Endoscopic evaluation of gastric conduit perfusion in minimally invasive Ivor Lewis esophagectomy

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ABSTRACT

INTRODUCTION: Laser-assisted indocyanine green (ICG) fluorescent dye angiography has been used in esophageal reconstructive surgery where it has been shown to significantly decrease the anastomotic leak rate. Recent advances in technology have made this possible in minimally invasive esophagectomy.

PRESENTATION OF CASE: We present a 69-year-old male with a T2N0M0 adenocarcinoma of the esophagus at the gastroesophageal junction who presented to our clinic after chemoradiation and underwent a minimally invasive Ivor Lewis esophagectomy. The perfusion of the gastric conduit was assessed intraoperatively using endoscopic ICG fluorescent imaging system. The anastomosis was created at the well-perfused site identified on the fluorescent imaging. The patient tolerated the procedure well, had an uneventful recovery going home on postoperative day 6 and tolerating a regular diet 2 weeks after the surgery.

DISCUSSION: Combination of minimally invasive surgery and endoscopic evaluation of perfusion of gastric conduit provide improved outcomes for surgical treatment for patients with esophageal cancer.

CONCLUSION: The gastric conduit during minimally invasive Ivor Lewis esophagectomy can be evaluated using endoscopic ICG fluorescent imaging.

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1. Introduction

Laser-assisted fluorescent dye angiography in esophageal reconstruction has been used to evaluate the perfusion of the gastric remnant prior to creating the anastomosis. Initial studies investigating this technology’s utility had mixed results and did not show a decrease in the number of postoperative anastomotic leaks [1]. Recently, however, a large study reevaluated the use of laser angiography in esophagectomy and found that the successful identification of well perfused gastric conduit margins significantly decreased the anastomotic leak rate [2]. A decreased leak rate has been associated with fewer additional interventions including reoperation and a shorter length of stay [3]. However, all of these studies were performed using fluorescent dye angiography for open operation. Here, we present the utilization of endoscopic indocyanine green fluorescent imaging (Pinpoint, Novadaq, Bonita Springs, FL) in a minimally invasive Ivor Lewis esophagectomy and discuss the potential immediate and long-term benefits of this technology.

2. Presentation of case

Our patient was a 69-year-old male with a newly diagnosed gastroesophageal junction (GEJ) mass on endoscopy. He had a history of diabetes, hypertension, and myocardial infarction and had previously undergone coronary artery bypass grafting. He also had an exploratory laparotomy for a ruptured appendix and an open cholecystectomy. The patient was monitored for Barrett’s esophagus and underwent an endoscopy that identified a 3 cm mass at the GEJ, which was biopsied and identified as a HER-2 positive esophageal adenocarcinoma. A PET-CT confirmed FDG-uptake in this region without any signs of metastatic disease. Further evaluation with an endoscopic ultrasound revealed a T2N0M0 esophageal cancer. The patient underwent induction chemotherapy with paclitaxel, carboplatin, and Herceptin and 50.4 Gy of radiation. He had a favorable response and was scheduled for a minimally invasive Ivor Lewis esophagectomy.

In the operating room, extensive adhesiolysis was performed laparoscopically. The gastrohepatic ligament was divided all the way to the GEJ and the stomach was mobilized. Using the electrothermal bipolar tissue sealing system, the omentum was carefully divided sparing the right gastroepiploic artery. The short gastriecs were also divided and a retro-esophageal space was opened. The posterior stomach was mobilized exposing the left gastric artery with its gastric and hepatic branches. The left
gastric branch was then divided with a vascular stapler. A Penrose was placed around the esophagus and advanced into the mediastinum. Pyloroplasty was then performed in a Heineke–Miculicz fashion. Next, the gastric conduit was created by dividing the stomach using serial firing of a laparoscopic tissue stapler creating an approximately 3 cm narrow conduit.

Endoscopic laser-assisted fluorescent dye angiography imaging system was used to evaluate the perfusion of the gastric conduit. The patient was injected with 2.5 mg of indocyanine green (ICG) and the gastric conduit was observed using a near infrared laparoscope that showed it was globally perfused (Fig. 1A–C). On the black and white view, the vascular plexus was clearly appreciated at the site where we plan to perform the anastomosis (Fig. 2A and B). After placing the feeding jejunostomy, the patient was repositioned in the left lateral position for thoracoscopic mobilization of the esophagus and en bloc lymph node dissection. After delivering the gastric conduit in the chest, an anatomic end to side, but a functional end-to-end gastroesophageal anastomosis was created with an end-to-end anastomastic 28 mm staple. Negative esophageal margins were confirmed prior to the construction of the anastomosis. The final gastric margin specimen was then divided (Fig. 2C) and a chest tube placed through one of the thoracoscopic ports. Postoperatively the patient was admitted to the intensive care unit for an overnight stay. He was started on tube feeds and transferred to the floor on postoperative day one. The nasogastric tube was removed on postoperative day four and chest tube a day later. He was discharged home on postoperative day six with an uncomplicated stay. The final pathology was ypT1aN0M0 or stage 1A. The surgical margins were clear of cancer and the patient had fewer than 1 mm foci of residual tumor. He tolerated a regular diet two weeks after surgery and his feeding jejunostomy tube was removed six weeks after surgery.

3. Discussion

An earlier study investigating the use of ICG fluorescent imaging in esophagectomy evaluated 40 patients who underwent a thoracic or cervical esophagectomy [1]. Gastric, jejunal or colonic conduits were resected and evaluated before and after mobilization into the chest. The study’s results showed that while ICG fluorescence detected organ perfusion, it did not reduce the anastomotic leak rate. Retrospectively, the authors noted no leaks occurred in cases where they could observe microcirculation in the conduit prior to anastomosis; however, small vessel perfusion was only observed in about half of the patients. Recently, Zehetner et al. investigated the use of ICG fluorescent imaging in esophagectomy. 150 patients were evaluated intraoperatively using this technology. In 49 of these, the lack of graft reach necessitated anastomosing the esophagus with proximal poorly perfused gastric conduit tissue. The leak in this group of patients was 45% compared to 2% in the group where the edges of the conduit were visually well perfused [2]. In both of these studies, they used an ICG fluorescent imaging system for open surgery. In our patient, we found that we can perform adequate evaluation of the gastric conduit with endoscopic ICG fluorescent angiography system. The combination of minimally invasive surgery and knowledge of perfusion of the gastric conduit has led to earlier removal of the nasogastric tube and chest tube facilitating an earlier discharge from the hospital.

Fig. 1. Use of endoscopic laser-assisted indocyanine green fluorescent dye angiography to evaluate the perfusion of the gastric conduit. (A) Laparoscopic view, (B) black and white infrared view showing perfusion of the conduit and (C) superimposed view showing perfusion in green on top of the laparoscopic view.

Fig. 2. Vascular plexus is clearly visualized on infrared view (A) at the site of the anastomosis with “s” marking the specimen and “c” marking the gastric conduit and superimposed view (B). (C) Stapling across the specimen marked “s” after creation of the anastomosis marked “A” between the esophagus and the gastric conduit marked “c”.
Addition of endoscopic ICG fluorescent angiography during minimally invasive Ivor Lewis esophagectomy may improve outcomes for treatment of patients with esophageal cancer.

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**Consent**
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**Author contribution**
VF, PG and MPK contributed to data collection, data interpretation, study concept and writing the paper.

**Guarantor**
Min P. Kim, MD, FACS.

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