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Creation of gastric conduit free-graft with intraoperative perfusion imaging during pancreaticoduodenectomy in a patient post esophagectomy



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ABSTRACT

As surgery becomes more successful for complicated malignancies, patients survive longer and can unfortunately develop subsequent malignancies. Surgical resection in these settings can be treacherous and manipulations of the patient's anatomy need to be closely considered before embarking on major operations. We report a case of a patient who survived esophageal resection for locally advanced esophageal cancer only to develop a new pancreatic head malignancy. Careful upfront planning allowed for a successful resection with an uncomplicated recovery.

She underwent open pancreaticoduodenectomy, and to maintain perfusion to the gastric conduit a microvascular anastomosis of the gastroepiploic pedicle was performed to the middle colic vessels. Intraoperative fluorescent imaging was used to evaluate the anastomosis as well as gastric and duodenal perfusion during the case.

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1. Introduction

Recent advances in gastrointestinal cancer diagnosis and treatment have resulted in improved survival. On top of other individual risk factors, long term effects of chemo-radiation increases the risk of developing a second malignancy [1]. Increased number of reports of patients who survived long enough to develop a second malignancy can be found in the literature. Awareness of this increased risk and close follow up is recommended.

Previous surgery as an integral part of the treatment for the initial malignancy can significantly alter the surgical anatomy. Surgical resection of a second malignancy can become complicated and treacherous if these alterations are not considered. Meticulous pre-operative planning is fundamental and the use of new modalities and techniques can be very beneficial in order to achieve an optimal oncologic result.

The incidence of a second malignancy after esophageal cancer is unknown and more specific the development of a subsequent pancreatic cancer is a rare event [2]. We present the unique case of a patient with resectable pancreatic adenocarcinoma who had previously undergone transthoracic esophagectomy for esophageal

cancer. She underwent pylorus-preserving pancreaticoduodenectomy with microvascular anastomosis of the gastroepiploic pedicle to the middle colic vessels. Intraoperative assessment of the vascular reconstruction was performed using an intraoperative fluorescent imaging platform (SPY system; Novadaq Technologies, Inc., Mississauga, Ontario, Canada). There are less than 20 case reports outlining the resection of pancreatic tumors in patients with previous esophagectomy [3]. To our knowledge this is the first report describing this specific technique as well as the use of intraoperative perfusion imaging.

2. Presentation of case

A 68 year old woman was referred to surgical oncology clinic with symptoms of vague abdominal pain for several months. The patient's history was significant for esophageal cancer that was treated with neoadjuvant chemo-radiation followed by Ivor-Lewis esophagectomy in 2001. She was currently in surveillance with no evidence of disease. During diagnostic work-up, multi-detector contrast computed tomography identified a pancreatic head mass associated with a dilated pancreatic duct (Fig. 4). Anatomically, the patient had a replaced right hepatic artery (Fig. 3) and evidence of the gastric conduit into the chest with a patent right gastroepiploic artery (Figs. 1 and 2). No concerning adenopathy or metastatic lesions were otherwise noted. An ERCP was performed which

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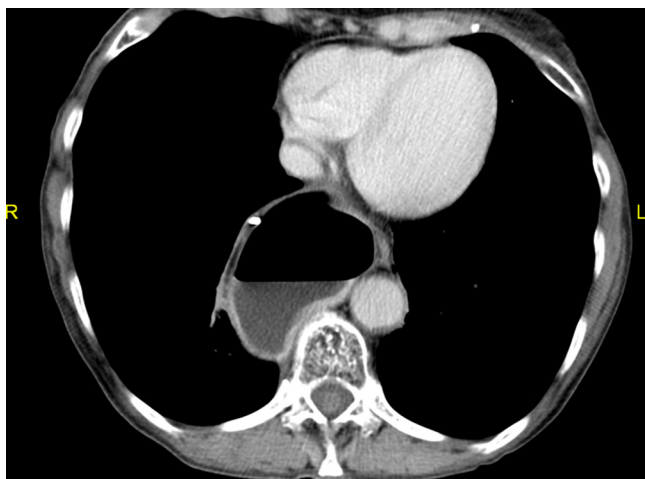


Fig. 1. Gastric conduit in the lower chest.



Fig. 3. Replaced right hepatic artery (arrow).

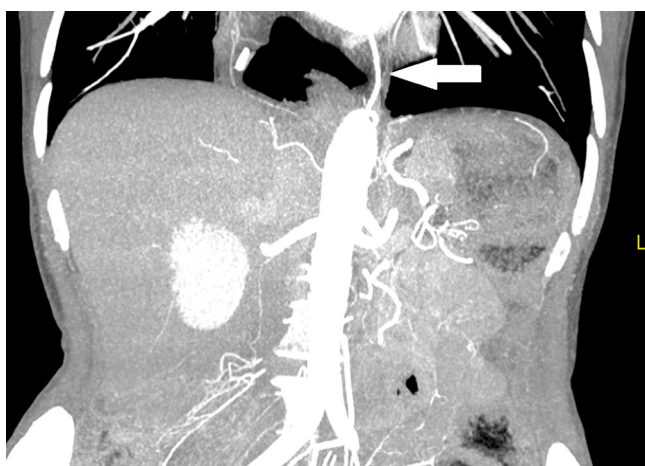


Fig. 2. Patent right gastroepiploic artery (arrow).

identified a pancreatic stricture and subsequent endoscopic ultrasound with biopsy was positive for pancreatic adenocarcinoma. This new primary cancer was considered resectable and she was offered surgical exploration for staging and potential curative resection.

With known history of esophagectomy with gastric pullthrough and the likelihood of dividing the only blood supply to the gastric conduit the patient was seen preoperatively by the microvascular plastic surgery service. Additionally, CT angiography was obtained to better detail the patient's anatomy and possibilities for reconstruction.

2.1. Operative technique

At exploration the patient showed no sign of disseminated disease. The duodenum was mobilized from the retroperitoneum with an extended Kocher maneuver well to the left of the aorta and up to the base of the superior mesenteric artery. Due to the previous esophagectomy, the proximal duodenum was rotated over medially, making the identification of the common hepatic artery difficult. The gastric antrum was also not visualized and the pylorus was near the level of the esophageal hiatus. After cholecystectomy, the common hepatic bile duct was isolated above the level of obstruction. At this point the replaced right hepatic artery was dissected free from the pancreatic head and mobilized back to the

superior mesenteric artery. The right gastroepiploic pedicle was visualized and, as expected, was felt to be the only significant inflow and outflow of the gastric conduit. The gastroepiploic pedicle was divided as close to the pancreas as possible, and the vessels were tagged for later revascularization. The duodenum was then divided beyond the pylorus using a 3.5 mm load GIA stapler. As expected, the duodenal stump at this point appeared congested and ischemic (Fig. 5).

The pancreaticoduodenectomy was completed and the reconstruction planned. A double Roux limb reconstruction was used with separate biliary and pancreatic limbs. One limb of jejunum was passed under the root of the mesentery for a standard two-layer duct-to-mucosa pancreaticojejunostomy. The second limb was mobilized up to the bile duct where an end-to-side hepaticojejunostomy was performed in a retrocolic fashion. Distal on this jejunal limb was the area where the duodenojejunostomy was to be performed after revascularization. The plastic surgery service then re-established vascular supply to the gastric conduit by performing a microscopic vascular anastomosis between the gastroepiploic pedicle and the middle colic artery and vein. The middle colic vessels were clumped prior to getting divided and the transverse colon was evaluated for its perfusion. An easily palpable marginal artery was identified throughout the length of the transverse colon and adequate flow was confirmed both clinically and with the Doppler devise. The plastic surgery team subsequently divided the middle colic vessels, swung them up and performed an end-to-end anastomoses using 8-0 Nylon sutures to the previously divided gastroepiploic vein and artery (Figs. 6 and 7).



Fig. 4. Dilated pancreatic duct with stent (arrow).

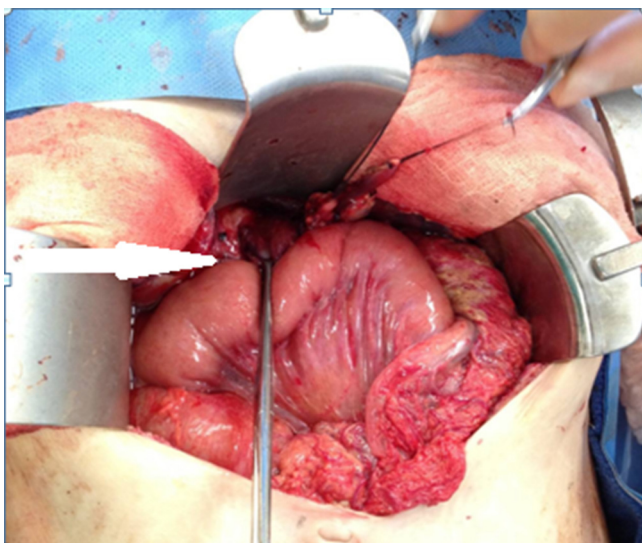


Fig. 5. Allis clamp placed on congested duodenal stump (arrow).

At the completion of the anastomosis a hand held Doppler was used to confirm pulsatile flow across the arterial anastomosis. The SPY imaging system was then utilized after intravenous injection of indocyanine green. This confirmed flow across the anastomosis as well as into the open duodenal stump (Fig. 8). Visually, the duodenum including the mucosa appears much healthier compared to before the revascularization.

With what appeared to be adequate perfusion to the gastric conduit and proximal duodenum, a handsewn end-to-side

duodenojejunostomy distal to the biliary anastomosis was fashioned. An entero-enterostomy below the transverse mesocolon between the two limbs completed the reconstruction.

The hospital course of the patient was uncomplicated and the patient was discharged home on postoperative day 8. She was started on Aspirin 81 mg on POD#3 that she continues until today. Pathology revealed a T3N0 pancreatic adenocarcinoma with negative margins. The patient has been seen back over a year from her resection and has not had gastrointestinal complications or evidence of tumor recurrence.

3. Discussion and conclusion

Even though the true incidence is unknown, developing a second primary malignancy after esophageal cancer treatment is not very common. Some studies have reported an incidence of 8.3–27.1% [2]. The most common location for development a secondary cancer are the head, neck, stomach, and lung/bronchus (likely due to common risk factors) [4] and in the USA the pancreas [2]. As previously stated the main reason for the increased incidence observed over time is the fact that patients with esophageal cancer can now survive longer. The most important risk factor commonly shared between esophageal cancer and a second primary is smoking. On the other hand in a study using the SEER registries performed by Amin et al. it is advocated that there is higher incidence of pancreatic cancer following some malignancies associated with certain genetic syndromes, after tobacco-related malignancies, cancers treated with radiation, and possibly other environmental factors, such as *Helicobacter pylori* infection [5].

After esophagectomy the most common reconstruction for restoration of the continuity of the GI tract is creation of a gastric conduit, whose blood supply relies mostly on the right

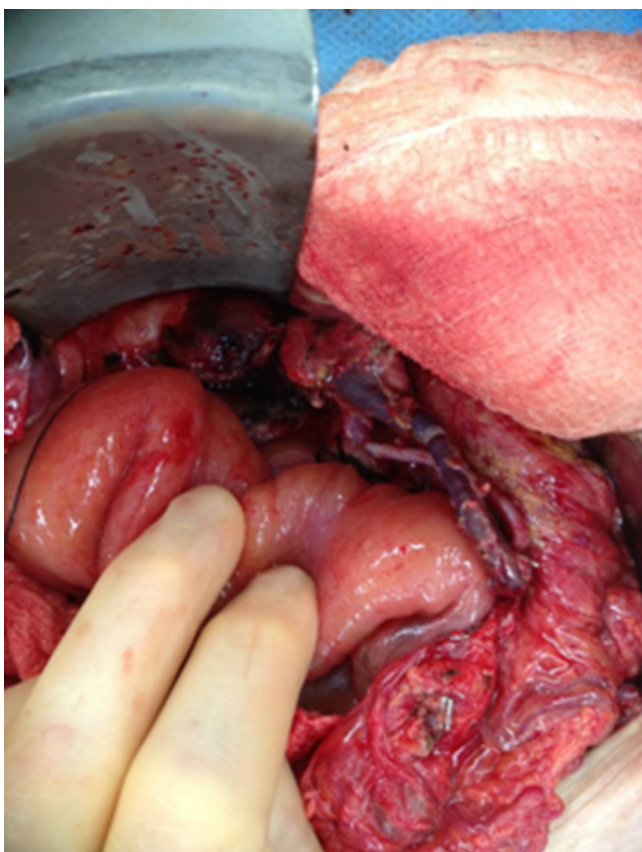


Fig. 6. The gastroepiploic pedicle anastomosed with the middle colic artery/vein, anterior to the Roux limb.

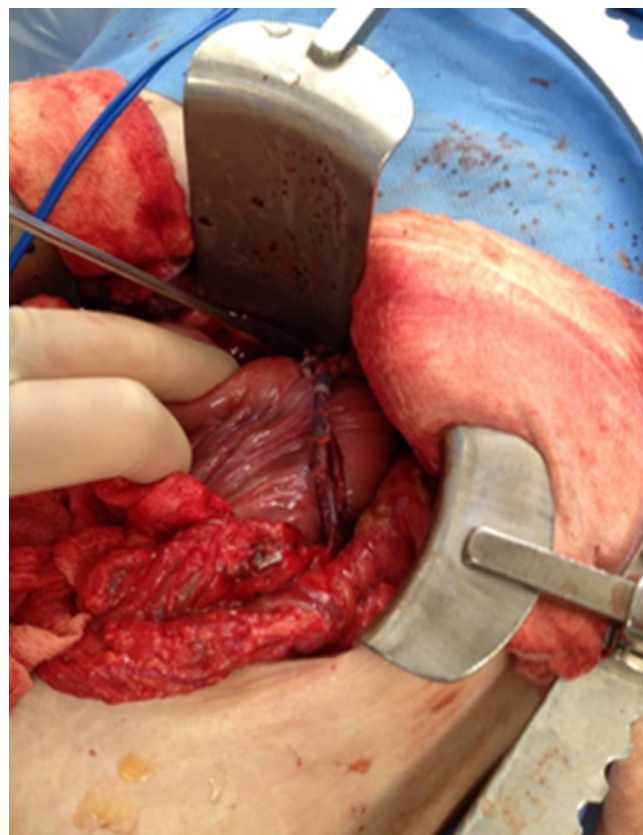


Fig. 7. The gastroepiploic pedicle anastomosed with the middle colic artery/vein, anterior to the Roux limb.

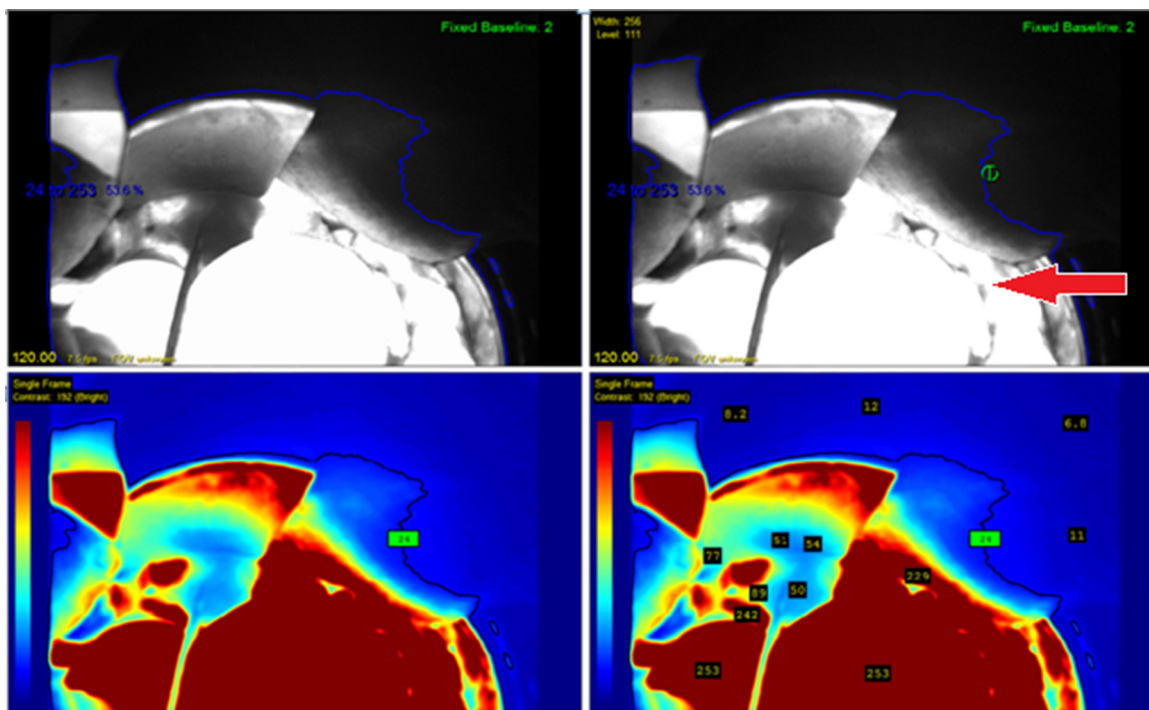


Fig. 8. SPY imaging demonstrating flow along the anastomosis and slightly congested duodenal stump, gastroepiploic pedicle (arrow).

gastroepiploic artery (GEA), through the gastroduodenal artery (GDA), and the venous outflow is preserved through the right gastroepiploic vein. Performing a typical pancreaticoduodenectomy (PD) would require ligating the GDA, but in the setting of previous esophagectomy that would compromise the viability of the gastric conduit. Inoue et al. in a recently published case report describes three different techniques previously used to overcome this technical challenge [3]. (A) PD with preservation of the GDA/GEA, (B) PD with division of the GDA/GEA and microvascular anastomosis, (C) PD with resection of the gastric conduit and reconstruction with small bowel or colon. Each technique has advantages and disadvantages and differ in indications, length of operation, and oncologic outcomes [3]. Our case required ligation and division of the GDA and gastroepiploic vessel due to tumor location. Microvascular reconstruction was contemplated prior to the procedure and the middle colic vessels allowed an excellent option at the time of the procedure. After the reconstruction we verified patency of the anastomosis and adequate blood flow using the Doppler and the SPY system. Similar technology has been utilized in ophthalmology, cardiovascular, plastics, and transplant surgery to assess the adequacy of vascular anastomoses and tissue perfusion. After the contrast agent (indocyanine green) is injected intravenously, the imaging device emits light at 806 nm causing it to fluoresce and emit light at 830 nm as it passes through the arterial vasculature. A camera equipped with an 830 nm filter captures the images and these images can be observed in real time or be saved to the hard drive. The software that analyzes the images provides quantification of perfusion by assigning numeric values to intensity of fluorescence [6] and appropriate values can confirm adequate perfusion. Commercial devices are available for use in the operating room [7]. In the case of gastrointestinal surgery, obviously an accurate assessment of bowel perfusion is critical to prevent tissue ischemia that may result in bowel perforation and anastomotic leaks. A major advantage of this system is that it provides real time imaging in a manner similar to angiography. Anastomoses can be revised if necessary, and additional poorly perfused tissue can be resected with immediate re-evaluation by the system. Usually the surgeon's qualitative

judgment is adequate, but special circumstances like our case may warrant the use of this technology [8,9].

In conclusion, prolonged survival after cancer treatment puts the patients at risk for developing a second primary malignancy. The use of new modalities has made challenging resections and reconstruction feasible, safe, and oncologically acceptable. In this case we were able to perform a complex reconstruction with good confidence that the anastomosis would heal and that the patient could be managed without major variation from postoperative routine.

Conflict of interest

None of the authors have any conflicts of interest to state. No personal or financial relationship exists, that could influence or bias our work.

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Authors contribution

Spyridon Pagkratis: manuscript writing, abstract writing, discussion writing, case report section writing, and data collection; Dimitrios Virvilis: case report section writing and data collection; Brett Phillips: data collection and images editing; Philip Bao: final editing and performed the procedure; Sami Khan: performed the procedure and contributed as part of the discussion; Jason Ganz: performed the procedure and contributed as part of the discussion and Kevin Watkins: final editing, abstract writing, and performed the procedure.

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. Patient's privacy and anonymity has been protected. No identifying names, numbers, or other characteristics have been used.

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