

*Short Communication*

# Indocyanine Green Fluorescence-Guided Laparoscopic Ureterolysis for Complex Gynecological Surgeries

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## Abstract

**Background:** To identify and safeguard the ureters of patients with deep infiltrating endometriosis or complex pelvic adhesion (obliterated cul-de-sac) using indocyanine green (ICG) during laparoscopic surgery. **Methods:** Stepwise surgical demonstration using narrated video footage. The stepwise procedures were: (1) Explore the abdominal cavity, resect pelvic adhesions, remove the right ovarian endometrioma cysts, and open the peritoneum to locate the fluorescence. (2) Place bilateral 5-Fr ureteral catheters through the cystoscope, inject ICG retrogradely, and clip the catheter to retain the ICG. (3) Identify the course of ureters and perform ureterolysis with real-time visualization under Near-infrared fluorescence. Resect the para-ureteral endometriosis and other pelvic endometriosis. **Results:** The patient was discharged on the 4th postoperative day with satisfactory surgical effect and without any complications. **Conclusions:** For complex gynecologic surgeries whereby ureterolysis might be challenging, ICG fluorescence imaging could be used to quickly identify the course of the ureter, prevent ureteral injury and reduce the risks of perioperative and postoperative complications. This case demonstrates that intraureteral ICG provided quick visualization of the ureter and allowed surgeons to safely perform ureterolysis. The proposed technique could be considered in complex gynecological cancer, pelvic floor disorder or endometriosis surgery.

**Keywords:** laparoscopic surgery; indocyanine green; ureter; ureterolysis; endometriosis

## 1. Introduction

Endometriosis often causes infertility and chronic pelvic pain. Surgical management of it has become a topic of increasing interest in gynecological surgery [1]. Localizing and separating the ureters in complex pelvic adhesion including stage IV endometriosis which is based on revised American Society for Reproductive Medicine (rASRM) classification during robotic or laparoscopic surgery can be challenging due to surrounding fibrotic tissues and distorted anatomy [2]. The indocyanine green (ICG) is a near-infrared fluorescent dye, which is widely used in various fields of surgery and gynecology. It is currently mainly used to detect various malignant tumors sentinel lymph nodes, endometriosis lesions, ureter, intestinal occlusion, vaginal disabled, uterine arterial blood perfusion, pelvic nerve, lymphatic edema, metastatic lesion shadow, etc., provided new methods for decision-making during the operation [3]. Although this technique was now mainly introduced in robotic surgery, most complex surgeries are performed using traditional laparoscopic platforms worldwide, we assessed the significance of fluorescence-guided laparoscopy for potential applications in hospitals without robotic-assisted laparoscopic. Thus, in this study, we developed a feasible method to identify the course of the ureters by injecting ICG under near infrared fluorophores (NIRF) during laparoscopic surgery whereby the ureter emits green fluorescence, demarcating it from its surrounding tissues.

## 2. Material and Methods

An academic tertiary care hospital. A 38-year-old woman with rASRM stage IV endometriosis presented with chronic pelvic pain, dysmenorrhea and dyspareunia for over 10 years. Gynecological pelvic examination, ultrasound and magnetic resonance imaging revealed uterine adenomyosis and right ovarian endometrioma with deep infiltrating endometriosis involving the obliterated posterior cul-de-sac, uterosacral ligament and surface of the rectum.

Stepwise surgical demonstration using narrated video footage (Video 1). The stepwise procedures were:

(1) Explore the abdominal cavity, resect pelvic adhesions, remove the right ovarian endometrioma cysts, and open the peritoneum to locate the fluorescence.

(2) Place bilateral 5-Fr ureteral catheters through the cystoscope, inject ICG retrogradely, and clip the catheter to retain the ICG.

(3) Identify the course of ureters and perform ureterolysis with real-time visualization under Near-infrared fluorescence. Resect the para-ureteral endometriosis and other pelvic endometriosis (Fig. 1).

(4) Place a pelvic drainage tube and remove it on postoperative day 2.

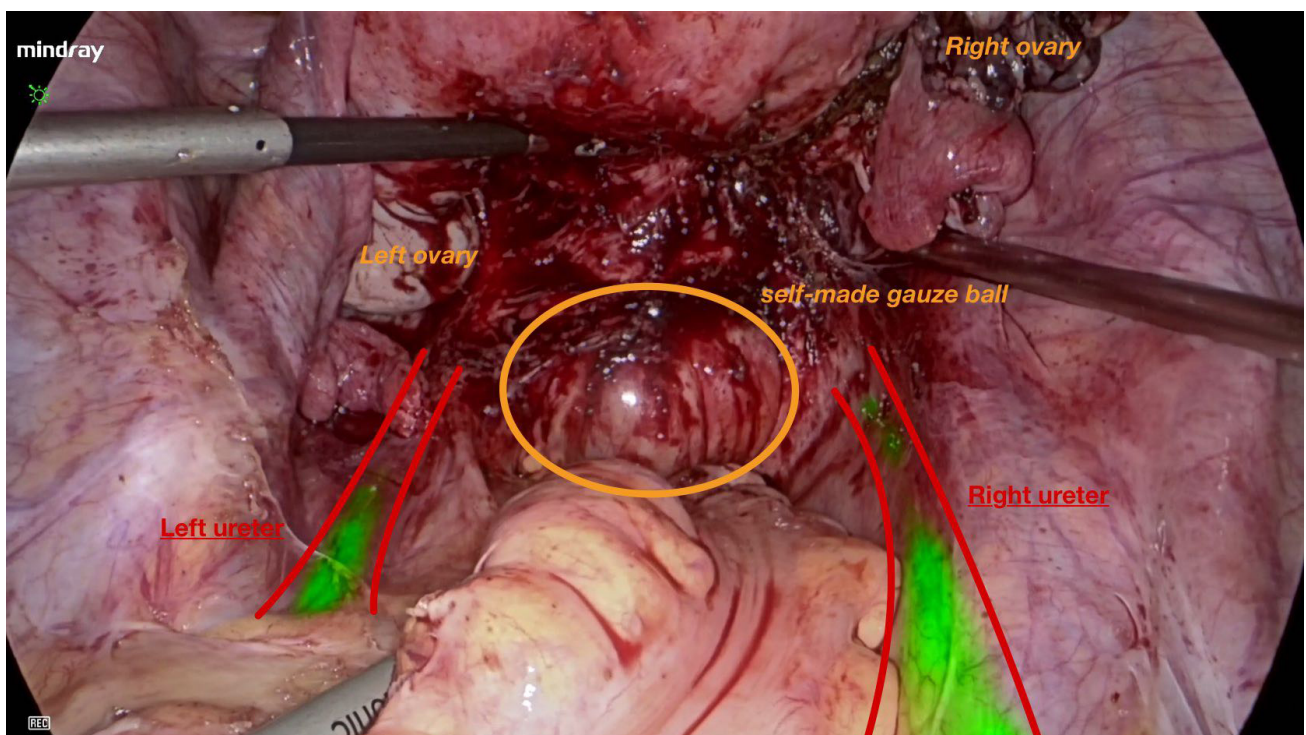
## 3. Results

The patient was discharged on the 4th postoperative day with satisfactory surgical effect and without any complications.



## Indocyanine green fluorescence-guided laparoscopic ureterolysis for complex gynecological surgeries

**Video 1. Stepwise surgical demonstration of Indocyanine Green Fluorescence-Guided Laparoscopic Ureterolysis.** The embedded movie may also be viewed at <https://doi.org/10.31083/j.ceog5006118>.



**Fig. 1.** Identify the course of ureters under near infrared fluorophores (NIRF), the ureter emits green fluorescence, demarcating it from its surrounding tissues.

### 4. Discussion

Endometriosis is mainly divided into ovarian endometriosis, peritoneal endometriosis (PE), and deep in-

filtrating endometriosis (DIE). It requires superb surgical skills and rich experience to achieve radical resection and retain the blood vessels and plant nerve functions of pelvic

organs as much as possible. The ability of ICG to combine with plasma protein can visualize organ or tissue irrigation in real time. New vascular generation and typical increased vascular density of DIE provide a basic principle for using NIRF-ICG technique [4,5]; past surgical history, fibrosis, and decreased new vascular production related to the use of estrogen hormone or gonadotropin hormone agonist may be the cause of peritoneal disease or the change of DIE nodule level microcirculation [6–8]. In recent years, more and more studies have used ICG to improve visualization and security.

The prospective trial, Gre-Endo, showed that sensitivity of NIRF-ICG was 87%, and specificity was 98.5%. The use of NIRF-ICG combined with WWhite light showed good results in intraoperative detection rate and fluorescence-guided surgery [9], which is also applicable to 3D laparoscopic and robotic surgery. NIRF-ICG can visually detect more occult lesions [10,11]. Another prospective study showed that the positive prediction values of for white-light laparoscopy alone, NIRF-ICG visualization alone, and the combination of white-light and NIRF-ICG were 89.8%, 68.8% and 86.7%, respectively. It showed that the diagnostic value of NIRF-ICG in identifying occult endometriosis appeared to be minimal, but subgroup analysis showed that ICG was helpful in demarcation of lesions and normal tissues, such as intestinal endometriosis [7].

The incidence of colorectal endometriosis in DIE patients is 5.3–12% [12,13]. Endometriosis intestinal surgical complications are the problem of endometriosis treatment, such as rectovaginal fistula, anastomotic leakage, anastomotic stenosis, and dysfunctional urination. A meta-analysis analyzed 17,495 patients in sixty studies, found that rectal surface lesion removal reduced postoperative complications, meanwhile, compared with segmental colorectal resection, disc excision had a shorter operating time, a shorter hospital stay, and a lower risk of postoperative bowel stenosis [12]. Evaluating vascular correlation via ICG helped to demarcate lesions and normal tissues, and increase the safety of the lesion removal, and helped patients who could not avoid intestinal resection observe whether the blood supply of intestinal suture and anastomose was sufficient [12,14,15]. A prospective study on thirty rectosigmoid endometriosis patients used ICG for the intraoperative vascular evaluation [13]. In this study, 40% of women presented a hypervascular pattern, while 60% presented a hypovascular pattern, and the latter seemed to be associated with a larger lesion nodule size and lower vascular density.

Because the surrounding fibrosis tissue and distorted anatomical structure, the positioning and separation of ureter in endometriosis or complex pelvic adhesion may be challenging. The incidence of urinary tract endometriosis (UTE) ranges from 16.4–52.6% in patients presenting DIE. The bladder is the most frequently involved organ in UTE, followed by ureter [16]. Multiple studies have

shown that the injection of ICG in urethra has indeed promoted the visualization of ureter and avoided medical injury [7,8]. A study examined 31 cases of ureters during conservative ureteral endometriosis surgery, and 5 cases were suspected of local ischemia at white light. Of these, 2 cases of NIRF-ICG presented regular fluorescence; thus, 3 cases confirmed irregular or absent fluorescence, requiring ureteral stent placement. It indicated that NIRF-ICG could be used to assess ureteral perfusion and guide surgical decision [17].

The applications of ICG in surgery are vast, we've only discussed the tip of the iceberg. European Association for Endoscopic Surgery consensus shown ICG fluorescence-guided surgery could be considered a safe and effective technology [18]. However, future robust clinical research is required to specifically validate multiple organ-specific applications, such as drug dose, concentration, route, administration time and retention time of ICG depending on the different applications.

## 5. Conclusions

For complex gynecologic surgeries whereby ureterolysis might be challenging, ICG fluorescence imaging could be used to quickly identify the course of the ureter, prevent ureteral injury and reduce the risks of perioperative and postoperative complications. This case demonstrates that intraureteral ICG provided quick visualization of the ureter and allowed surgeons to safely perform ureterolysis. The proposed technique could be considered in complex laparoscopic cancer, pelvic floor disorder or endometriosis surgeries.

## Availability of Data and Materials

All data generated or analyzed during this study are included in this published article.

## Author Contributions

QL—literature review and drafting of the manuscript; YY—detailed data collection and literature review; CZ—clinical management and review of the scientific research. All authors contributed to editorial changes in the manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work. All authors read and approved the final manuscript.

## Ethics Approval and Consent to Participate

All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Huai'an Maternal and Child Health Hospital (approval number: 2022073).



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## Conflict of Interest

The authors declare no conflict of interest.

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