contraindications

Statement 1: *Tattooing should not be used in the cecum* (Agreement score 4.37; degree of consensus 85%)

Statement 2: *In general, tattooing should not be performed in the rectum* (Agreement score 4.10; degree of consensus 79%)

We obtained quick consensus on not to perform tattooing in the cecum, because there is already a natural landmark for this location such as the ileocecal valve and appendiceal orifice. On the other hand, consensus was not so easily obtained about the use of tattooing in the rectum. Finally, after 2 rounds, agreement was reached on the statement that in general tattooing should not be performed in the rectum. We did not succeed in reaching agreement on the exceptions to this general advice. Mostly, it seemed a matter of local agreements between endoscopists and surgeons.

Tattooing in the rectum is controversial because of the higher rate of mesorectal spilling of tattooing, being considered for some surgeons as

inconvenient, because it may complicate subsequent surgery. Moreover, the location is readily measured from the anal verge. Rectal surgery requires precision to avoid stoma and optimise functional results and tattooing is fairly imprecise and the submucosal dispersion of tattoo cannot be predicted with any great accuracy. However, there are also reports showing some advantages of tattooing in the rectum, such as the reduction of preventive ileostomy rates ¹¹ or a higher rate of retrieved lymph nodes in patients receiving neoadjuvant chemo-radiotherapy ¹².

Indications for tattooing

We described 4 scenarios: a) deep invasive cancer; b) resected superficial neoplasia at risk of submucosal invasion; c) neoplasia left in situ that will be resected at a following occasion and d) resected polyp with an indication of surveillance of the polypectomy site.

a. Deep invasive cancer.

Statement 3: *Tattooing should be used in case of an endoscopic diagnosis of deep invasive cancer.* (Agreement score 4.52; degree of consensus 97%)

In case of an endoscopic diagnosis of deep invasive cancer, surgical treatment is commonly indicated and tattooing is used to facilitate tumour location, especially in case of laparoscopic surgery ¹. At minimally invasive surgery, the tumor is not palpable by the surgeons, and therefore the tumor location must be determined prior to the patients' arrival in the operating room. A blind resection may lead to resection of the wrong colonic segment, an

unexpected change in the previously planned procedure, or a permanent ostomy. Although deep invasive cancer is a clear indication for tattooing and there was significant agreement on that, large variability has been described in clinical practice ⁶. It is important to remark that in case of suspected cancer, the tattoo should be placed prior to the biopsy of the lesion, in order to avoid inadvertent contamination of the needle with malignant cells via the biopsy channel of the scope and subsequent cancer inoculation into another colonic site ¹³.

b. Superficial neoplasia at risk of submucosal invasion after resection:

Statement 4: *Tattooing should always be used after endoscopic resection of a lesion with suspicion of submucosal invasion.* (Agreement score 4.59; degree of consensus 97%)

Consensus was reached about tattooing all the endoscopically identified neoplasia where the endoscopist has a suspicion of potential submucosal invasion. This recommendation is in line with polypectomy guidelines ^{4,10}, and there is consensus that these lesions should be always tattooed independently of their shape, size or the chance of redetecting the location at a next endoscopy. Given the potential need of follow-up treatment by surgery, circumferential tattooing should be placed at the first colonoscopy.

c. Neoplasia that is referred for resection at a subsequent

colonoscopy:

Statement 5: *For a colorectal lesion that is left in situ but considered suitable for endoscopic resection, tattooing may be used if the lesion is considered difficult to detect at a subsequent endoscopy.* (Agreement score 4.62; degree of consensus 100%)

In case consensus was reached on tattooing only those that are considered difficult to detect at a subsequent colonoscopy. No agreement was achieved in terms of shape or size of these lesions, so this indication is based on the judgement of the endoscopist. Whereas injection of appropriately diluted and sterile solutions is generally safe, with rare complications mainly related to transmural injection ¹⁴, unnecessary tattooing must be avoided. This is for safety reasons, as well as to preclude multiple markings in the colon for the future which could potentially complicate endoscopic identification of one specific target lesion. Special mention should be made regarding transverse colon, because unique aspects of length, relative mobility and often significant shortening of this colonic segment during colonoscopy make it particularly subject to variable performance characteristics at subsequent colonoscopy, challenging timely and accurate lesion localization. Same can be considered for sigmoid colon, although to a much lesser extent.

d. Resected polyp that needs future surveillance of the polypectomy**scar**

Statement 6: *A tattoo should be placed for polyps ≥ 20 mm resected piecemeal with additional predictors of recurrence.* (Agreement score 4.04; degree of consensus 84%)

Tattoo ink may be placed after finishing an endoscopic mucosal resection (EMR) to enable future detection of the scar, which is not always readily apparent at endoscopy. Scars appear as white discolorations of the colonic wall, associated with disruption of the mucosal vascular pattern and haustral folds. Also, this indication has a wide variability in clinical practice. Only one possibility reached consensus: lesions with a size larger than 20 mm with additional predictors of recurrence. In cases with uncertainty about completeness of the resection, the statement “*A tattoo should always be placed when there is uncertainty about the completeness of the resection (either after pEMR or after a non-radical resection)*” obtained an agreement score of 4.00, but degree of consensus was only 71%, below the accepted threshold. However, this situation may also be considered as a potential indication for tattooing.

Additional predictors of recurrence can be considered ^{11,18}: lesions larger than 40 mm, use of complementary thermal techniques for resection, prior failed attempts at resection and size, morphology, site and access scale level ¹⁰ . After EMR of large polyps, residual neoplasia should be excised using hot and cold avulsion ¹⁷. Use of thermal ablation of visible residual neoplasia is a strong predictor of recurrence ^{16,18}. However, thermal ablation of the mucosal defect margin with argon plasma or soft coagulation can be used as adjuvant treatment for invisible recurrence, having been proven as safe and highly effective ¹⁹. No consensus was reached on size or method of resection as the only criteria for tattoo placement, for instance in all lesions larger than 20 mm resected piecemeal.

2. METHODOLOGY OF TATTOOING

Technique of tattooing

Statement 7. *Technique of tattoo: a saline bleb in the submucosal layer should be created before tattooing.* (Agreement score 4.17; degree of consensus 79%)

Statement 8. *A tattoo should never be injected directly into or underneath a lesion that might be endoscopically removed at a later point in time.* (Agreement score 4.79; degree of consensus 97%)

Statement 9. *The volume of each tattoo should be enough to ensure adequate visualization at later procedures and generally not to exceed 1 ml per injection site.* (Agreement score 3.96; degree of consensus 85%)

Experts agree on the technique of creating a saline bleb (**Figure 2**)¹⁶ in order to ensure adequate submucosal injection of the tattoo ink and to prevent dye infiltration of the muscularis propria or a transmural injection, which leads to diffuse staining and potential spillage into the peritoneum²⁰. This technique has been associated with fewer errors in localization¹. Agreement was also achieved regarding the advice of avoiding direct injection into lesions, especially when future endoscopic treatment is expected, in order to avoid submucosal fibrosis that could hamper or prevent future endoscopic resection of lesions⁸, or even facilitate spread of malignant cells if they are directly injected during tattoo placement²². There was also agreement about a maximum volume of 1 ml per injection site to avoid unwanted tattoo dispersion, although data to support this are absent.

Location and number of tattoos

Statement 10. *For the localization of polyps or scars tattoos should be placed 3-5 cm distal (anal side) of the lesion.* (Agreement score 3.93; degree of consensus 79%)

Statement 11. *For localization of lesions referred for surgery, 2 or 3 tattoos should be placed circumferentially at necessary sites.* (Agreement score 4.17; degree of consensus 93%)

Statement 12. *For the localization of polyps or scars at a subsequent endoscopy, in general only one tattoo is needed.* (Agreement score 4.03; degree of consensus 83%).

This group of statements addressed the localization and characteristics of tattooing. In general tattoos should be placed 3-5 cm distal in the anal side of the lesions for further identification, moreover this location should be adequately reported in the endoscopy report. There are differences in the technique between marking a deep invasive cancer for surgery and marking a lesion for further endoscopic resection (**Figure 3**). For surgery it is important to circumferentially place the tattoos, in order to facilitate laparoscopic identification in any case²³. Marking at the site of the mesenteric colon may go unnoticed, a situation that is avoided with 2-3 tattoos¹. For future endoscopic resections, it is important to establish adequate marking without increasing the risk of fibrosis. With one single tattoo, adequate visualization is achieved avoiding potential risk of complications. This tattoo should however be placed at

least 3-5 cm anally from the lesion, in order to avoid diffusion of ink under the lesion that may hamper future endoscopic resection. For this purpose, using a limited injection volume of ≤ 1 ml is also important.

Documentation of tattooing

Statement 13. *Details of the tattoo injection should be clearly stated in the endoscopy report.* (Agreement score 4.76; degree of consensus 100%)

Statement 14. *The tattoo should be photo-documented in the endoscopy report.* (Agreement score 4.30; degree of consensus 90%)

Statement 15. *An institutional protocol for tattooing should be implemented in each centre.* (Agreement score 4.45; degree of consensus 93%)

Finally, consensus was reached about different aspects of the documentation of tattooing, underscoring the importance of adequately reporting details of tattooing, such as estimated location, number, volume or distance to the lesion, as well as photo-documentation with pictures or video that could facilitate localization of the marked lesion in future endoscopies^{4,14}. Aside of cecum and rectum, the location of the lesions cannot be exactly ascertained by endoscopists. Because of that, location estimated in the endoscopy report should always be considered as approximate, being this the main reason for placing tattoos. Patients who have received tattoos should be told that a tattoo is present, and future colonoscopists must be notified of the presence, reason and location of the tattoo. It is also important that local institutional protocols are in place in endoscopy units and tumor multidisciplinary committees in order to

make clear instructions about this important part of endoscopy.

DISCUSSION

Accurate localization of significant neoplastic lesions within the colorectum is critical to ensure their timely identification at subsequent surveillance or treatment by colonoscopy or surgery. The placement of an indelible tattoo by submucosal injection of sterile carbon particle suspension is the major means by which this is done. According to this Delphi multidisciplinary consensus process there is a need for clear standardization of endoscopic tattooing indications, technique, and documentation in order to prevent errors of lesion localization at subsequent endoscopy or surgery.

The relevance of this agreement is its comprehensive perspective which allowed us to identify four possible tattoo indications, namely surgical localization for either deep or superficially invasive cancer, as well as endoscopic localization of lesions that remain in situ or post-resection scar. In addition, we showed that different indications result in a different number of tattoos, mainly due to the different therapeutic approaches required. Similarly, the proposed standard of injecting only anally and on at least two quadrants before referring a lesion to surgery represents an important point of transparency to prevent misunderstanding with the surgeon.

The results of this Delphi process establishes an expert agreement on indications and technical aspects of tattooing of colorectal lesions. Experts were

selected because of their clinical and research track record and implicit knowledge and publications about quality of colonoscopy, polypectomy technique and participation in national and international guidelines. Colonic surgeons were included to provide additional user face expertise on the topic. The panel of experts that have participate in this Delphi process includes some of the most prolific and influential professionals in the field of colonoscopy. However, it is important to note that expert opinion may have the limitation of offering a different point of view in some respects, from that found in community endoscopists. Our consensus set the basic indications and methodology of this useful technique, trying to avoid variability, at least in the most elemental points about when (and when not) to use it and how to perform and document tattooing. Organized expert consensus, using tools like the Delphi process is an optimal way to establish basic agreement in clinical practice, especially in topics where research and sound evidence is scarce. Ultimately, this type of consensus is aimed at improving the quality of management of patients with CRC or colonic polyps. Adoption of recommendations of this consensus statement will avoid consequences of inadequate localisation of CRC at surgery, incorrect treatment of polyps or polypectomy scars as well as potential complications of this technique. Moreover, these statements set the baseline for future research on this topic (**table 3**).

In summary, this expert consensus has identified several areas of agreement regarding the appropriate use of colorectal tattooing, developing different clear statements about where tattooing should not be used, when it should be used and how that should be done. These statements are a starting point for good clinical practice as well as for future research studies that could

further improve the appropriateness and utility of tattooing in endoscopy.

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Table 1. Statements with consensus

Domain	Sentence	Agreement score	Degree of consensus (%)	SD
1. When should tattooing not be used? *	Tattooing should not be used in the cecum	4.37	85	0.84
	In general, tattooing should not be performed in the rectum	4.10	79	1.11
2. When should tattooing be used (see exceptions. part 1)				
2A. When should tattooing be used in case of deep invasive cancer? *	Tattooing should be used in case endoscopic diagnosis of deep invasive cancer	4.52	97	0.57
2B. When should tattooing be used in case of superficial neoplasia at risk of submucosal cancer after resection?	Tattooing should always be used after endoscopic resection of a lesion with suspicion of submucosal invasion	4.59	97	0.57
2C. When should tattooing be used in case of superficial neoplasia that needs to be resected at the next examination?	For a colorectal lesion that left in situ but considered suitable for subsequent endoscopic resection, tattooing may be used if the lesion is considered difficult to detect in future endoscopy	4.62	100	0.49
2D. In which of these scenarios would you put a tattoo after polyp removal because of need of future surveillance?	Polyps > 20 mm resected in piecemeal with additional predictors of recurrence	4.04	84	1.06
3. How should tattoos be placed?	Technique of tattoo, a saline bleb in the submucosal layer should be created before tattooing	4.17	79	0.87
	For the localization of polyps or scars tattoos should be placed 3-5 cm distal (anal side) of the lesion	3.93	79	0.72
	For localization of lesions referred for surgery 2 or 3 tattoos should be placed circumferentially at necessary sites*	4.17	93	0.66
	A tattoo should never be injected directly into or underneath a lesion that maybe endoscopically removed at a later point	4.79	97	0.49
	For the localization of polyps or scars at a subsequent endoscopy, in general only one tattoo is needed	4.03	83	0.82
	The volume of each tattoo should be enough to ensure adequate visualization at later procedures and generally not to exceed 1 ml per injection site	3.96	85	0.65
	Details of the tattoo injection should be clearly stated in the endoscopy report	4.76	100	0.44
	The tattoo should be photo-documented in the endoscopy report	4.30	90	0.67
	An institutional protocol for tattooing should be implemented in each	4.45	93	0.74

*Questions were surgeons were allowed to participate in

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Table 2. Statements where consensus was not reached

Domain	Sentence	Agreement score	Degree of consensus (%)	SD
1. When should tattooing not be used? *	Tattooing should not be used in the right colon	1.93	11	1.14
	Tattooing should not be used proximal to splenic flexure	1.37	0	0.63
	Tattooing could be used in the rectum in case of deep invasive cancer	2.63	30	1.24
	Tattooing could be used in the rectum in case of superficial neoplasia at risk of submucosal cancer after resection	3.11	59	1.22
	Tattooing could be used in the rectum for detection of potential recurrence after endoscopic resection	3.11	56	1.34
	Tattooing should be used in the rectum in case of neoadjuvant chemo-radiotherapy treatment	2.52	19	1.01
	Tattooing could be considered in the rectum. when required for localization at surgery or neoadjuvant treatment	3.52	66	1.33
2. When should tattooing not be used (see exceptions, part 1)				
2A. When should tattooing be used in case of deep invasive cancer? *	Tattooing should be used always	2.85	41	1.13
	Tattooing should be used only if referred for surgery	2.74	33	1.23
	Tattooing should be used only if cancer is considered difficult to identify at surgery	2.85	38	1.35
2B. When should tattooing be used in case of superficial neoplasia at risk of submucosal cancer after resection?	Tattooing should be used only if non-pedunculated lesion	2.41	15	1.12
	Tattooing should be used only if lesion considered difficult to identify in future procedures	2.74	30	1.23
	Tattooing should be used in all the lesions higher than 20 mm because they could be considered as suspicious of invasive CRC	2.85	44	1.38
2C. When should tattooing be used in case of superficial neoplasia that needs to be resected at the next examination?	Tattooing should be used always	2.44	30	1.37
	For a colorectal lesion that is left in situ but considered suitable for subsequent endoscopic resection, tattooing should always be performed (see exceptions. part 1)	2.79	31	1.29
	Tattooing should be used only if referred for surgery	2.37	19	1.18
	Tattooing should be used only if referred for endoscopic treatment	2.07	11	0.96
	Tattooing should be used only if > 20 mm	2.19	11	0.92
	Tattooing should be used only if > 10 mm	2.19	11	0.96
	Tattooing should be used only if non-pedunculated lesions	2.41	22	1.15
2D. In which of these scenarios would you put a tattoo after polyp removal because of need of future surveillance?	Polyps > 10 mm resected in piecemeal	2.60	20	0.91
	Any resected polyp > 20 mm	3.04	42	1.20
	Polyps > 20 mm resected in piecemeal	3.48	64	1.29
	Any resected polyp, irrespectively of the size. when the scar could be considered as difficult to identify in future procedures	3.31	50	1.35
	A tattoo should only be placed when there is uncertainty about the completeness of the resection (either after pEMR or after a non-radical resection) if future detection of the scar might be difficult (see exceptions. part 1)	3.34	59	1.32
	A tattoo should always be placed when there is uncertainty about the completeness of the resection (either after pEMR or after a non-radical resection)	4.00	71	1.09
	Technique of tattoo, tattoo can be made by direct injection	2.76	36	1.09
3. How should tattoos be placed?	In case of a planned ileo-colonic anastomosis, only one site needs to be tattooed 5 cm distal (anal side) from the lesion*	3.39	57	0.96
	In case of a planned colo-colonic anastomosis, one site 5 cm anally from the lesion and one site 5 cm orally from the lesion should be tattooed*	2.68	25	1.12
	In case of a planned colo-colonic anastomosis, only one location should be marked by tattoo: 5 cm distal (anal side) from the lesion*	3.18	46	1.12
	Location of tattoo, tattoos should be placed 3-5 cm proximal to the lesion (cecal side of the lesion)*	2.22	11	0.89
	Location of tattoo, tattoos should be placed 3-5 cm in both sides of the lesion (distal and proximal)*	2.22	11	0.97
	Location of tattoo, the tattoo location does not matter as long as the location is clearly stated in the endoscopy report*	2.73	38	1.40
	Number of tattoos, just one tattoo on the same side of the lesion should be placed*	2.15	12	0.83
	Number of tattoos, just one tattoo on the opposite side of the lesion should be placed*	2.38	23	0.98
	Number of tattoos, at least two tattoos (distal and proximal) should be placed*	2.20	12	0.91
	Number of tattoos, at least two tattoos on opposite sides of the colonic lumen should be placed*	3.35	58	1.13
	Number of tattoos, 3-4 circumferential tattoos should be placed*	2.65	27	0.98
	Number of tattoos, the number of tattoos does not matter as long as the details are clearly stated in the endoscopy report*	2.58	33	1.06
	Number of tattoos, it depends on the indication of tattooing: circumferential tattooing for CRC or polyps sent to surgery; one tattoo is enough for polyps amenable to endoscopic review*	3.85	77	0.78
	Volume of tattooing, 1 ml. of tattoo should be injected per site	3.25	50	0.94
	Volume of tattooing, 2 ml. of tattoo should be injected per site	2.33	13	0.92
	Volume of tattooing, enough amount of tattoo should be injected per site able to ensure adequate visualization	3.85	81	0.95

*Questions were surgeons were allowed to participate in

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Table 3. Questions for future research

Research questions
Usefulness of rectal tattooing   Should tattooing be used in rectal cancer?   Should tattooing be used for localization after neoadjuvant chemoradiotherapy   Should tattooing be used in the rectum in case of potential recurrence after endoscopic resection   Which are the complications of rectal tattooing
When should tattoos be used in case of deep invasive neoplasia: prior or after biopsies?
When should tattoos be used in suspected superficial neoplasia: always or only in selected cases? Which would be these selected cases?
When should tattoos be used in cases of future endoscopic resection: always or only if considered as difficult to detect? Always in non-polypoid lesions larger than 20 mm?
When should tattoos be used in cases of future surveillance: always in piecemeal RME of lesions larger than 20 mm? always where there is uncertainty about the completeness of the resection?

FIGURE LEGENDS

Figure 1. Flow-chart of the Delphi process

Figure 2. Tattooing with saline bleb technique

Figure 3. Tattooing technique with different indications

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1. **Prime** needle with saline
2. **Advance** needle through endoscope
3. Approach and insert needle into mucosa at an **oblique** angle
4. Create **saline bleb** (to reduce risk of transmural injection)
5. Inject 0.5-1ml **of tattoo** per bleb

Tattooing for Surgical Resection

(deep invasive cancer or suspected submucosal invasion)

→ referrals to surgeon

Place the tattoos in 2-3 quadrants circumferentially, 3-5 cm from the lesion on the distal (anal) side.

Tattooing for Future Endoscopic Resection

→ referrals to interventional GIs

Place a single tattoo 3-5cm from the lesion on the distal (anal) side.

Tattooing for Surveillance of Large or Piecemeal Resected Polyps

Place the tattoo after lesion removal, 3-5cm distal from the resection defect.

WHAT YOU NEED TO KNOW

Background and context

Tattooing is particularly important for identification of colonic lesions to enable surgical or future endoscopic treatment of lesions. There is a lack of clinical studies to establish indications and methodology for tattooing.

New findings

This expert consensus has identified several areas of agreement regarding the appropriate use of colorectal tattooing, developing different clear statements about where tattooing should not be used, when and how it should be used.

(Table 1).

Limitations

This manuscript is not an experimental study. More robust evidence is needed to support the indications and technique of tattooing. Nevertheless, these statements set the baseline for future research on this topic.

Impact

Adoption of recommendations of this consensus statement will avoid consequences of inadequate localisation of CRC at surgery, incorrect treatment of polyps or polypectomy scars as well as potential complications of this technique.

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