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Case report

Evaluating gastric remnant ischemia by indocyanine green fluorescence-guided surgery after distal gastrectomy in a patient with prior Nissen fundoplication: A case report

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ABSTRACT

Introduction: Recent studies showed that intraoperative indocyanine green (ICG) fluorescence imaging-guided surgery helped evaluate organ perfusion. Whereas whether the gastric remnant can be preserved after distal gastrectomy for the cases of post-Nissen fundoplication remains unclarified. This case report demonstrated the applicability of intraoperative ICG fluorescence-guided surgery to assess the gastric remnant's blood supply after distal gastrectomy.

Case presentation: A 68-year-old man who previously underwent Nissen fundoplication for esophageal hiatal hernia was diagnosed with early gastric cancer in the lower body of the stomach. We performed laparoscopic distal gastrectomy to preserve the left gastroepiploic vessels considering the dissection of a part of the short gastric vessel from the previous Nissen fundoplication. After completing Billroth I reconstruction, the color of the serosal surface did not show any signs of ischemia. However, intraoperative esophagogastroduodenoscopy showed an ischemic change of the remnant stomach. In addition, ICG fluorography revealed insufficient blood supply to the gastric remnant compared with that to the pancreas and liver. Consequently, we converted to total gastrectomy to avoid necrosis in the gastric remnant.

Conclusion: We performed intraoperative ICG fluorescence-guided surgery in patients with early gastric cancer after Nissen fundoplication. ICG fluorescence may be useful in preventing postoperative gastric remnant ischemia, especially in high-risk patients.

1. Introduction

Intraoperative indocyanine green (ICG) fluorescence provides appreciable visualization of the vascular system by capturing the near-infrared light emitted by the intravenously injected ICG dye with a dedicated camera [1]. ICG can help determine the blood flow status of the gastrointestinal tract, lymphatic flow and locate hepatic tumors [2,3]. Interestingly, recent studies demonstrated the usefulness of intraoperative ICG fluorescence-guided surgery for evaluating organ perfusion. Further, other advantages, including reduced postoperative complications in colorectal cancer because of ICG fluorescence-guided surgery have been reported recently. Nevertheless, its benefit in gastric cancer remains less explored [4,5], and there are no established evaluation methods for using ICG. In standard distal gastrectomy (DG), the bilateral gastric and gastroepiploic vessels are dissected. The gastric remnant is generally resistant to ischemia because of the blood flow from the splenic artery branch and the rich microvascular network under the gastric mucosa [6]. Therefore, gastric remnant ischemia is an infrequent postoperative complication with a high mortality rate. The risk of gastric remnant ischemia increases when the splenic vessels are dissected. This risk is also higher in DG after the Nissen fundoplication surgery, which is performed for treating esophageal hiatal hernia requiring partial dissection of the short gastric vessels. Moreover, whether the gastric remnant can be preserved when DG is performed after Nissen fundoplication needs to be clarified.

Herein, we describe our experience of performing intraoperative ICG fluorescence-guided surgery in an elderly patient with a history of Nissen fundoplication, which is the first report describing the use of ICG

Abbreviations: ICG, indocyanine green; DG, distal gastrectomy.

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fluorescence-guided surgery in a patient with a history of Nissen fundoplication.

2. Case presentation

A 68-year-old man with a history of Nissen fundoplication for esophageal hiatal hernia was referred to our hospital after endoscopy showed signs of gastric cancer. In addition, he had a history of hypertension, benign prostatic hyperplasia, and chronic smoking (20 cigarettes/day) for 45 years, with no alcohol consumption habits or allergic episodes.

Preoperative computed tomography and esophagogastroduodenoscopy showed early gastric cancer (cType 0-IIa + IIc) at the lower body of the stomach with no apparent lymph node or distant organ metastasis (cStage I, cT1bN0M0 [7], Fig. 1).

Usually, the bilateral gastric and gastroepiploic vessels are dissected during DG. However, we planned a laparoscopic DG to preserve the left gastroepiploic artery and vein to avoid gastric remnant ischemia because of partial dissection of the short gastric vessels in the previous Nissen fundoplication.

Laparoscopic surgery was performed using five ports. No apparent peritoneal dissemination or liver metastases were observed. Because of the previous surgery, adhesion removal was time-consuming. As planned, we preserved the left gastroepiploic artery and vein. We then performed laparoscopic DG with D1 + lymph node dissection and delta-shaped Billroth I anastomosis. No ischemic findings were observed from the color of the serosal surface after Billroth I reconstruction (Fig. 2A). When gastroduodenoscopy was performed to observe the anastomosis, the remaining mucous membranes of the stomach showed ischemic changes (no data shown), unlike when the cutting line was determined. Therefore, ICG and near-infrared laparoscopy were performed to evaluate the blood supply into the residual stomach. 2 ml of ICG were administered to the peripheral vein at a concentration of 2.5 mg/ml of ICG, and ICG fluorography was studied after 1 min [2], showing insufficient blood supply to the remnant stomach to the pancreas and liver (Fig. 2). For each organ, the pancreas began to stain at 50 s after ICG administration (Fig. 2B), the liver began to stain at 60 s (Fig. 2C), and the stomach began to stain at 1 min and 20 s (Fig. 2D), 20 s later than the time of evaluation. The stomach began to stain slowly, and there were poor staining findings around the anastomosis (Fig. 2D). After concluding on the insufficient blood flow to the gastric remnant and around the anastomosis, we converted to a total gastrectomy in laparotomy to avoid gastric remnant ischemia.

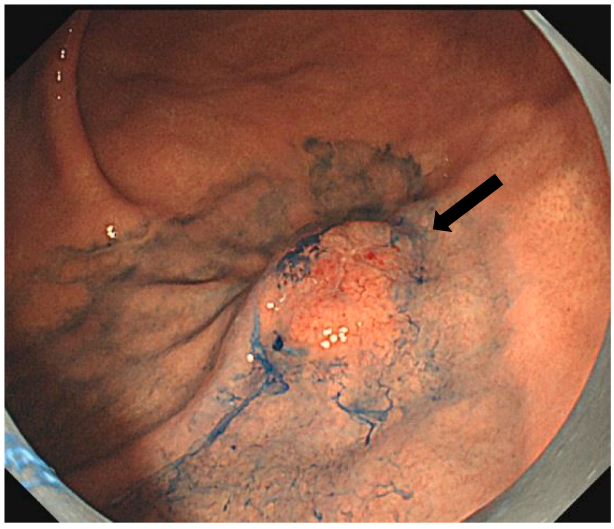

Fig. 1. Esophagogastroduodenoscopy was conducted before surgery. Gastric cancer (cType 0-IIa + IIc) was detected at the lower body of the stomach (black arrow).

The operation time was 491 min, with a total blood loss of 330 ml. Pathological examination revealed Stage IIB gastric cancer.

Due to postoperative ileus, his discharge was prolonged up to postoperative day twenty-five, with no other significant issues. After one postoperative year, has an excellent physical condition without recurrence.

3. Discussion

The main blood vessels supplying blood to the stomach are the bilateral gastric and gastroepiploic arteries dissected during DG. The risks of ischemia in the gastric remnant are low because of the blood supplied by the splenic artery branch and the rich microvascular network under the gastric mucosa [6]. However, gastric remnant ischemia after subtotal gastrectomy was first reported in 1953 [8]; it occurs in 0.2%–0.3% of patients after gastrectomy with mortality rates of 40%–70% [9,10]. Although the mortality rate is thought to decrease with improved diagnostic capabilities, gastric remnant ischemia is one of the fatal postoperative complications. The risk of gastric remnant ischemia is high in the DG if the splenic vessels are dissected because the blood supply to the gastric remnant from the splenic artery branch/short gastric artery is no longer available [11–14]. There are some reports of DG after distal pancreatectomy in a similar situation, and the risk of remnant gastric ischemia after splenic vessels resection was mentioned as well [15–18]. Another report on ischemic complications after DG emphasized that the short gastric artery was essential for maintaining the blood supply to the remnant stomach [19].

Although ICG fluorescence-guided surgery is beneficial, its application depends upon the subjectivity of the surgeon, and the evaluation method for ICG fluorescence remains unestablished. In addition, from several reports where intraoperative ICG was used to evaluate gastric blood flow, issues with the splenic artery system of patients have been described, which increased the risk of remnant gastric ischemia [12–14]. We performed intraoperative ICG fluorescence-guided surgery for the result from intraoperative endoscopy. Since this case was evaluated according to the blood flow evaluation of the colon [2], it is undeniable that it does not reflect the total original blood flow evaluation of the residual stomach. However, there was an apparent decrease in blood flow compared to the surrounding organs, and the fluorescence of the anastomosis part was also reduced. Hence, we converted to total gastrectomy to avoid ischemic complications in the gastric remnant. There are some limitations in this case report. Firstly, there is also a Doppler echo to evaluate residual gastric blood flow directly, but it requires technical skill. In this respect, it is also crucial that the ICG fluorescence method is easy to perform. After normal Billroth I method reconstruction, secondary, residual gastric blood flow should be evaluated by the ICG fluorescence method. However, the number of residual gastric blood flow evaluation cases related to some problematic cases, including this case and the splenic artery occlusion, is small, and it is not realistic to create an index that clarifies the relationship between fluorescence intensity and gastric necrosis or suture failure. Therefore, we compared the ICG dye staining in the remnant stomach and surrounding organs. Since there are currently no established evaluation methods, more cases should be accumulated with the same procedure to evaluate the gastric remnant hemodynamics using ICG fluorescence imaging in the future.

4. Conclusion

Although only a few reports examined the application of ICG fluorescence-guided surgery for evaluating gastric remnant blood flow, our case experience highlights that intraoperative ICG fluorescence evaluation can safely and efficiently assess the blood flow in the gastric remnant, and thereby help in preventing postoperative gastric remnant ischemia, especially in high-risk patients.

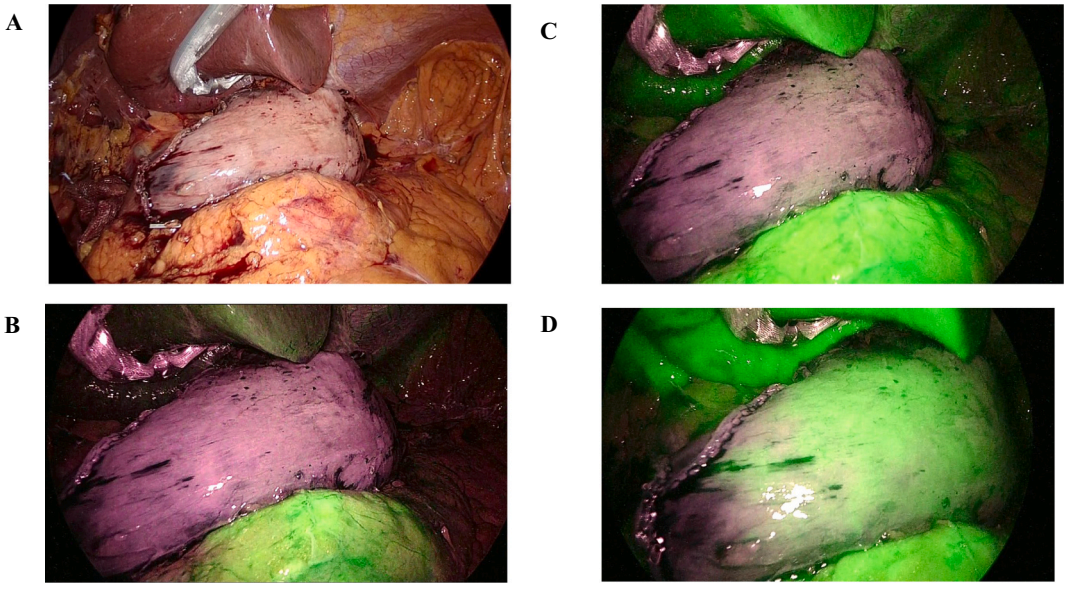

Fig. 2. A. No ischemic findings were observed from the color of the serosal surface after Billroth I reconstruction.
B. Indocyanine green (ICG) dye (5 mg) was injected through a peripheral vein. One minute after ICG administration, the ICG fluorography showed insufficient blood supply to the gastric remnant compared to the pancreas and liver.
C. At 50 s after ICG administration, the pancreas began to stain.
D. At 1 min and 20 s after ICG administration, the stomach began to stain. Poor staining around the anastomosis is observed. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

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Ethics approval and consent to participate

This study was carried out under the principles of the Declaration of Helsinki.

Informed consent

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 Editor-in-Chief of this journal on request.

Guarantor

Shunta Ishizaki and Naoto Takahashi are guarantors.

Provenance and peer review

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CRediT authorship contribution statement

SI, NT and RY prepared the manuscript under the supervision of KE. NT, TI and KT performed the surgeries. Other co-authors have discussed the contents of the manuscript. All authors have read and approved the final manuscript.

Declaration of competing interest

The authors declare that they have no conflict of regarding the publication of this paper.

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