Short Communication: A Novel Application of Indocyanine Green Immunofluorescence in Emergent Colorectal Surgery

Running Title: ICG in Emergent CRS

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Conflicts of Interest: None

Disclosures: Mr Chand is a consultant for Novadaq, Inc., serving on the speaker bureau unrelated to this work. There is no relevant disclosure to this work.

Word Count: 765

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Abstract

Aim: To report on the feasibility of ICG fluorescence imaging to localize lesions in emergent minimally invasive surgery.

Method: A 49-year old female presented to the emergency department with a previously unknown malignant bowel obstruction. She was taken emergently to the operating room for a laparoscopic extended right hemicolectomy, based on tumor location from imaging. With intraoperative difficulty localizing the lesion, an on-table colonoscopy was performed. When the tumor was encountered, peritumoral ICG injections were performed, and the fluorescence lymphoscintigraphy was performed intraoperatively in an attempt to visualize the primary tumor laparoscopically.

Results: Intraoperative ICG Immunofluorescence allowed precise, real-time localization of the mass in the descending colon. This information changed the course of the operation, as a laparoscopic left hemicolectomy was then performed instead of the planned extended right hemicolectomy. The patient underwent an end-to-end anastomosis without the need for a defunctioning ileostomy.

Conclusion: From this case, we demonstrate the use of ICG fluorescence imaging for tumor localization in the emergent setting is safe, feasible, and effective. This information gained from this technology enables real-time decision making, and can even change the operative plan in the emergent setting for the best patient outcomes.

What does this paper add to the existing literature?

This paper offers a novel application of an emerging technology- ICG fluorescence- that in this capacity allowed precise, real-time localization of a previously unknown mass in the emergent setting, and changed the course of the operation.

KEY WORDS

Immunofluorescence; lymph node mapping; indocyanine green; fluorescence angiography; fluorescence imaging; laparoscopic colorectal surgery

Short Communication

Indocyanine green (ICG) fluorescence angiography has shown value for visualizing perfusion when injected intravenously, and novel uses continue to be reported in the elective setting (1–6). Here we present the 1st report of ICG fluorescence imaging in emergent surgery to localize the mass in a malignant bowel obstruction. A 49-year-old female with no significant medical history or prior colonoscopy presented to the emergency department with two-months of progressive colicky abdominal pain, nausea and obstipation. On examination, she had a distended abdomen and generalized tenderness to palpation. A CT-scan was suggestive of a tumor at the splenic flexure with associated large bowel obstruction (Figure 1). However, an incompetent ileocecal valve allowed some degree of decompression into the small bowel, reducing the severity of her symptoms. From this work-up, the patient was taken to the operating room. Based on the situation of the tumor described on the CT scan, a laparoscopic extended right hemicolectomy was planned. Given the lack of tattoo in the emergent setting and difficulty identifying the lesion in an obese patient, the patient had an on-table colonoscopy.

The tumor was encountered, and saline lift to ensure we were in the desired, submucosal plane. Careful attention was paid to ensure we remained within the submucosa and did not penetrate the bowel wall, which would result in ICG spillage into the peritoneal cavity and obscured visualization under fluorescence. Then, submucosal injections of ICG were performed at 3 points approximately 2cm distal to the tumor. A volume of

1mL/ injection using a concentration of 5mg/10mL was employed. The PINPOINT® (Novadaq, Mississauga, Ontario, Canada) laparoscope with near infrared (NIR) function was to visualize the primary tumor laparoscopically. ICG is excited by fluorescent light in the NIR spectrum in real-time. The bowel was decompressed endoscopically as best possible to facilitate the subsequent laparoscopic resection. The tumor was localized in the descending colon with the fluorescent laparoscope (Figure 2). After extracoporealization of the specimen, the tumor location pinpointed by the ICG was further confirmed by direct palpation and repeated fluorescence imaging (Figure 3). This information changed the course of the operation. Based on the real-time localization, a laparoscopic left hemicolectomy was then performed instead of the planned extended right hemicolectomy. The patient underwent an end-to-end anastomosis without the need for a defunctioning ileostomy. The pathology revealed an R0 resection of a pT4bN2 descending colon adenocarcinoma, with 13 of the 15 nodes retrieved involved (Figure 4). There were no adverse events or injection related events.

In this report, we demonstrate the use of ICG fluorescence imaging for tumor localization in the emergent setting is safe, feasible, and effective. This information gained from this technology enables real-time decision making, and can even change the operative plan in the emergent setting for the best patient outcomes. As this is the 1st report of this valuable tool as in intraoperative adjunct, there are no comparisons with other methods, advantages or disadvantages to consider. We experienced no technical difficulties or complications. From the technical perspective, it is important to ensure there is no spillage of ICG into the peritoneal cavity that can result in obscuring of the image and

false positive identification. Further, there is a risk of perforation in performing on-table colonoscopy in an emergent patient, and this needs to be considered on a case-by-case basis. If undertaken, decompression of the bowel is an essential step to facilitate the laparoscopic resection, as a grossly dilated colon can be difficult to maneuver, will hamper access, and can increase the risk for perforation with instrumentation of the bowel. These factors were considered to safely complete the procedure.

The use of laparoscopy has been shown to be a safe and efficient alternative to more traditional laparotomy in the emergent setting (7). However, due to body habitus and lack of tactile feedback, in less obvious lesions, it is not always possible to confidently identify a suspected tumor on the basis of CT scan alone. This can have implications in operative planning, intra-operative strategy, patient counseling, and- in rare circumstances- result in missing the lesion completely. From the normal 'white-light' laparoscopic image seen in figure 1a, it is not possible to identify the pathology but the 'near infrared' and fluorescence images of the same segment of bowel clearly show the area injected with ICG. In this report, rapid tumor localization meant a change in surgical strategy prior to any inappropriate mobilization, from an extended right hemicolectomy to left hemicolectomy. In addition, a more appropriate oncological resection was performed by visualizing the optimal vascular pedicle and obviated the need to convert to an open laparotomy to localize the lesion.

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Figure Legend

Figure 1 CT-Scan image of splenic flexure mass with associated large bowel obstruction

Figure 2 Tumor localized with ICG fluorescence in an intraoperative, intracorporeal view from the near infrared enabled laparoscope demonstrating the descending colon lesion visible after ICG is injected peritumor and excited by fluorescent light in the NIR spectrum

Figure 3 Confirmation of the tumor after extracorporalization of specimen in white light, NIR, and CSF modes.

Figure 4 Pathologic R0 specimen of T4bN2 descending colon cancer with 15 lymph nodes localized with ICG