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Near infrared perfusion assessment of gastric conduit during minimally invasive Ivor Lewis esophagectomy

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ABSTRACT

Introduction: Anastomotic leak and conduit necrosis are devastating complications following Ivor Lewis esophagectomy. Near infrared imaging (NIR) using IndoCyanine Green allows for real time tissue perfusion assessment which may reduce anastomotic leak during minimally invasive Ivor Lewis esophagectomy (MIE).

Methods: Forty consecutive MIE were performed by a single surgeon at a tertiary referral center. The first 20 were assessed for gastric conduit perfusion by clinical criteria (Group 1). The second 20 were also assessed using NIR laparoscopic system (Group 2).

Results: Comparing Group 1 to Group 2, no significant differences were found in overall complication rate, readmission or reoperation rate. NIR resulted in resection of the non perfused proximal portion of the conduit in 30% (6/20). Two patients in group 2 group developed anastomotic leak (2/20) compared to 0 in Group 1 ($p = 0.49$). Graft necrosis led to one mortality in Group 1, while there were 0 mortalities in Group 2. ($p = 1.0$).

Conclusion: Although NIR plays a role in assessment of tissue perfusion, in our study its use did not result in reduction of anastomotic leak rate.

1. Introduction

Esophagectomy is one of most invasive procedures in gastrointestinal surgery and despite improvements in surgical techniques and perioperative care, the mortality rate remains high.[1] A study using the National Surgery Quality Improvement Program database (NSQIP) between 2006 and 2011 reported that the morbidity of patients with esophagectomy was 43.8% and mortality was 3.8%.[2] In particular, anastomotic leak after esophagectomy remains an important cause of patient morbidity and impaired quality of life.[3–5] In the majority of cases, reconstruction after esophagectomy is done using a gastric conduit that is perfused by the right gastroepiploic arcade. Perfusion at the proximal portion of the graft, in the area where the anastomosis is typically created, is variable but often tenuous because the gastroepiploic arcade rarely reaches the tip of the graft. Instead, the most proximal portion of the graft is typically perfused by intramural capillaries within the wall of the stomach and small vessels in the omentum along the greater curvature.[6]

Historically, evaluation of the blood flow of the gastric conduit has been a challenge to most surgeons as relying on inspection of the color of gastric serosa is often inaccurate and misleading. Indocyanine green (ICG) fluorescence angiography and Doppler examination have recently been used to assess blood supply and assist in conduit construction. These modalities have been employed in an effort to reduce anastomotic complications after esophagectomy.[6,7]

The Near Infrared (NIR) laparoscopic system (PINPOINT Endoscopic Fluorescence Imaging System, NOVADAQ, Mississauga, ON, Canada) is used to provide high definition (HD) white light imaging during minimally invasive surgery (MIS), as well as NIR irradiation and ICG fluorescence emission imaging. This system provides a real-time false-color superimposition of ICG fluorescence signal on the HD white light view. This overlay allows simultaneous appreciation of dynamic perfusion and visualization of the conventional MIS video image.

In theory, the PINPOINT system might provide valuable real-time information about perfusion of the gastric graft during minimally invasive Ivor Lewis esophagectomy (MIE) and this might influence

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resection margins and surgical outcomes. The hypothesis is the use PINPOINT system during MIE esophagectomy would reduce anastomotic leak rates.

2. Methods

After Institutional Review Board approval (IRB#201600651) a retrospective analysis of prospectively collected data of all MIE performed at our institution was performed. All MIE from April 2014 to January 2016 were included. All surgeries were performed for cancer and were performed by a single surgeon (ZA) at a tertiary referral center. Cases were analyzed in 2 groups. Group 1, the conduit was evaluated using standard clinical criteria by inspecting the color of the gastric serosa. Group 2, NIR technology was used intraoperatively for assessment of graft perfusion. Data is presented as mean ± standard deviation unless otherwise stated. Significance is defined as $P \leq 0.05$. Comparative analysis was performed using student *t* test for continuous variables and Fishers exact for binary variables or Chi square test with Pearson correlation where appropriate.

3. Technique

The abdominal portion of the procedure was performed laparoscopically. Dissection began by opening the gastrocolic omentum below the level of the pylorus, taking care to preserve the right gastroepiploic arcade. The right gastric artery was preserved in all patients. The greater curvature of the stomach was mobilized and the short gastric vessels are divided. The left gastric artery was dissected and transected using the vascular stapler after all nodal tissue is lifted off the celiac axis. A 5 cm wide gastric conduit (Fig. 1) was constructed using multiple firings of the laparoscopic linear stapler. Pyroloplasty was performed in all patients.

The thoracic portion was performed thoracoscopically with the patient in the left lateral decubitus position. The inferior pulmonary ligament was incised and the right lung was retracted. The mediastinal pleura was incised and the esophagus was dissected to the level of the azygous vein, which was divided using the laparoscopic vascular stapler. The gastric conduit was pulled into the right chest, the specimen removed and end to end esophagogastric anastomosis was constructed intracorporeally using the mechanical circular stapler 25 mm DST XL EEA (Covidien, Newhaven, CT, USA).

Beginning in February 2015, NIR assessment of conduit perfusion was done using the PINPOINT system - 7.5 mg of ICG is injected intravenously and conduit perfusion assessment is done 60 s after injection. A marking silk stitch was placed when there was a demarcation between the perfused and non-perfused part of the conduit (Fig. 2). The non-perfused segment was resected in the chest, and the anastomosis was constructed between the native esophagus and perfused proximal stomach.

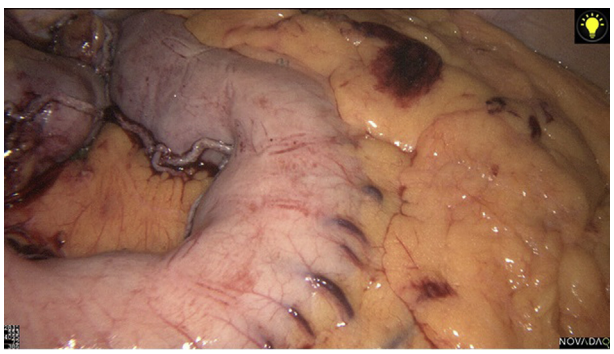

Fig. 1. Tubularized gastric conduit.

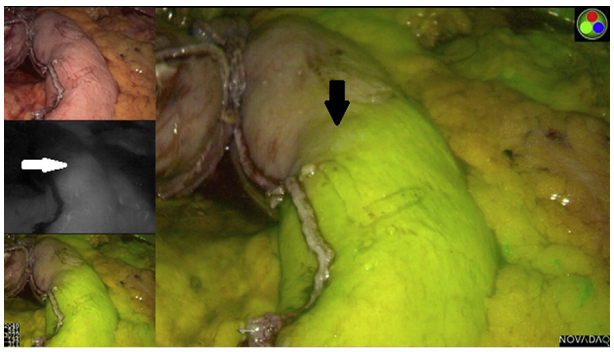

Fig. 2. Gastric conduit after ICG injection on NIR with poor perfusion evident in proximal conduit. Line of perfusion demarcation (arrows) shown in PINPOINT modes.

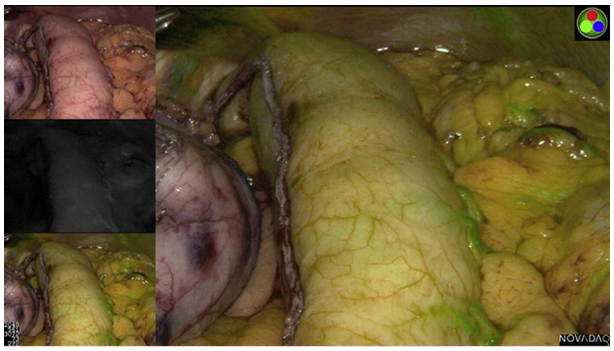

Fig. 3. Gastric conduit after ICG injection showing good perfusion throughout conduit.

When the conduit appeared well perfused throughout (Fig. 3) a stitch was still placed on the anterior surface of the conduit for orientation purposes upon transposition into the chest.

All patients underwent upper GI contrast study on day 4 prior to oral intake. Anastomotic leak was defined as full thickness defect of esophagus, conduit, anastomosis or staple line.[8] Oral intake was started the day of upper GI contrast study if the study was negative for leak.

4. Results

During the study period, 40 consecutive patients having undergone MIE. Group 1, 20 consecutive patients (April 2014–January 2015). Group 2, 20 consecutive patients (February 2015–January 2016) were NIR was used. The administration of ICG caused no adverse events in the NIR group. No differences were found between the 2 groups with regard demographic or preoperative parameters (Table 1).

Table 1
Demographic and preoperative date Group 1 vs Group 2.

Value	Group 1 (n = 20)	Group 2 (n = 20)	P value
Age (years)	66.2 ± 8	61.8 ± 12.8	0.2
% Male	80	80	1
BMI (kg/m^2)	26.3 ± 4.1	26.4 ± 4.9	0.97
% adenocarcinoma	70	90	0.24
Neoadjuvant therapy (%)	95	85	0.6
COPD (%)	20	15	1
Coronary artery disease (%)	15	25	0.69
Peroperative albumin (mg/dL)	3.9 ± 0.4	3.9 ± 0.4	0.69

COPD: chronic obstructive pulmonary disease.

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