

Use of Indocyanine Green for Localization and Preservation of Ureters in Robotic-Assisted Colon Surgery

Daniel Slack, Sandeep Sachidananda, Diego Holguin, Jayakara Shetty, Zhongqiu John Zhang

Department of Surgery, Waterbury Hospital, Frank H Netter School of Medicine at Quinnipiac University, Waterbury, Connecticut, USA

Correspondence should be addressed to Zhongqiu John Zhang, zzhang@wtbyhosp.org

Received: April 10, 2020; Accepted: April 14, 2020; Published: April 21, 2020

ABSTRACT

Objective: Identification and preservation of the ureter is a technical challenge in colon and pelvic operations. Intraoperative fluorescence imaging (IFI) with Indocyanine green (ICG) facilitate can be used as an adjunct to facilitate recognition of the ureters during robotic-assisted surgery. We reviewed our experience using the IFI during robotic-assisted colon resections.

Method: We retrospectively reviewed cases using IFI technology from October 2015 to March 2018. Urologic surgeons placed bilateral ureteric stents and instilled ICG preoperatively. A near-infrared laser and lens filter converted the ICG to a green color. At surgeon's discretion, Firefly mode allowed visualization of the ureters. We assessed the success rate of ureter identification as well as the feasibility of this technology.

Results: We identified 22 cases in which IFI with ICG was used. We observed a 100% success rate in identifying and preserving ureters. The majority of cases were sigmoid colostomies in the setting of complicated diverticulitis. No ureteric injuries were encountered.

Conclusion: IFI with ICG enables quick and straightforward identification of the ureters during colon resections. This novel technique is easy to perform and effective in visualization of the ureters. This technology has the potential to decrease the rate of intra-operative ureteral injury in complicated colon resections.

KEYWORDS

Indocyanine green; Firefly; Robotics; Colorectal; Ureteral injury

1. INTRODUCTION

Ureteral injury is a rare but very morbid complication in many colorectal and gynecological procedures with a reported rate of 0.3-1.0% [1,2]. Identification and

preservation of the ureter is a technical challenge during colon and pelvic surgery. This challenge is significantly more apparent in pelvises that have been previously operated on or in areas that have substantial

Citation: Daniel Slack, Use of Indocyanine Green for Localization and Preservation of Ureters in Robotic-Assisted Colon Surgery. Clin Surg J 4(1): 14-16.

© 2021 The Authors. Published by TRIDHA Scholars.

inflammation. Studies examining ways to reduce or prevent ureteral injuries with the use of stents or lighted stents have had mixed results [3-5]. The use of fluorescent dye has recently been included as an adjunct method to enable intraoperative identification and hence preservation of the ureter during robotic-assisted surgery. Thus far the use of these fluorescent dyes has been used on the ureters mostly for urological or gynecological procedures [6, 7]. We found little data regarding its use for general or colorectal surgery procedures, specifically hemicolectomies and sigmoid colostomies. Our aim was to study the feasibility and utility of IFI using ICG during robotic-assisted colon resections.

2. METHODS

We reviewed completed cases in which our surgeon used IFI technology from October 2015 to March 2018. The decision to use IFI with ICG was made on clinical grounds by the operating surgeons. An urologist performed an on-table cystoscopy with the placement of bilateral ureteric stents and instillation of 5 cc of ICG to each ureteric orifice under direct vision. Each patient consented to the use of ICG, the cystoscopy, and the colon resection based on clinical indication. The stents were left in place during the procedure and removed at the end of the procedure.

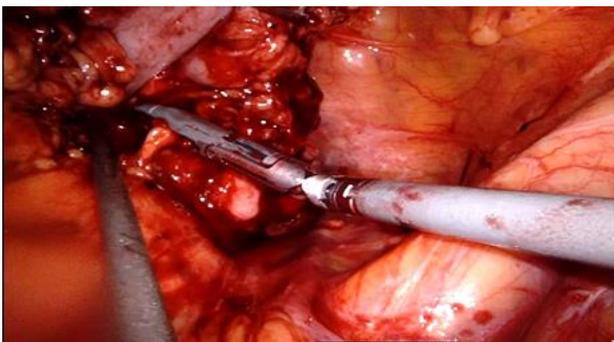


Figure 1: Intra-operative image of a sigmoid colectomy for complicated diverticulitis without Firefly.

Surgeons used the da Vinci XI surgical system (Intuitive Surgical, Sunnyvale, CA USA). This system allows for

the utilization of near-infrared laser that helps the ICG fluoresce as well as lens filtering, called the Firefly Fluorescence Endoscope system that converts the fluorescing ICG to a bright green color. Firefly mode is used as needed throughout the operation to visualize the ureters at the surgeon's discretion by the flip of a switch on the surgeon console (Figure 1 and Figure 2).



Figure 2: Same intra-operative image with Firefly mode demonstrates the left ureter.

3. RESULTS

We identified 22 cases in which IFI with ICG was used. We observed a 100 % success rate in identifying and preserving ureters. There were 16 (72.7%) sigmoid resections with most, 15 out of 22 cases (68.2%) in the setting of recurrent/complicated sigmoid diverticulitis. No ureteric injuries occurred in this series. The mean follow up is 30 days. There were no complications during the urologist's portion of the procedure and no adverse reactions in any of our patient population to the ICG or late effects of the stenting. At our institution the cost of ICG is \$66.00, and the cost of the urological supplies to perform the cystogram, stent placement and ICG instillation is \$150.00 in total.

4. DISCUSSION

One drawback of robotic surgery is the loss of tactile feedback. In our experience, the use of IFI with ICG enables easy identification of the ureters during robotic assisted colon resections. Our early experience with this

alternative technique has shown that this is both easy to perform and effective in allowing visualization of the ureters. This is especially in difficult cases where the risk of ureteral injury can be high. The reported adverse event rate to ICG is very small, at less than 1 in 40,000 patients; and mostly comprises hypersensitivity reactions [8]. This may be more likely to be a factor with intravenous use rather than direct instillation into the ureters but in any event it is a rare phenomenon. No side effects or renal complications occurred with the use of ICG in our patient population. Therefore, this technology has the potential to decrease the rate of intra-operative ureteral injury in both complicated colon resections and

in pelvic gynecological procedures. Future comparative studies should be performed to better assess whether there is true reduction in ureteric injury identification and prevention.

5. DISCLOSURES

All authors have no financial disclosures to report. All authors involved in this case report have no conflicts of interest to disclose.

Contributors: Scott Kurtzman MD, FACS. Special thanks for Miss Tiffany Zhang's manuscript proof reading.

REFERENCES

1. Halabi WJ, Jafari MD, Nguyen VQ, et al. (2014) Ureteral injuries in colorectal surgery. *Diseases of the Colon & Rectum* 57(2): 179-186.
2. Marcelissen TA, Hollander PP, Tuytten TR, et al. (2016) Incidence of iatrogenic ureteral injury during open and laparoscopic colorectal surgery. *Surgical Laparoscopy, Endoscopy & Percutaneous Techniques* 26(6): 513-515.
3. Beraldo S, Neubeck K, Friderici EV, et al (2013). The Prophylactic use of a ureteral stent in laparoscopic colorectal surgery. *Scandinavian Journal of Surgery* 102(2): 87-89.
4. Speicher P, Goldsmith Z, Turley R, et al. (2014) Trends and predictors of ureteral stenting in laparoscopic colorectal Surgery. *Journal of Surgical Research* 186(2): 496.
5. Borowiec AA, Gill SR, Birch DW, et al. (2011) The utility of lighted ureteral stents in laparoscopic colorectal resection: A survey of Canadian surgeons. *Gastroenterology Research* 4(4): 143-148.
6. Siddighi S, Yune JJ, Hardesty J (2014). Indocyanine green for intraoperative localization of ureter. *American Journal of Obstetrics and Gynecology* 211(4): 436.
7. Lee Z, Moore B, Giusto L, et al. (2015) Use of indocyanine green during robot-assisted ureteral reconstructions. *European Urology* 67(2): 291-298.
8. Manen LV, Handgraaf HJ, Diana M, et al. (2018) A practical guide for the use of indocyanine green and methylene blue in fluorescence-guided abdominal surgery. *Journal of Surgical Oncology* 118(2): 283-300.