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Case Report

# Role of indocyanine green (ICG) imaging for determining optimal hemicolectomy side in transverse colon tumors: A case report

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Abstract

Introduction: Indocyanine green (ICG) fluorescence imaging has become an invaluable tool for assessing tissue perfusion and lymphatic drainage during colorectal surgeries. It is beneficial in determining the extent of resection, especially when preoperative imaging results are ambiguous.

Aim: This paper aims to highlight our strategy for preoperative tumour localization in managing an elderly male with a colon tumour.

Case study: A 72-year-old male presented with an endoscopically obstructed ascending colon tumour and was scheduled for a laparoscopic extended right hemicolectomy. However, preoperative computed tomography revealed a synchronous tumour involving both the ascending and transverse colon. To pinpoint the exact tumour location, a repeat endoscopy with clip placement was performed, followed by abdominal radiography. Surprisingly, the clip was located in the transverse colon rather than the ascending colon as initially suspected. Intraoperatively, we injected ICG at the tumour site and used laparoscopic imaging to map the ICG flow. Based on these findings, we adjusted our surgical plan and performed a left hemicolectomy with primary anastomosis instead of the initially planned procedure.

Results and discussion: We summarize the relevant studies and discuss the impact of leading technologies on preoperative colon tumour localization.

Conclusions: Colorectal tumour localization using endoscopic clip placement and ICG fluorescence imaging are reliable for guiding surgeons to better surgical outcomes, especially when dealing with tumours in watershed areas.

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## 1. INTRODUCTION

Preoperative colorectal tumour localization is important to ensure accurate surgical resection particularly when laparoscopic surgery is rising. Measuring lesion distance using anatomical landmarks like the anal verge or cecum can sometimes be inaccurate. Endoscopic submucosal injection of tattooing agents can be challenging due to poor visualization of the markings on the colonic serosal surface. Misidentification of tumour location can lead to inappropriate surgical approaches, incomplete resections, or unnecessary removal of healthy tissue. Yeung et al reported up to a 14% error rate in preoperative tumour localization.[1]

To overcome these limitations, advanced techniques such as endoscopic clip placement, radiographic imaging, and indocyanine green (ICG) fluorescence imaging can help mitigate these inaccuracies, particularly in challenging anatomical regions or cases with synchronous lesions. A systematic review by Acuna et al.[2] even suggested an adaptation of routine colonoscopic tattooing given the higher incidence of localization error in conventional colonoscopy compared to colonoscopic tattooing. ICG fluorescence imaging is an advanced technique that highlights vascular structures, lymphatic pathways, and tissue perfusion in real-time. It is constructive in determining the extent of resection, especially when preoperative imaging results are ambiguous. Its safety was reported in the case series by Narihiro et al.[3] We present an innovative approach for accurate preoperative localization of a tumour. A metal clip was placed endoscopically at the colonic tumour site, followed by an immediate plain abdominal radiograph. The actual location changed our operative direction. The tumour location was further confirmed with intraoperative colonoscopy and the use of ICG.

## 2. AIM

The study aim to discuss the surgical approach focusing on the use of various diagnostic tools, including computed tomography (CT) imaging, colonoscopy, ICG fluorescence imaging, and intraoperative decision-making, to precisely locate the tumour and guide surgical planning.

## 3. CASE STUDY

A 72-year-old Malay male with a background history of diabetes mellitus, ischemic heart disease, and prostate cancer initially presented with symptoms suggestive of prostate cancer progression. CT of the thorax, abdomen, and pelvis showed the prostate tumour extending into the mid and lower rectal region, causing a significant mass effect of the rectum. In addition, there was another tumour visualised in the ascending colon (Figure 1A). Initial colonoscopy revealed a fungating tumour in the colon but suspicious of the location either in the transverse or ascending colon. It occupied two-thirds of the lumen, obstructing the further passage of the scope. Biopsies from the lesion confirmed adenocarcinoma. He was referred to our department for further management for a laparoscopic extended right hemicolectomy.

Upon meticulous review of the CT imaging, we noticed a synchronous tumour involving both the ascending and transverse colon (Figure 1B), raising uncertainty about the precise tumour location. A subsequent colonoscopy was performed in which a clip was placed near the suspicious site for localization purposes (Figure 2). An abdominal radiography was taken and it was revealed that the clip was located in the distal transverse colon (Figure 3), not the ascending colon as initially suspected.

Given the discrepancy in tumour location and the need for precise resection margins, intraoperative ICG fluorescence

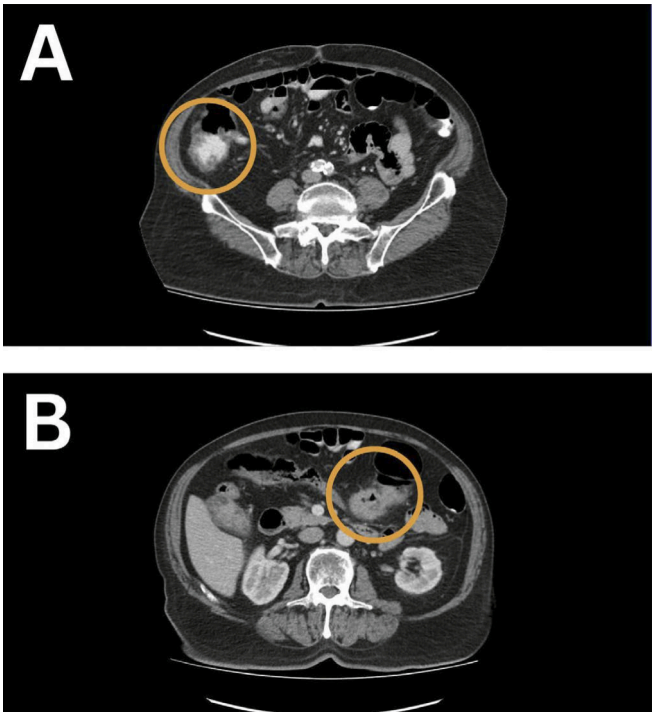


**Figure 1. Possible synchronous tumour (circle) at ascending (A) and transverse colon (B) from CT imaging.**

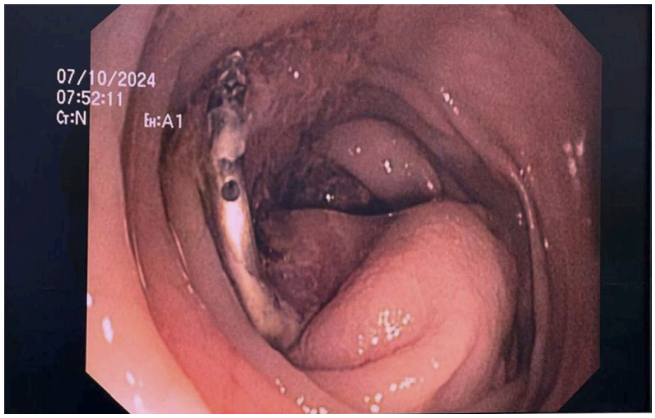


**Figure 2. A colonic haemostatic clip was applied at the constricting tumour for more accurate identification of the tumour.**

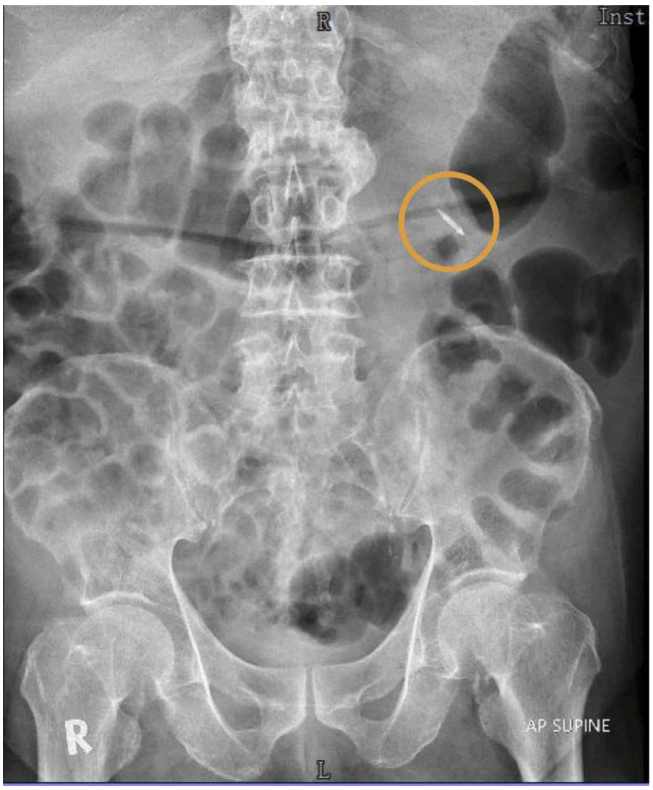


**Figure 3. A radiopaque clip (circle) was seen at the left upper quadrant suggestive of distal transverse colon.**

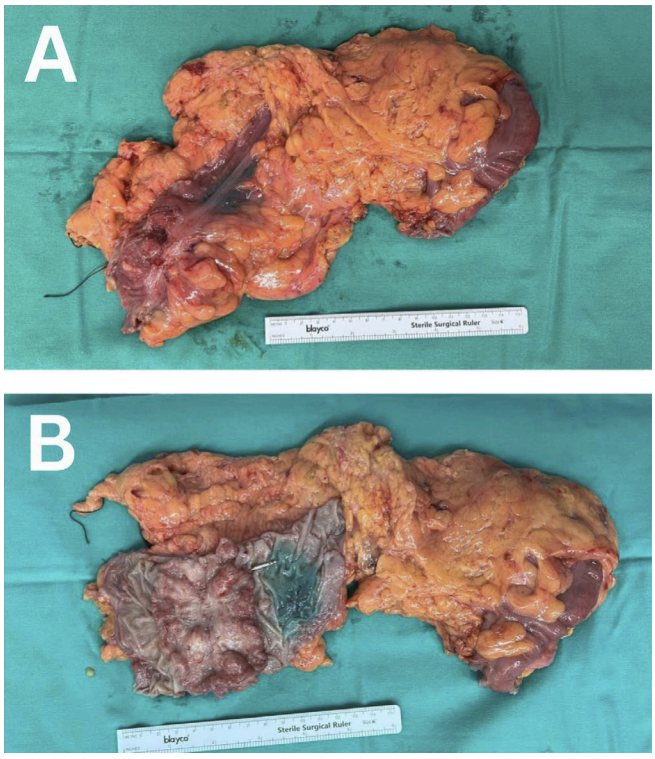


**Figure 5. Gross specimen (A) of the left hemicolectomy containing tumour with fluorescent staining just distal to the tumour (B) and adequate proximal margin.**

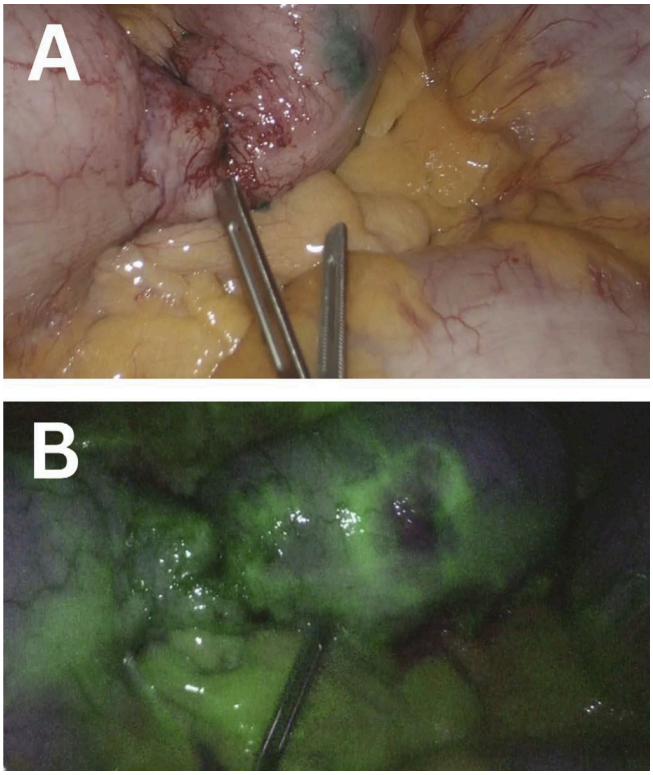


**Figure 4. The ICG stain (A) was seen just distal to the tumour during laparoscopic examination. Image of a tumour following ICG injection, visualized under near-infrared light (B), highlighting blood flow directed towards the IMA circulation sparing the SMA.**

imaging was employed. Intra-operatively, on-table colonoscopy was performed and the tumour was identified near to the intact hemostatic clip. An ICG fluorescence imaging was performed, with three injections of 1 mL each administered just distal to the tumour. ICG fluorescence revealed perfusion in the inferior mesenteric artery (IMA) territory, while no uptake was observed in the superior mesenteric artery (SMA) territory (Figure 4). The tumour was identified as T4a at the distal transverse colon. There was no tumour identified at the ascending colon. No peritoneal lesions or liver metastases were identified. Based on these findings, the surgical plan was revised. A left hemicolectomy with primary anastomosis was performed instead of the initially planned extended right hemicolectomy.

The colon turned out dilated post-colonoscopy, prompting conversion to open surgery. The left branch of the middle colic artery and the left colic artery were ligated and divided 4 cm proximal to the tumour. The resected specimen (Figure 5) was sent for histopathological evaluation. The specimen revealed a moderately differentiated adenocarcinoma (pT3N0), modified Dukes B stage. The tumour was margin-free, with no lymphovascular invasion.

The patient had an eventful recovery post-operatively. He was complicated with post-op ileus and managed with total parenteral nutrition for nine days. He was discharged on postoperative day 16. One month after discharge, the patient was readmitted with abdominal pain and pus discharge from a laparoscopic site. CT abdomen revealed a left anterior intraperitoneal collection near the previous drainage

tract. The collection was successfully drained under image guidance, and the patient was discharged after one week of hospitalization. At follow-up, the patient demonstrated satisfactory recovery with no evidence of local recurrence or systemic disease.

## 4. RESULTS AND DISCUSSION

The initial discrepancy between the tumour's presumed location (ascending colon) and its actual site (transverse colon) in this case highlights the risk for mislocalization during preoperative assessment, especially in cases of poorly visualized tumours. The initial CT scan shows a possible tumor in the cecum but no tumour was identified at the ascending colon intra-operatively suggesting possible artifact on the CT scan. To address this issue, use of virtual colonoscopy (or CT colonography) can help to assess the entire colon, visualizing the cecum and confirming whether the suspected tumor is truly present or an artifact. Relying on measurements from anatomical landmarks during colonoscopy alone can be unreliable which has an error rate of about 11.3%, as demonstrated by Cho et al.[4] In this case, preoperative imaging and endoscopy initially suggested a tumour in the ascending colon. However, repeat endoscopy with clip placement and subsequent radiographic imaging revealed that the primary lesion was located in the transverse colon.

Colorectal tumour localization using endoscopic clip placement is a reliable technique to identify the location of a lesion. A study by Tatsuno et al.[5] recommended tumour localization using endoscopic clip placement, followed by immediate abdominal radiograph to prevent clip loss due to mucosal sloughing. However, we must acknowledge the drawbacks of this method in intraperitoneal tumours. The transverse colon, being intraperitoneal and suspended on a mobile mesentery, is prone to displacement during surgery, which, unlike the fixed sigmoid or rectum, may impact the precision of clip placement. It is thus important to consider tumour mobility in surgical planning. Endoscopic tattooing remains the most precise and routine technique for preoperative tumour localization, particularly in laparoscopic procedures. Intraoperative endoscopy should only be used when the tattoo is not visible. It comes with the risk of bowel distension and possible conversion to open surgery as in our case.

ICG fluorescence imaging played a pivotal role in confirming the tumour site intraoperatively. Indocyanine green is a water-soluble dye that emits a fluorescent green light under near-infrared light. ICG fluorescence helped refine resection margins, reduced the risk of complications (e.g., anastomotic leakage), and improved precision in colorectal and general surgeries.[6,7] ICG was found to be safe and easy to integrate into the surgical workflow. No significant adverse events were reported in our case. It is also essential to appreciate that the optimum timing of ICG before fluorescence imaging varies between surgical fields. A study by Simion et al.[8] recommends ICG injections at least 30 minutes before fluorescence imaging in laparoscopic surgery and 30–60 seconds in colorectal surgery. While ICG is highly sensitive, the PILLAR II trial noted that ICG improved perfusion assessment but did not consistently correlate with reduced anastomotic complications.[9] Surgeons require training to interpret the fluorescence signal and integrate it effectively into decision-making. ICG fluorescence imaging provides valuable insights into tissue perfusion and lymphatic drainage, especially for tumors in vascular watershed areas. It aids in determining resection margins but should be used in conjunction with established oncologic principles, such as complete mesocolic excision and central vascular ligation techniques, to ensure optimal tumor removal and long-term outcomes.

We tailored the surgery to the exact tumour location based on real-time visualization from ICG findings, by switching from an extended right hemicolectomy to a left hemicolectomy with primary anastomosis. This outcome demonstrates the role of ICG in enhancing surgical precision and ensuring favorable oncological and functional results. While marking the tumour with a clip and performing radiographic imaging can be useful, the transverse colon's mobility may compromise the precision of this technique. We recommend the routine use of endoscopic tattooing prior to laparoscopic procedures with intraoperative endoscopy as a backup when tattooing fails, considering its higher precision compared to radiographic imaging or clip placement.

## 5. CONCLUSIONS

(1) The outcome of our case was achieved through a combination of serial imaging, intraoperative reorganization, and surgical adaptability.
(2) ICG fluorescence imaging is a promising tool in colorectal surgery, particularly in complex cases, to guide resection and enhance surgical precision.
(3) The use of ICG not only useful for bowel perfusion assessment, it also can assist for resection margins and avoidance of anastomotic leak.
(4) However, challenges like cost, accessibility, and availability of trained surgeons to interpret the fluorescence signal should be acknowledged.

### Conflict of interest

Authors declare that there is no conflict of interest.

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