Surgical Technique

Using an indocyanine green fluorescent imaging technique for laparoscopic rectal cancer surgery: a case report

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Abstract: Colorectal cancer is a clinically common malignancy with high incidence and mortality rates. Surgery remains the preferred treatment option for colorectal cancer. Laparoscopic surgery is more widely used than open surgery due to its advantages of reduced surgical trauma and faster postoperative recovery. However, complications such as anastomotic leakage, bleeding, intestinal obstruction, and intra-abdominal infections can still occur, prolonging hospital stays and impairing patient recovery. In particular, anastomotic leakage is a severe complication that significantly affects the postoperative recovery of patients. Indocyanine green (ICG) fluorescence imaging (FI) combined with 4K laparoscopy has emerged as a promising approach for enhancing surgical quality. ICG is a water-soluble tricarbocyanine dye with low toxicity, a strong binding affinity to plasma proteins, and a short half-life, making it suitable for intraoperative use. It enables the real-time visualization of blood flow, which facilitates the detection of metastases, the assessment of anastomotic perfusion, and precise lymph node dissection. This technology has been shown to improve the detection of positive lymph nodes and reduce postoperative complications. We report the case of a 66-year-old male patient with rectal adenocarcinoma who underwent fluorescent laparoscopy-assisted radical resection of rectal cancer (Dixon procedure). The patient initiated ambulation on postoperative day (POD) 1, followed by successful flatus passage and bowel movement initiation on POD 2, and was discharged on POD 6 after the removal of the pelvic drain. This article highlights the application techniques and advantages of ICG-FI laparoscopic technology in rectal cancer surgery to provide a reference for its clinical application.

Keywords: Indocyanine green (ICG); fluorescence imaging (FI); laparoscopic rectal cancer surgery; case report

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Introduction

Colorectal cancer, one of the common malignant tumors in the digestive system, ranked third in global incidence and second in mortality among all malignant tumors in 2020 (1). Surgery is currently the primary treatment for colorectal cancer (2). In recent years, indocyanine green (ICG)-labeled near-infrared (NIR) fluorescence laparoscopic technology has been gradually applied in clinical practice. This technology can and navigate anatomical structures in real-time intraoperatively, and which has shown great potential in minimally invasive surgery, has been gradually applied in clinical practice. In colorectal surgery, the application of ICG-fluorescence imaging (FI) technology, which is widely used to enhance tumor lesion visualization, improve the detection rate of lymph nodes, and evaluate anastomotic perfusion, has gradually increased (3). In this article, we describe the case of a 66-year-old male patient with rectal cancer who underwent radical resection by fluorescence laparoscopy, the intraoperative situation, and our experience to provide a reference for clinical application of ICG-FI (*Video 1*). We present this article in accordance with the SUPER and CARE reporting checklists (available at https://jgo.amegroups.com/article/view/10.21037/jgo-2025-245/rc).

Preoperative preparations and requirements

A 66-year-old male was admitted to The Fourth Hospital of Hebei Medical University in January 2023, complaining of blood in the stool for six months, accompanied by an increased frequency of bowel movements, anal drops, and a sense of urgency and heaviness, but no abdominal pain or bloating. The patient had a body mass index of 22.86 kg/m^2, an Eastern Cooperative Oncology Group performance status score of 0, and no significant medical history.

Highlight box

Surgical highlights

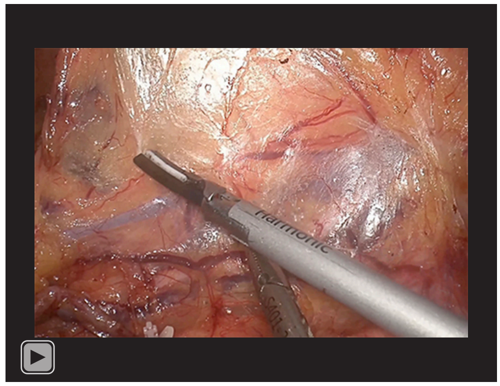
- Indocyanine green fluorescence imaging (ICG-FI) enhances colorectal cancer surgical precision and outcomes through: real-time tumor mapping for accurate resection with minimized residual risk; direct anastomotic perfusion visualization to reduce postoperative leakage; minimally invasive integration, combining precision with accelerated recovery.

What is conventional and what is novel/modified?

- The standard laparoscopic rectal cancer surgery (Dixon procedure) relies on anatomical landmarks and tactile feedback for tumor localization and lymphadenectomy. Anastomotic perfusion is assessed subjectively by visual inspection and bleeding patterns. Postoperative lymph node yield typically ranges between 15–18 nodes for T3 tumors, with quality control dependent on surgeon experience.
- ICG-FI enables real-time tumor mapping with enhanced margin visualization, facilitating accurate resection while minimizing residual tumor risk through improved intraoperative detection. The technology provides direct visualization of vascular perfusion at anastomotic sites, allowing immediate intervention for blood flow optimization and significant reduction in postoperative leakage complications. This approach combines minimally invasive advantages with real-time fluorescence guidance, reducing surgical trauma while improving procedural accuracy. The dual benefits of precision and safety contribute to accelerated postoperative recovery.

What is the implication, and what should change now?

- It is necessary to conduct in-depth research on this technology, establish standardized operation norms, enhance the safety and accuracy of tumor resection, and improve the prognosis of patients.



Video 1 Fluorescent laparoscopy-assisted radical resection of rectal cancer (Dixon procedure).

The digital rectal examination (DRE) was performed in the knee-chest position. No masses were palpated upon insertion of the finger to a depth of 7 cm, and the glove showed no blood staining upon withdrawal. The tumor markers, such as carcinoembryonic antigen and carbohydrate antigen 19-9, were normal. For the colonoscopy (*Figure 1*), the scope was inserted into the ileocecal region, and a discoidal elevated neoplasm (about 2.5–3 cm in size) was observed about 8 cm from the anal verge in the rectum. The pathology results showed adenocarcinoma. Pelvic high-resolution magnetic resonance imaging showed a rectal wall mass, consistent with the manifestation of rectal cancer (imaging stage T3N0M0) (*Figure 2*). The patient refused preoperative chemoradiotherapy.

In January 2023, following a comprehensive evaluation, a fluorescent laparoscopy-assisted radical resection of rectal cancer (Dixon procedure) was performed under general anesthesia at The Fourth Hospital of Hebei Medical University. The 4K Fluorescent Endoscope (Nuoyuan, Nanjing, China), which can be used in conjunction with ICG fluorescent tracers and provides a one-touch selection of white light, fluorescent, and fusion images during minimally invasive endoscopic procedures, was used in the surgery. It can simultaneously switch between lymphatic, organ, and tumor imaging modes with just one button. Customized modes can also be saved based on the operator's specific requirements. Additionally, the camera handle allows for the easy capturing of photographs and

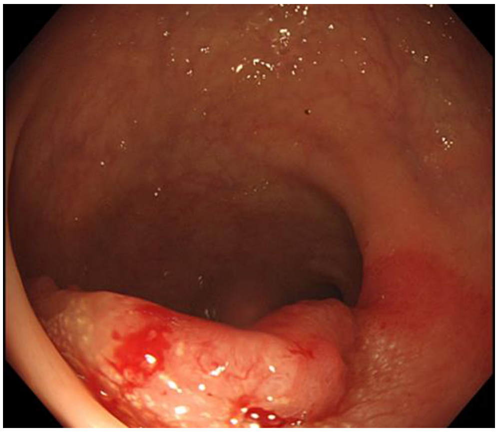


Figure 1 Colonoscopic image.

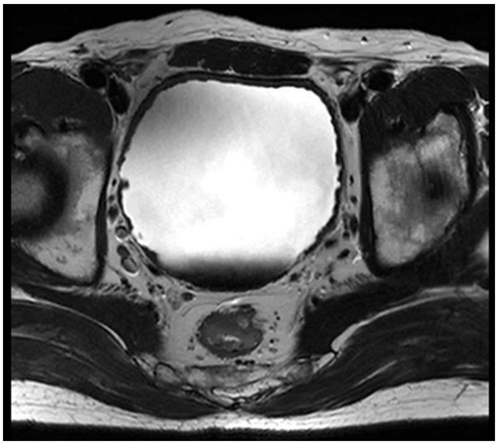


Figure 2 Preoperative magnetic resonance imaging.

videos, while the host workstation offers advanced features, such as color gradient images and the quantitative analysis of fluorescence intensity. The surgical team comprised experienced surgeons, anesthesiologists, and nurses.

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Declaration of Helsinki and its subsequent amendments. Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

Step-by-step description

The patient was positioned in the Trendelenburg lithotomy posture with his head elevated and feet lowered. Additionally, the operating table was inclined to the right. The primary surgeon stood on the right side of the patient, the first assistant on the left side of the patient, and the mirror-supporting hand was on the same side as the operator. A 10-mm trocar was placed at the upper edge of the umbilicus using the traditional five-port technique. Pneumoperitoneum was established, and the air pressure was maintained at 13 mmHg. A 30°-laparoscopic lens was inserted through this trocar under the observation of the laparoscopic monitor, bypassing the deep inferior epigastric artery. A 12-mm trocar was placed on the medial two transverse fingers of the right anterior superior iliac spine as the main operating hole for the main knife. A 5-mm trocar was placed flat umbilically in the right midclavicular line to make a secondary operating hole for the primary knife. A 5-mm trocar was placed at the intersection of the left lateral border of the rectus abdominis muscle, and the umbilical horizontal line provided the main operating hole for the assistant. To make an auxiliary operating hole, a 5-mm trocar was inserted into the outer 1/3 of the line between the left anterior superior iliac spine and the umbilical cord.

The liver, abdominal, and pelvic cavity, greater omentum, small intestine, and mesocolon were explored from far to near, and no tumor implantation or metastatic nodules were found. The tumor was located 1 cm above the peritoneal reflection and did not invade the serosa. First, three sites were selected 1 cm from the tumor margin for subserosal injection of ICG (Rui Du, Dandong, China), with 0.2 mL administered at each site (*Figure 3A*).

During the operation, the fusion mode and lymphatic imaging mode were used to observe the mesenteric lymph node tracing imaging situation (*Figure 3B,3C*). The prehypogastric nerve fascia, which is composed of microvessels and small pieces of fat, was visible and served as a guide to expand Toldt's space without entering the wrong level too deeply. The medial approach was used for surgery. The peritoneum was incised at the level of the sacral promontory (*Figure 3D*) using an ultrasonic scalpel (Johnson & Johnson, New Brunswick, NJ, USA), and the incision was extended to the junction where the root of the mesentery and the root of the sigmoid colon meet to enter the left Toldt's space.

Next, inferior mesenteric artery (IMA) 253 lymph node dissection was performed (*Figure 3E,3F*). Before performing the IMA root dissection, the space behind the vessels was fully expanded to ensure the thoroughness and safety of the dissection. According to the knowledge of applied anatomy,

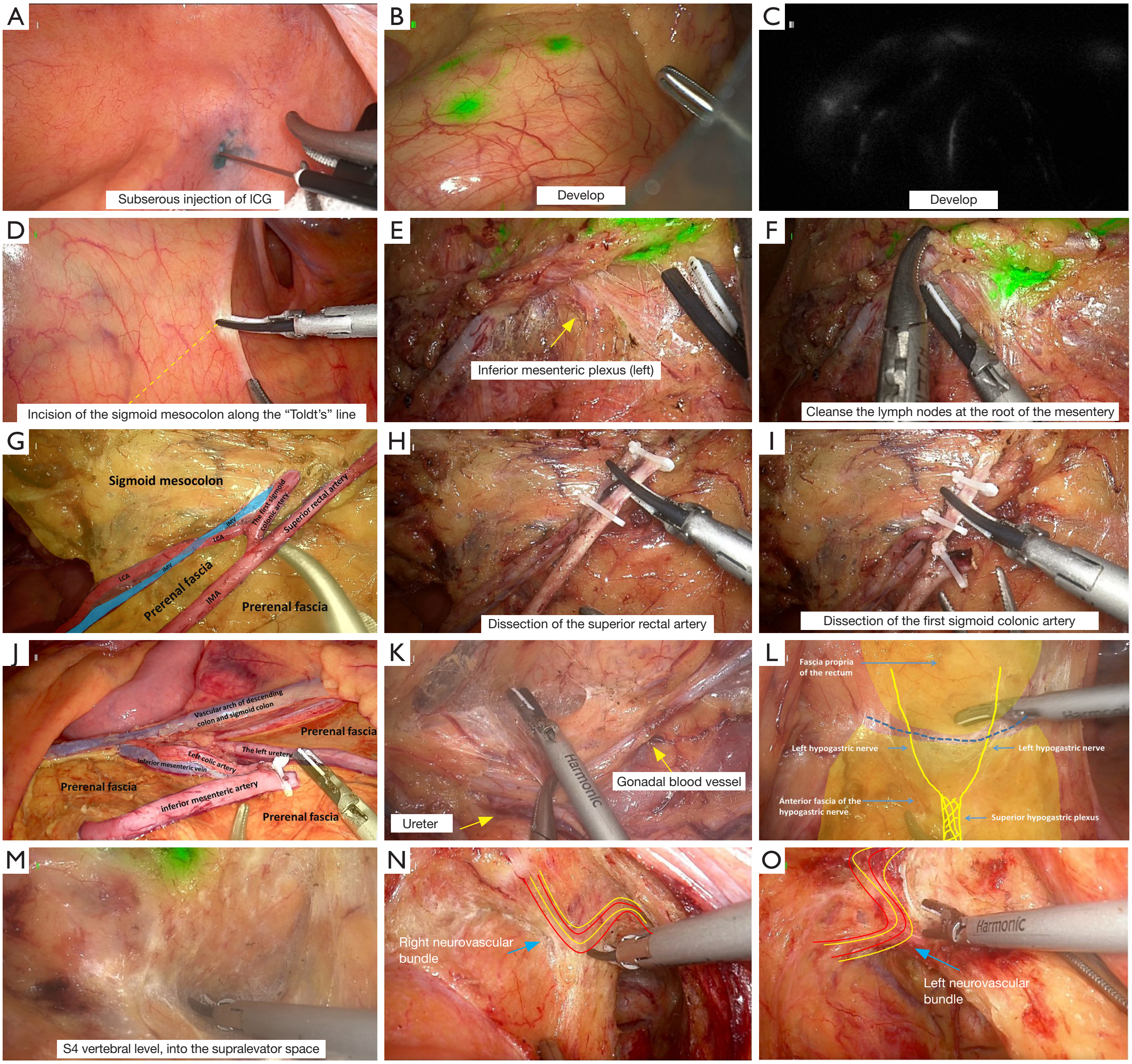


Figure 3 Intraoperative images. (A) Subserosal injection of ICG; (B) visualization of colonic mesenteric lymph nodes; (C) visualization of colonic mesenteric lymph nodes and lymphatic vessels; (D) incision of the mesentery at the level of the sacral promontory; (E) exposure of the inferior mesenteric nerve plexus; (F) skeletonization of the inferior mesenteric artery with lymph node dissection; (G) demonstration of the common trunk of the left colonic and sigmoid arteries after vessel skeletonization; (H) transection of the superior rectal artery; (I) transection of the first branch of the sigmoid artery; (J) post-transection vascular presentation; (K) dissection of the left Toldt’s space with exposure of the left ureter and gonadal vessels; (L) dissection of the retrorectal space with exposure of bilateral hypogastric nerves; (M) incision of the rectosacral fascia at S4 level to enter the supralevator space; (N) exposure of the right NVB; (O) exposure of the left NVB. ICG, indocyanine green; NVB, neurovascular bundle.

the IMA root was naturally exposed by the dissection of the right bundle of the inferior mesenteric plexus (IMP) with an ultrasonic scalpel at the angle of confluence below the left and right bundles of the IMP. The abdominal aorta was exposed. Directly in front of it was an oval window without a plexus, which we chose to open. This not only protected the nerve but also ensured the thoroughness of the lymph node dissection.

A total of 253 lymph nodes above the IMP level were dissected, and the IMA was cut off at 0.5 cm from the IMP. The vessel was dissociated distally along the IMA root until the left colic artery was exposed and preserved (*Figure 3G*). The superior rectal artery (*Figure 3H*) and the first branch of the sigmoid artery (*Figure 3I*) were ligated and severed. The inferior mesenteric vein (IMV) was dissected at the same level as the severed artery (*Figure 3J*) to ensure blood supply to the proximal bowel. After the vein was cut off, the ultrasonic scalpel was used for abrupt and sharp separation, and Toldt's gap was expanded. Care was taken to protect the reproductive vessels and ureters (*Figure 3K*).

Subsequently, the posterior rectal space was mobilized according to the principle of total mesorectal excision (*Figure 3L*). The intersphincteric plane below the sacral promontory was identified, and sharply separated toward both sides of the rectum using an "apple-peeling" technique. The perirectal fascia was gradually cut down on both sides, taking care to protect the pelvic nerves on both sides. Continue dissecting downward to the level of the fourth sacral vertebra, where a dense tissue, the rectosacral fascia, was identified. Transected the rectosacral fascia to enter a relatively loose space known as the supralevator space (*Figure 3M*). Proceed with downward dissection until reaching the pelvic floor.

Next, the left lateral space was mobilized. A harmonic scalpel was utilized to divide the anatomical adhesions between the sigmoid colon and the lateral abdominal wall. Dissection was continued cephalad as far as possible toward the splenic flexure region to prepare for subsequent anastomosis. Appropriate traction was maintained to ensure sufficient tension for surgical maneuvers at the correct tissue plane. Meticulous care was taken to preserve the left ureter and left hypogastric nerve. Sharp dissection was then carried out caudally along the mesorectal fascia (also termed fascia propria recti) until reaching the neurovascular bundles (NVBs). The identical technique was applied during the right-sided dissection.

Next, the anterior wall was dissected. Approximately 0.5 cm above the peritoneal reflection, incise the peritoneal bridge to enter the anterior space of Denonvilliers' fascia. Perform an inverted U-shaped arc incision, then transect the anterior layer of Denonvilliers' fascia at a distance of 0.5 cm from the seminal vesicles to enter the posterior space of Denonvilliers' fascia, while carefully preserving the bilateral NVBs (*Figure 3N,3O*).

Next, a 5-cm ruler was selected and placed below the lower edge of the tumor to mark the position of the planned transection, and the denudation of the intestinal tube was then performed. A 10-cm ruler was then selected and placed above the upper edge of the tumor to mark the position of the planned transection, and the mesentery of the sigmoid colon was then trimmed. After the denudation of the intestinal tube at the initially planned transection site, 3 mL of ICG was injected into the peripheral vein, and the blood supply of the proximal intestinal tube and mesentery was observed 60 seconds later (*Figure 4A,4B*). The Sherwinter scoring system (4) was used to evaluate the blood supply at the anastomotic site as follows: 1 point: no fluorescence; 2 points: patchy areas of no fluorescence; 3 points: uniform fluorescence; 4 points: complete fluorescence, with locally high fluorescence; and 5 points: high fluorescence. An anastomotic score ≥3 points (uniform fluorescence or locally high fluorescence) indicates good blood supply at the anastomotic site. The perfusion score at the anastomotic site for this patient was 5 points; thus, there was no need to change the pre-cut line for extended resection.

A linear cutter (Johnson & Johnson) was used to cut off the bowel, and a 5-cm incision was made in the lower abdomen to remove the specimen and disconnect the bowel. Finally, the pneumoperitoneum was reconstructed, and anastomosis was performed using a stapler (three-row nail shape) (Huasen, Changzhou, China) through the end-to-end anastomosis of the anus and rectum. After the anastomosis was completed, ICG was injected again via the peripheral vein. Under standard FI mode, fluorescence visualization of the intestinal tract at the anastomotic site became apparent within approximately 60 seconds to 2 minutes, allowing for assessment of blood perfusion at the anastomotic site (*Figure 4C,4D*).

The upper margin of the tumor was 10 cm away from the upper edge of the incision, and the lower margin was 5 cm away from the lower edge of the incision. The surgically resected specimen measured 3 cm in longitudinal axis × 3 cm in circumferential diameter × 1 cm in intestinal wall thickness, occupying about half of the intestinal lumen (*Figure 5*). The patient's postoperative pathology (*Figure 6*) revealed adenocarcinoma, grade II, invading the pericolonic adipose tissue. No definite lymphovascular or perineural invasion was identified. Tumor budding grade: low. Circumferential resection margin: negative. Proximal and distal margins: negative. The lymph node results were as follows: peripancreatic lymph nodes: 0/5; mesenteric lymph nodes: 0/4; and mesenteric root lymph nodes metastasis:

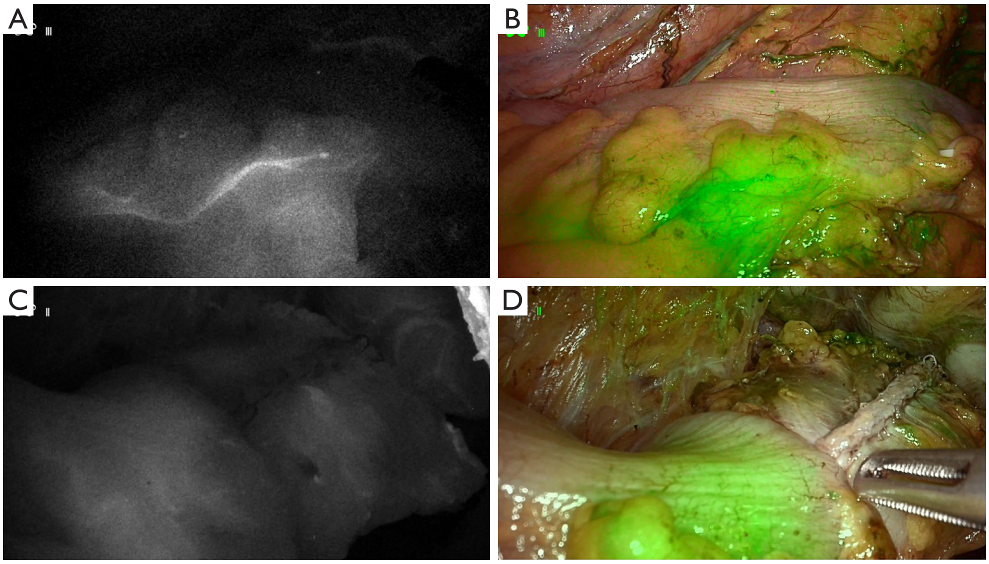


Figure 4 Blood supply at the anastomotic. (A,B) Fluorescence imaging of the proximal bowel before rectal transection; (C,D) evaluation of anastomotic blood supply at the anastomosis under fluorescence mode.

0/9. MutL homolog 1 (MLH1) (+), postmeiotic segregation increased 2 (PMS2) (+), MutS homolog 2 (MSH2) (+), MutS homolog 6 (MSH6) (+), human epidermal growth factor receptor 2 (HER2) (1+), pan-tropomyosin receptor kinase (pan-TRK) (−). Kirsten rat sarcoma viral oncogene homolog (KRAS)/neuroblastoma RAS viral oncogene homolog (NRAS)/v-Raf murine sarcoma viral oncogene homolog B (B-RAF) (−), wild-type (+). The patient had a revised postoperative diagnosis of rectal adenocarcinoma (pT3N0M0 stage IIA). The duration of the surgery was 120 minutes.

Postoperative considerations and tasks

Postoperatively, it is crucial that patients be encouraged to perform active in-bed movements such as turning over, leg lifts, and muscle contractions to enhance blood circulation and prevent thrombosis. Once permitted by the doctor, early ambulation is highly beneficial for recovery. It is essential that the patency of abdominal drainage tubes, urinary catheters, infusion tubes, and oxygen inhalation tubes be ensured to avoid dislodgement or compression. In the early postoperative period, patients should consume a light, easily digestible diet, gradually transitioning from water to clear liquids (e.g., rice soup, milk, and soy milk), to semi-liquids, and finally to a normal diet within 1–2 weeks. Consuming dietary fiber-rich foods aids regular bowel movements. Psychological support is vital; patients should maintain a positive attitude, actively participate in treatment and rehabilitation, and seek psychological help if needed. For stage IIA patients with complete surgical resection and no high-risk factors, postoperative chemotherapy is typically unnecessary. However, regular follow-ups are crucial, including blood tests, liver and kidney function assessments, tumor marker tests, and chest/abdominal computed tomography (CT) scans every 3–6 months for the first 2 years, then every 6 months until 5 years postoperative surgery, followed by annual checks. A colonoscopy should be performed within the first year, repeated after 2 years, and then every 2 years thereafter.

Patients undergoing Dixon surgery for rectal cancer may develop various complications that require systematic preventive and management strategies. For anastomosis-related complications such as anastomotic leakage and stenosis, preoperative nutritional support, intraoperative ICG fluorescence assessment of blood supply, and prophylactic stoma creation can effectively reduce risks. The prevention and treatment of pelvic dysfunction, including low anterior resection syndrome and sexual dysfunction, necessitate emphasis on nerve preservation techniques and postoperative rehabilitation. Surgical technique-related complications like presacral hemorrhage and stoma issues can be prevented through meticulous operative procedures and standardized stoma formation.

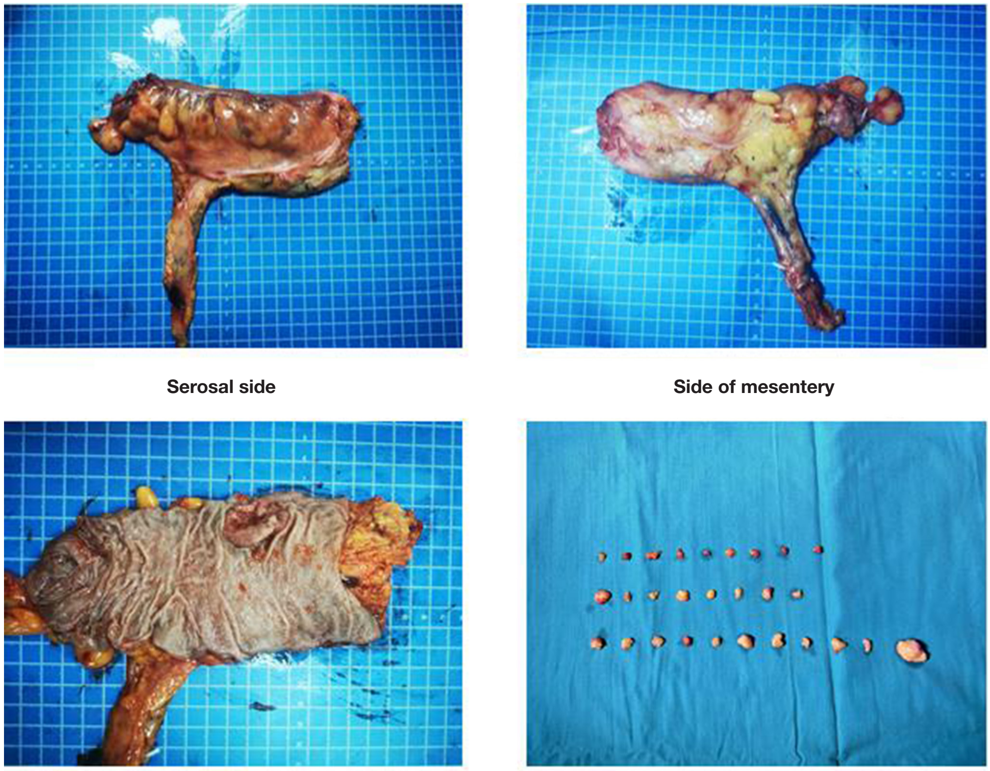


Figure 5 Postoperative specimen.

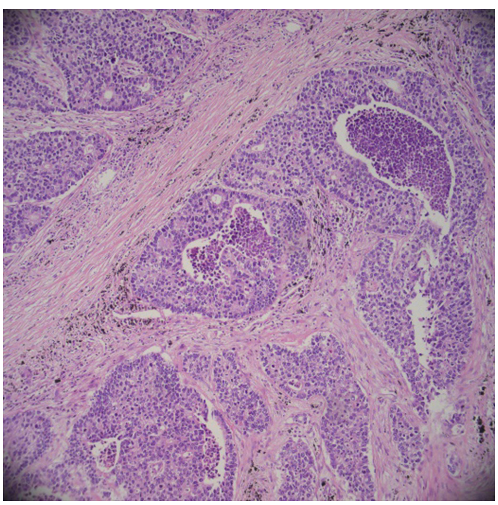


Figure 6 Postoperative pathology (hematoxylin and eosin: 100×).

Systemic complications such as deep vein thrombosis and intestinal obstruction require combined mechanical prophylaxis with pharmacological anticoagulation, along with early mobilization. Postoperative management should be individualized with rigorous follow-up monitoring, particularly focusing on local recurrence within the first two years. Clinical decision-making should incorporate the latest evidence-based guidelines, such as the European Society of Clinical Pharmacy (ESCP) consensus recommendations on ICG fluorescence technology, to ensure optimal therapeutic outcomes for patients.

In our case, the patient was able to get out of bed on the first day after surgery. The first flatus and defecation occurred on the second day after surgery. The anesthesia was clear, and the patient began a clear liquid diet on the second day after surgery, followed by a liquid diet. The pelvic drainage tube was removed on the sixth day after surgery, and the patient was discharged smoothly. Routine blood tests and liver and kidney function were normal 3 months after surgery. There were no signs of recurrence or abnormal fluid accumulation in the chest and abdomen CT scans (*Figure 7*). The patient's urinary and sexual functions have been preserved with minimal impairment postoperatively, and no signs of recurrence have been

Figure 7 Postoperative computed tomography examination.

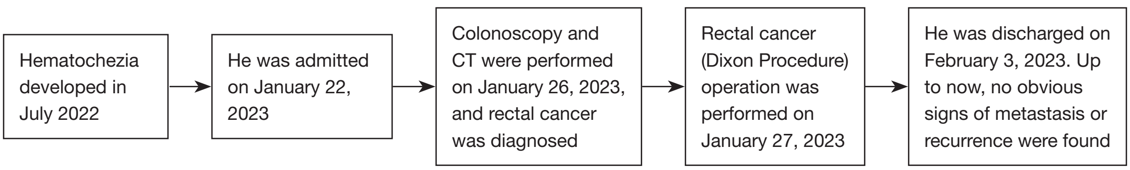


Figure 8 The patient's clinical timeline.

observed during serial follow-up examinations. The clinical course is detailed below (*Figure 8*).

Tips and pearls

In this case, the tumor stage of the patient was T3. Before the surgery, through the precise subserosal injection of ICG, the tumor was accurately located, enabling the accurate determination of the lower resection margin of the intestinal tract, and ensuring the adequacy of the intestinal resection range. This video demonstrates fluorescence-guided precise identification of the demarcation between the superior rectal artery and left colic artery. The left colic artery was preserved to ensure perfusion, along with radical lymph node dissection. With ICG fluorescence guidance, both lymph nodes and lymphatic vessels were clearly delineated, significantly shortening the duration of lymph node dissection. During the operation, the 253 groups and mesenteric lymph nodes were precisely located and thoroughly cleaned, ensuring the thoroughness and safety of the lymph node dissection, and significantly improving the lymph node detection rate. The application of this technique not only optimized the surgical process but also provided a more accurate basis for the postoperative pathological assessment. Additionally, in this case, an intravenous injection of ICG was used to assess the vascular perfusion of the bowel before and after the anastomosis in real time. The accurate assessment of the bowel blood supply effectively prevented postoperative anastomotic leakage. The ICG-FI technology was easy to operate, significantly improved surgical efficacy and quality, shortened the operation time, reduced the surgical risks, and provided a safer and more efficient surgical experience for the patient.

Additionally, we utilized the Nanjing Nuoyuan 4K fluorescence laparoscopy system. This device features synchronized light source technology, which automatically adjusts excitation light intensity in real-time during surgery, ensuring consistent imaging quality even with instrument movement. Its high sensitivity and superior visualization are demonstrated in the surgical video, where even very small lymph nodes (2–3 mm) can be clearly identified, enabling more precise and thorough lymph node dissection. Furthermore, the system facilitates dissection along the correct anatomical planes, providing excellent nerve protection and resulting in optimal postoperative functional outcomes. It also significantly reduces operative time, leading to faster patient recovery and shorter hospital stays.

In summary, fluorescence-guided laparoscopic radical resection for rectal cancer, applying the aforementioned technical approaches, offers patients a more precise and efficient surgical treatment option, and could further improve patient prognosis and quality of life. The implementation of this technology will not only enhance surgical precision and safety but will also provide a new development direction for the minimally invasive treatment of colorectal cancer, and thus has significant value for clinical promotion.

Discussion

ICG is an anionic, amphiphilic, water-soluble fluorescent dye with a molecular weight of 776 daltons (5,6). It can rapidly bind to proteins after entering the human body, and has NIR absorption and emission fluorescence properties, emitting fluorescence that can be detected by a probe or a camera when excited by NIR light (electromagnetic waves with wavelengths in the range of 800–840 nm, and visible light in the wavelength range of 390–780 nm) (7-9). The advantages of NIR include its high tissue penetration and the low autofluorescence of biological tissues, which provide sufficient contrast. In addition, the NIR wavelengths are invisible to human eyes, and thus do not change the surgeon's view of the surgical area (10,11). The standard dose of ICG is less than 2 mg/kg, and ICG is almost non-toxic as long as the patient is not allergic to iodine (12). The half-life of ICG is 3–5 minutes, and it is eliminated by the liver within 15–20 minutes, excreted in bile in its original form, with tissue penetration of up to 5 mm (3,13).

The simultaneous use of FI and ICG has been proven to be effective in the identification and characterization of tumors and metastatic lymph nodes (14-16). Thoroughly standardized lymph node dissection is of great significance in determining postoperative lymph node metastasis and tumor staging, as well as in improving patient prognosis and reducing postoperative recurrence rates. The prognosis of patients with stage I and II colon cancer is relatively good; however, 30% of such patients will experience systemic disease recurrence (17). One of the main reasons for this high recurrence rate may be insufficient pathological staging related to undetected lymph node metastasis (18). According to the relevant literature, regardless of whether lymph node metastasis is positive or negative, the more lymph nodes detected, the higher the survival rate (19).

Currie *et al.* and Hirche *et al.* (20,21) showed that ICG can be used for lymph node mapping in colorectal cancer surgery, improving the lymph node detection rate and enhancing the surgical quality. A study has demonstrated that compared to the control group, the fluorescence-guided lymphadenectomy group exhibited a significantly higher median number of harvested lymph nodes and reduced postoperative hospital stay (22). In the present case, the retrieval of 28 lymph nodes further validates that the ICG-FI technique can substantially improve lymph node yield and enhance clinical outcomes. Overall, the advantages of real-time lymph node mapping with ICG cannot be ignored. Notably, it can: instantly color small lymph nodes located between arteries and veins, at the mesenteric root, and distant (lateral) lymph nodes, helping to thoroughly clean lymph nodes during lymph node dissection; identify lymphatic drainage areas, enabling more precise cleaning during surgery, and avoiding the residue of local lymph nodes; and guide surgeons to perform personalized lymph node dissection based on the extent of colon resection. Moreover, ICG-FI not only plays a crucial role in colorectal cancer surgery but has also been widely adopted in various other surgical procedures. A study by Chen *et al.* (23) demonstrated that in laparoscopic radical gastrectomy, ICG fluorescence technology enables precise tumor localization, improves the detection rate of small lymph nodes, and increases the total number of harvested lymph nodes, potentially leading to better patient outcomes. Similarly, in esophageal cancer surgery, ICG fluorescence enhances lymph node detection rates (24). Additionally, ICG-FI allows real-time visualization of thoracic duct anatomy, reducing unnecessary prophylactic ligation and lowering the risk of chylothorax (25), which may further contribute to improved postoperative prognosis. The safety and reliability of ICG-FI in lymphatic tracing during colorectal cancer surgery have been preliminarily confirmed; however, its evaluation criteria, specific injection process, and dosage still require further research. More prospective studies need to be conducted to provide high-level evidence-based support.

Anastomotic leakage is one of the most common complications of colorectal surgery, and can lead to pelvic cavity infection, diffuse peritonitis, and even septic shock, and severe cases can lead to multiple organ dysfunction or even death (26). The key to anastomotic healing is good blood flow, and blood flow disorders can directly increase the incidence of anastomotic leakage. In the past, surgeons have often assessed the blood flow of anastomosis during colorectal surgery using methods such as intraoperative endoscopy and direct observation (of the intestinal wall color, degree of arterial pulsation, intestinal peristalsis, and anastomotic bleeding); however, such assessments are subjective and rely on previous experience, which directly affects the accuracy of evaluations. In colorectal surgery, ICG-FI is mainly used to assess the blood flow at the anastomosis, and the real-time and visual FI of the blood flow at the anastomosis plays an important role in reducing the occurrence of anastomotic leakage (27). ICG-FI has also been utilized in the management of long-segment transplant ureteral strictures (TUS). As a common complication following renal transplantation with an incidence of 2–10.5%, long-segment (>3 cm) or pan-ureteral strictures present significant therapeutic challenges, with conventional endoscopic treatments demonstrating limited success rates (25–62%). Foo *et al.* (28) demonstrated that ICG-FI enables precise identification of the stricture ureteral segment, real-time evaluation of anastomotic blood supply, and reduction in postoperative complications including urinary leakage and recurrent stricture formation. The quality of intraoperative FI directly determines the accuracy of evaluations of blood flow perfusion at the anastomosis. Factors that may affect imaging quality include the optimal dose and timing of the ICG administration, the method and site of the ICG injection, the distance between the laparoscopic lens and the intestine, external lighting conditions, the NIR light intensity, and individual differences and the baseline characteristics of the patient (29,30).

Conclusions

Intraoperative ICG-FI technology has great potential in the surgical treatment of colorectal cancer. As outlined above, multiple studies have confirmed the significant potential of ICG in (sentinel) lymph node mapping, the qualitative and quantitative assessments of anastomotic blood supply, and reducing the occurrence of anastomotic leakage; however, the application of ICG-FI technology in colorectal cancer surgery is still in its early stages. Currently, there are no established standards or guidelines for the dose, injection site, observation time, or other aspects of ICG application, and there is a scarcity of prospective randomized controlled studies. Therefore, in-depth research on this technology is needed to establish standardized operating procedures, improve the safety and accuracy of tumor resection, and improve patient prognosis.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Declaration of Helsinki and its subsequent amendments. Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

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