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10.2478/AMB-2022-0019

CASE REPORT

LAPAROSCOPIC GASTRECTOMY WITH ICG GUIDED D2 LYMPH NODE DISSECTION – A CASE REPORT AND REVIEW OF THE LITERATURE

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Abstract. *Radical surgery for gastric cancer remains the only reliable therapeutic tool and cornerstone for definitive treatment. With improving resectability, patients are given a better opportunity for long-term survival. Indocyanine green (ICG) is able to define more precisely the boundaries of the tumor in early and advanced gastric cancer. In addition, it can noticeably improve lymph node dissection and reduce the risk of subsequent complications. In this paper we present our experience with laparoscopic gastrectomy together with a review of the available literature.*

Key words: *gastric cancer, laparoscopy, lymph node dissection, indocyanine green*

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Received *– 7 February 2022;* ***Accepted*** *– 2 April 2022*

INTRODUCTION

Radical laparoscopic gastrectomy (LG) finds widespread application in the treatment of gastric cancer due to its mini-invasiveness and patients' early postoperative recovery [1-3]. Adequate lymph node dissection is a complex step in radical surgery and remains crucial for the accurate pathological staging and favorable long-term survival [4, 5]. The proper identification and dissection of lymph nodes usually depends largely on the experience of the surgeon.

Radical lymphadenectomy may significantly improve the overall survival rate and enhance the accuracy of tumor staging in gastric cancer patients. The retrieval of more lymph nodes has become the current recommendation for most surgeons [6].

Since Kitano et al. [7] reported the first laparoscopic distal gastrectomy performed on a patient with gastric cancer in 1994, radical LG has found wide use in clinical practice [8, 9]. Currently, lymph node dissection is performed without the guidance of image-enhancing devices, but rather on the individual discretion and experience of the surgeon. The complex vascular and lymphatic anatomy of the stomach can be a real challenge for surgeons to harvest enough lymph nodes without increasing the risk of lymphadenectomy-associated complications. With the development and extensive use of minimally invasive techniques, surgeons continue to search for methods and ways to visualize lymph nodes in real time to perform isolated and more precise dissection of metastatic nodes only.

Indocyanine green (ICG) is a known diagnostic reagent used in the assessment of liver function and cardiac output. It can also serve as a dye for stomach cancer like methylene blue. Unfortunately, the ICG is

not well visible to the naked eye. Therefore, devices have been developed to ensure a satisfactory level of detection when it accumulates in tumor cells. ICG absorbs the light in the near-by infrared range between 600-900 nm and emits fluorescence at a wave-length between 750 and 950 nm. Thus, resection lines can be more accurately identified and tumor resectability improved by minimizing the presence of residual tumor cells (R1) in healthy tissues particularly in specific histological types (Lauren diffuse type and Borrmann types III and IV).

As a new emerging surgical navigation technique, fluorescent imaging with ICG, satisfactory results have been achieved in lymph node dissection in breast cancer, non-small cell lung cancer and others. The successful use of the ICG imaging technology in laparoscopy and the near-infrared (NIR) fluorescent imaging have enabled better tissue penetration and more accurate identification of lymph nodes in hypertrophic adipose tissue, compared to other dyes in the visible light spectrum. The ICG navigation system has become a new direction for research in the minimally invasive approach as part of the treatment of gastric cancer [6].

It is well known that in cases of relatively early diagnosis of gastric carcinoma (at clinical stages cT2N0, cT2N1, cT3N0), laparoscopic radical gastric subtotal resection with D2 lymph dissection is considered crucial for favorable oncological outcomes and preserving to a maximal extent the function of the stomach remnant. Although the use of ICG to determine the location of the tumor has been discussed in a previous retrospective study [10], neither standard D2 lymph dissection, nor precise gastric resection using this technique have been reported, especially in the context of total gastrectomy.

This may be the reason why there are only few randomized large-scale clinical studies evaluating the safety, efficacy and feasibility of laparoscopic ICG-guided gastrectomy with D2 lymph node dissection in patients with gastric cancer. The present case report aims to demonstrate individual performance technique, benefits and postoperative results after ICG-guided laparoscopic gastric resection with total D2 lymph dissection.

CASE DESCRIPTION

A 64-year-old patient was referred to our surgery clinic with upper dyspeptic complaints, asthenia and adynamia. Fibrogastroendoscopy was performed and revealed a 2-2.5 cm prepyloric ulcer lesion with raised margins and a deep base along the lesser curvature of the stomach. 7 biopsies from different locations were taken. The histopathological report showed poorly-differentiated high-grade adenocarcinoma (G3). Preoperatively the patient was staged by chest, abdomen and pelvis computed tomography with no evidence of metastatic regional lymph nodes and secondary involvement of parenchymal organs. Following diagnostic laparoscopy with peritoneal lavage and Pap 1 according to the Papanicolaou classification, the patient was referred for neoadjuvant treatment (cT2N0M0).

Preoperative endoscopic injection of ICG

We dissolved 25 ml of ICG in 20 ml sterile water. 24 hours prior to surgery, the solution was injected endoscopically into the submucosal layer of the stomach wall approximately 1 cm away from the macroscopic tumor margins (bolus of 0.5-1 ml in each quadrant of the tumor, according to the Korean group instructions that used this technique for lymph node mapping) with a special endoscopic needle, which helps to define the clear border between the tumor and the normal tissue. This method is based on data from previously published studies [11, 12]. In addition, this could allow clear diffusion to the lymph nodes and subsequent sentinel lymph node dissection.

Intraoperative ICG imaging

The images were generated by using a high-resolution camera (Image 1 SPIES; Karl Storz) connected to a 30º laparoscope with a powerful xenon light source (D-Light P-System; Karl Storz). The light source of the ICG fluorescent system is a light guide that emits photons with a wavelength of 760 nm, while the detector is connected to the camera of the device with limited filtering used to filter light with a wavelength below 820 nm. Fluorescent signals were transmitted to a digital video processor and displayed on a real-time video monitor.

By detecting ICG, we identified the exact tumor location in the infrared phase, which clearly visualized its size and boundaries and the surrounding tissue (Figures 1, 2). This allowed accurate determination of the proximal and distal resection lines according to the oncological principles (Figure 3).

Distally and proximally we disconnected the stomach using linear mechanical staplers and performed Billroth II with Roux-en-Y intracorporeal reconstruction (Figures 4, 5), assessing the vitality and blood supply using ICG.

Lymph nodes that had accumulated ICG appeared as round spots emitting clear fluorescence, defined as fluorescent lymph nodes (FN) (Figure 1). FNs were carefully dissected from the surrounding adipose tissue. Lymph nodes were isolated from the entire specimen, the presence of ICG being detected during incision.

Postoperative period

Rehabilitation was initiated 12 hours postoperatively and enteral feeding was resumed on the 2nd postoperative day. On the 8th postoperative day the patient was discharged from the clinic. The histopathological report confirmed the preoperative histology result – moderately (G2) to poorly differentiated (G3) tubular adenocarcinoma. Tumor infiltration of the proper muscle layer without invasion of the subserosal adipose tissue and serosa was reported. Of the 34 harvested lymph nodes that were examined, tumor metastases were found in 7. The resection lines from the gastric corpus mucosa and duodenum were free of residual tumor cells (pT2N3aR0). The suprapyloric and infrapyloric lymph nodes (Figures 6, 7) which were visible on the infrared light and accumulated indocyanine green, were found to have tumor metastases.

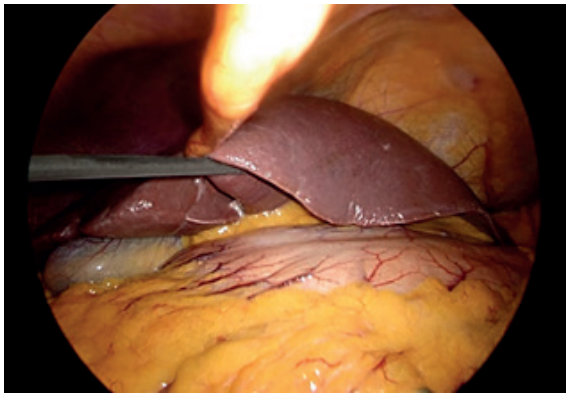


Fig. 1. Normal laparoscopic view

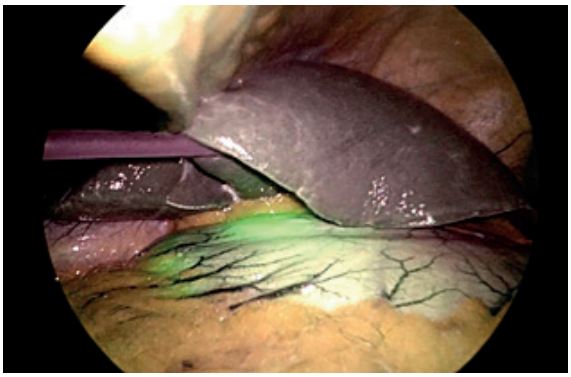


Fig. 2. Laparoscopic view with ICG fluorescence

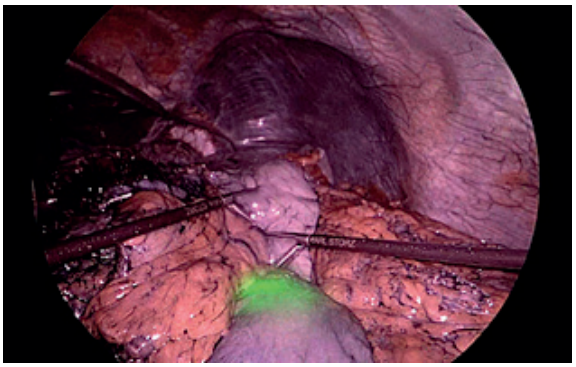


Fig. 3. Measuring of the proximal resection line

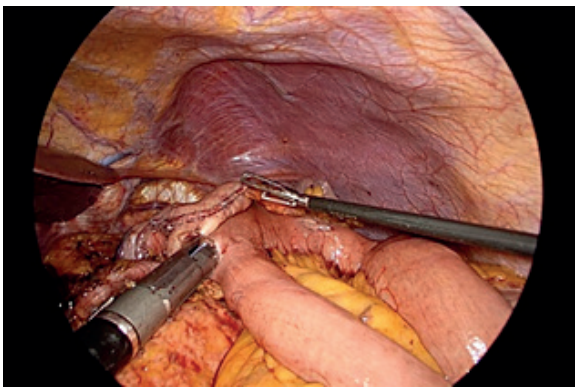


Fig. 4. Intracorporeal gastroentero-anastomosis

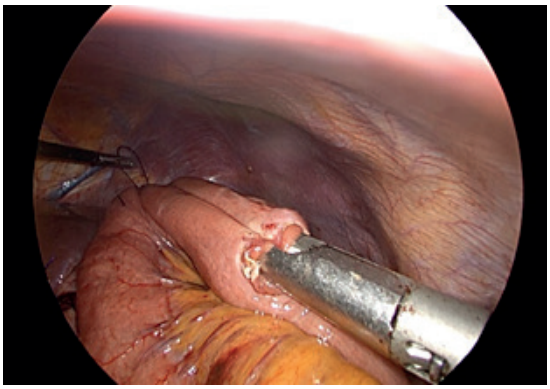


Fig. 5. Jejuno-jejuno-anastomosis a modo Braun

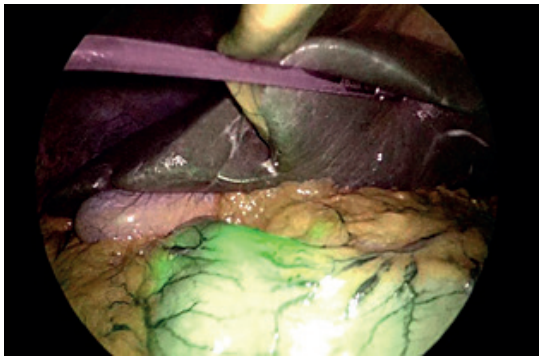


Fig. 6. Suprapyloric LN. Lymph node station 5

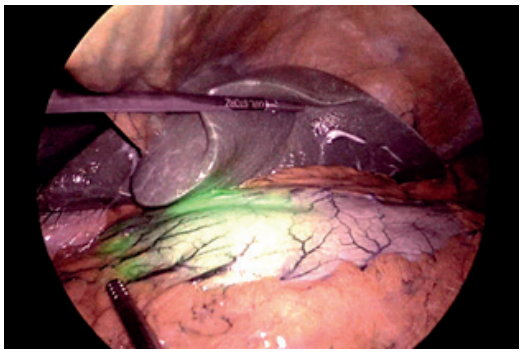


Fig. 7. Infrapyloric LNs and LNs along the greater curvature. Lymph node station 6

DISCUSSION

When trying to determine the adequate resection lines during laparoscopic gastrectomy in cases of

stomach cancer, it is of utmost importance to identify the exact tumor localization. This would not be a problem in open surgery of large tumor cases, when the neoplastic formation could be easily palpated. However, this is an important aspect during laparoscopy in cases of early-stage tumor, particularly if the formation is in the proximal part of the stomach, where organ preservation is sought to a maximum extent. Several methods for detecting tumor borders exist: endoscopic injection of Indian ink [13], endoscopic clipping and intraoperative echoendoscopy [14, 15].

Among these methods, the most commonly used in Japan is the Indian ink, because it does not require additional equipment and its financial cost is low. However, during its application the exact border of the tumor fades and is obscured, because a larger amount of ink is needed to be injected to ensure its detection through the serous surface of the stomach. Endoscopic clipping takes more time and requires often endoscopic ultrasonography or X-ray fluoroscopy. On the other hand, complications may be caused by clips falling out or also due to other reasons [16]. Intraoperative fibrogastroscopy is the safest method and provides sufficient information on the exact extent of the resection lines [17]. Still, this requires the presence of additional medical staff in the operating room. Moreover, fibrogastroscopy in a supine patient poses different challenges for the endoscopists, and in some hospitals additional staff and equipment are not available.

To overcome all these difficulties during surgery, we selected ICG-guided laparoscopy, which is routinely used to isolate sentinel lymph nodes. We confirmed that the lymph nodes which accumulated indocyanine green ink had tumor invasion, as reported by other authors [18, 19]. Sentinel lymph dissection requires peritumoral injection of ICG into the submucosal layer of the stomach wall-, which is a procedure similar to our method, and several previous studies have reported the efficacy and safety of this method [20].

ICG navigated laparoscopy is easily managed and does not complicate the surgical procedure; the transition from normal (white light) to ICG mode is performed smoothly with a foot pedal. As the infrared camera detects the fluorescent signal of indocyanine green through the stomach wall and the serous surface, the dye does not need to be seen macroscopically, as is the case with Indian ink, allowing the injection of relatively less ICG, preventing blurring of boundaries.

In conclusion, by submucosal injection of 1 ml of indocyanine green 24 hours before surgery, we obtained the exact location of the tumor with clear boundaries defining the resection lines, which were confirmed by the histopathology. The metastatic lymph nodes were readily identified, the patient received a reliable disease staging thus allowing limited lymph dissection and excellent oncological results at the a low intra- and postoperative risk.

Disclosure Summary: *The authors have nothing to disclose.*

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