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Endoscopic tattoo: the importance and need for standardised guidelines and protocol

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Summary

Preoperative endoscopic tattoo is becoming more important with the advent of minimally invasive surgery. Current practices are variable and are operator-dependent. There are no evidence-based guidelines to aid endoscopists in clinical practice. Furthermore, there are still a number of issues with endoscopic tattoo including poor intraoperative visualisation, complications from tattooing and inaccurate documentation leading to the need for intraoperative endoscopy, prolonged operative time and reoperation due to lack of oncologic resection. This review aims to collate and summarise evidence for the best practice of endoscopic tattoo for colorectal lesions in order to provide guidance for endoscopists.

Keywords

Endoscopic, tattoo, colonoscopy, colorectal surgery

Introduction

Preoperative tumour localisation with endoscopic tattoo for colorectal resections has been established for 35 years. With more surgeons training to perform minimally invasive colorectal surgeries, new challenges are beginning to surface. One of these challenges is intraoperative lesion detection and accurate localisation. Laparoscopic/robotic instruments do not provide a significant degree of haptic feedback and make locating small colonic lesions challenging.[1] A second challenge is the lack of standardisation with endoscopy practices. Often, the decision to tattoo is based on the endoscopist's clinical judgment. Currently, there is no evidence-based guideline to help clinicians navigate clinical practice. The goal of this review is to analyse current literature to provide guidance for endoscopists.

Methods

A literature search was conducted using OVID MEDLINE, Cochrane Database of Systematic Reviews, NLM PubMed and EMBASE. The search was conducted with the key words: colonoscopy, tattoo, technique, endoscopy, colorectal cancer and colorectal surgery. All relevant papers were reviewed, and the information was collated and summarised in this review.

Importance of tumour localisation

Colonoscopy is utilised in preoperative localisation of lesions, but most tumours are described in relation to major anatomic landmarks such as the ileocecal valve, hepatic flexure or splenic flexure. Endoscopists also use the length of the colonoscope that has been introduced to provide information regarding tumour location. However, these methods are limited because patients may have redundant colonic loops that make anatomical measurements challenging and inaccurate. Inaccurate tumour localisations have led to reports of laparoscopic resection of the wrong segment of colon, requiring conversion to open laparotomy and additional resection.[2] Thus, a precise tumour localising method is essential for laparoscopic colorectal tumour resection and obtaining the necessary margins. Methods that have been used historically include preoperative barium enemas, colonoscopy with clip or tattoo, CT scans, CT colonography, intraoperative colonoscopy with clip or tattoo, and proctoscopy with stitch.[2,3] Barium enemas are poor at visualising small or flat tumours.[3,4] Intraoperative colonoscopy prolongs operative time, is technically challenging and may lead to postoperative complications due to bowel distension.[2] Usage of clips is unreliable due to poor visualisation and clip migration.[2] Currently, most data strongly support the use of permanent endoscopic tattoos as the most effective means to ensure accurate intraoperative detection of colorectal lesions.[3–5]

Preoperative endoscopic tattoo

As early as 1958, Sauntry and Knudtson[6] first introduced the idea of tattooing a colonic polyp using

methylene blue and since that time further studies by Knoernschild[7] produced a series of data on 190 patients who underwent successful endoscopic tattooing. It was not until 1975, when Ponsky and King[8] suggested that endoscopic tattooing could be useful for intraoperative localisation of colonic lesions, that the technique became more widely used. Feingold et al.[3] conducted a retrospective review of 50 patients who underwent preoperative endoscopic tattooing for intraoperative tumour localisation. They reported an 88% success rate of tattoos that accurately visualised and localised the tumour leading to successful tumour resection with appropriate proximal and distal margins and lymph node retrieval.[3] Similarly, in a prospective comparative clinical study by Arteaga-González et al., patients were separated into preoperative endoscopic tattoo group (TG) or non-tattoo group (NTG), which localised the tumour intraoperatively via contrast enema. Tumours were visualised successfully and precisely in 100% of the TG vs. 80.8% of the NTG.[4] The TG also had a significantly lower operative time and operative blood loss.[4] There were no complications in the TG, whereas the NGT's lack of precise tumour visualisation led to one unnecessary resection of a healthy segment of colon and another patient with inadequate resection margins.[4] Thus, it was concluded that preoperative endoscopic tattoo is a safe, effective and arguably superior method for intraoperative tumour localisation.

Substances for tattooing

Initial studies performed by Hammond et al. experimented with a number of compounds such as methylene blue, indigo carmine, indocyanine green and India ink injected into dog colon.[9] From these initial studies, it was demonstrated that India ink is the most effective agent based on permanence and limited biologic reaction the tattoo dye.[9] India ink seemed to persist for the greatest time. Tattoos of India ink have been reassessed ten years post injection and found to have no reduction in intensity.[10] Tattoos consisting of India ink provide superb intraoperative identification with a rate of 97% of lesions at laparoscopy.[11] India ink is currently the most used and most commonly accepted substance for tattoo.

Scientists have refined the substances contained in India Ink and have generated a compound known as Spot® (GI Supply, Camp Hill, PA, USA), which consists of highly purified carbon particles as tattooing material in an attempt to reduce the mild tissue inflammation caused by traditional India Ink.[12] India ink has the disadvantage of needing to be diluted and sterilised, which is cumbersome and time-consuming. Spot® has been shown to be safe and effective without patient complications such as pain, fever or abscess, formation.[12]

Timing of endoscopic tattoo

Optimal timing of preoperative tattoo is important. Unfortunately, there is limited evidence describing the optimal time to tattoo. Conaghan et al.[13] conducted a prospective review on the frequency of tattooing prior to laparoscopic colorectal surgery and noted that there was significant disparity between practices. Currently, there is no standardised protocol for when is the best time to tattoo; however, Feingold et al. recommend tattooing at time of diagnostic colonoscopy since properly placed tattoos are permanent and long-lasting. Another option is to tattoo the day before anticipated laparoscopic colorectal resection in order to take advantage of the preoperative bowel prep.[3] Based on this, we recommend routine tattooing of any suspicious lesion at time of diagnostic procedure or repeat scope and tattoo the day before, if necessary. Timing of endoscopic tattoo still requires further analysis and considerations of cost and patient outcome should be analysed.

Technique of tattooing

In addition to utilising an appropriate dye that provides permanence, it is also important to use a systematic and clear approach to tattoo. It has been estimated that the number of incorrect resections due to lack of preoperative localisation for colorectal cancers is approximately 10–20%.[14,15] One technique for effective colonic tattooing is the 'Four Quadrant' method proposed by Hyman and Waye,[16] which ensures circumferential labelling in four 90° quadrants of the affected segment of colon. In this review, they did not specify whether proximal or distal tattoo was more beneficial. The logic behind this system is to ensure that tattoos are visible intraoperatively and not missed because they were applied along the mesenteric or retroperitoneal side of the colon. The needle should also be inserted at a 45° angle to the surface of the mucosa to ensure submucosal tattooing.[17] Tattoo beyond the submucosa increases the risk of tattoo spillage, which may cause inflammatory reactions and give false localisation parameters. Intraperitoneal spillage increases the difficulty of identifying colonic lesions as the tattoo is spilt throughout the abdomen rather than being localised to a particular area.

Sawaki et al.[18] reported a two-step method for the introduction of colonic dye as a safe method to ensure intramural instillation of India ink and to

avoid spillage. The first step involves raising a submucosal bleb in the wall of the colon with 0.5 mL of saline followed by the injection of 5 mL of India ink into the bleb. The goal of this two-step technique is to reduce the degree of intraperitoneal spillage of dye reported to be between 2.4% and 13%.[18] A similar method was introduced by Fu et al., where 3 mL of saline is initially injected into the submucosal layer with identification of submucosal elevation. Next, the saline syringe is replaced by a syringe containing India ink and 0.2 mL is injected. Finally, the India ink syringe is replaced by the saline syringe and a final flush of 2 mL saline is injected to push out the remaining India ink. The authors compared their technique to the conventional technique of injecting India ink directly into the colonic wall. There was significantly greater tumour visualisation in the new technique compared to the conventional technique, 98% vs. 86%.[19] There was no significant difference between complication rates, but the complication rate was 1.8% with the new technique as opposed to 8.3% with conventional technique.

In addition to labelling four quadrants and ensuring appropriate instillation, some authors debate as to whether or not proximal or distal tattooing is most appropriate. For many surgeons and gastroenterologists, however, the distal margin has become the standard of care to ensure adequate oncologic resection margins.[3,13,20] Sufficient distance between the lesion and tattoo is needed to minimise the risk of tumour cell seeding.[20] Although the risk is low, there is still a 0.003% to 3.3% risk of needle-track implantation of tumour cells with endoscopic tattoo.[21,22] There is currently no evidence-based recommendation on the ideal distance to tattoo; however, anywhere from 2 to 5 cm has been suggested so that the tattoo location can aid surgeons to obtain adequate oncologic resection margins.[5,19] Regardless of the endoscopist's choice of where to tattoo, we recommend accurate documentation of where tattoo was placed relative to the lesion.

Current tattoo techniques are operator-dependent. However, based on the evidence presented, the ideal method to tattoo a colonic lesion is tattooing all four 90° quadrants at 2 to 5 cm distal to the lesion using India ink.[5,16,18,19] When injecting, a pre-ink saline injection should be placed to ensure submucosal placement and to prevent spillage.[18,19] One can consider a post-ink saline injection to ensure all the India ink is injected.[19]

Rectal tumours

Unlike operative management of cancers in the ascending colon to sigmoid colon, it is debated whether or not tumours in the rectum should be tattooed. Traditionally, the practice of tattooing rectal polyps or tumours is not done.[5] The arguments behind that practice is given the proximity of the tumour to the anus, proctoscopy or digital exam can be easily done; furthermore, submucosal tattoos are difficult to visualise secondary to the thick mesorectum.[5] Rectal anatomical landmarks including the valves of Houston and mesorectum are unique to the rectum, which can act as identifying structures when localising rectal tumours. Another reason for this avoidance of rectal cancer tattooing is the possibility of local lymph node uptake of endoscopic tattooing material leading to uptake by regional lymph nodes and a false upstaging of rectal tumours on MRI. Spillage of tattoo into the mesorectal plane can make open or laparoscopic resections of rectal tumours very difficult as the dye can completely obscure normal anatomic planes needed to complete a total mesorectal excision.

However, a retrospective review done by Keller et al.[23] demonstrated potential benefit to tattooing rectal tumours. About 5–8% of presumed benign polyps removed at colonoscopy showed invasive carcinoma.[23] By not tattooing, there is no other method of identifying the location of the removed polyp.[23] It was also found that endoscopists had difficulty predicting malignant potential of polyps. Tattoos helped accurately localise sites that may have been difficult to identify via endoscopy or rectal exam; tattoo also helped plan distal resection margins for polyps that had high-grade dysplasia.[23] Given there is significant negative implications in failing to localise a rectal polyp such as inappropriate use of neoadjuvant therapy, removal of excessive lengths or wrong segment of bowel, or creation of unnecessary or permanent ostomies, being able to localise resected polyps is pertinent. That being said, this is the only published source supporting rectal polyp tattooing. Perhaps tattooing after rectal polypectomy, incomplete rectal polypectomy or prior to neoadjuvant chemoradiotherapy would be beneficial. Further studies are warranted.

Tattooing multiple lesions

Currently, there are no guidelines to instruct endoscopists on what to do in situations where there are multiple lesions or synchronous tumours. In this situation, we recommend tattooing at least 2 cm proximal to the most proximal lesion and 2 cm distal to the most distal lesion. This will allow surgeons to obtain the necessary proximal and distal resection margins without confusion with too many tattoos.

The need for consistent methodology and standardised guideline

Despite more recent developments and frequent usage of endoscopic tattoo to localise colorectal lesions, there are still many inconsistencies and inaccurate localisation.[13,24] Conaghan et al.[13] conducted a retrospective review looking at the frequency and accuracy of tattooing prior to laparoscopic colorectal surgery. In their review, only 65% of patients underwent tattoo localisation prior to surgery. Of the lesions that were tattooed, 74% (37/50) were accurate, 8% (4/50) were visible but inaccurate, and 18% (9/50) were invisible.[13] Vignati et al.[24] reported up to 14% of tumour locations were inaccurately identified intraoperatively after preoperative endoscopic tattoo. Endoscopic tattooing is also very operator-dependent.[15] Despite best efforts, tattoo visualisation still range between 78.6% and 88% depending on location, technique, and operator.[3,17,24]

Currently, there are no standardised protocols or national guidelines from any major gastroenterology or general surgery organisations, including American College of Gastrogenterology, American Society for Gastrointestinal Endoscopy, European Society of Gastrointestinal Endoscopy, British Society of Gastroenterology and National Institute for Health and Care Excellence. A few smaller academic centres have developed their own protocol on endoscopic tattoo, which maintains consistency only within that specific location.[25] However, nationally and internationally, there is still too much diversity. This calls for a more standardised methodology for preoperative endoscopic tattoo for tumour localisation.

Another important and under-recognised area that needs improvement is accurate documentation of endoscopy and tattoo. Accurate documentation of location of lesion, appearance of lesion, location of tattoo in relation to the lesion and technique of tattooing used will be helpful to aid further steps of localisation if the tattoo is not visualised. With the advent of technology, one option of documentation and reporting consistency is video recordings of colonoscopies. A uniform documentation method will help standardise clinical practice of endoscopy.

Conclusion

We recommend that every colonic lesion requiring resection should be tattooed at least 2 cm distally using the four quadrant technique. In addition, accurate colonoscopic report documenting the size, nature of the lesion and tattoo location accompanied by photographic or video supplements is crucial. For multiple lesions, we recommend tattooing at least 2 cm proximal to the most proximal lesion and 2 cm distal to the distal lesion. With regard to rectal lesions, our advice is to tattoo any suspicious polyps removed, any incomplete polypectomies, lesions requiring further investigation with MRI or endoanal ultrasound, and prior to neoadjuvant chemoradiation; otherwise, intraoperative rigid sigmoidoscopy can be used to accurately localise rectal lesions. All endoscopic tattoos should be placed with a meticulous two-step technique.

Preoperative endoscopic tattoo has become the standard of care for accurate tumour localisation in the advent of minimally invasive colorectal surgery. Current practices are still diverse, inconsistent and based on operator preference and skill. A more evidence-based standardised protocol needs to be established.

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