Digestive Diseases and Sciences (2019) 64:3038–3039
https://doi.org/10.1007/s10620-019-05565-y

EDITORIAL

Going with the Flowmetry: How Doppler Assessment Helps Predict the Formation of Anastomotic Strictures After Esophagectomy

Matthew M. Rochefort[1] · Jon O. Wee[1]

Published online: 4 March 2019

Esophageal cancer is the eighth most common cancer worldwide, with squamous cell carcinoma representing the majority of cases. Over the past 10–20 years, however, there have been a vastly increasing number of adenocarcinoma cases [1]. An esophagogastrectomy with creation of a gastric conduit and an esophago-gastric anastomosis is the most common surgical treatment for patients with early-stage esophageal cancer without evidence of distant metastatic disease [2]. The area of the anastomosis between the esophagus and the stomach is the source of significant morbidity in terms of both anastomotic leaks and postoperative stricture formation [3]. Postoperative stricture formation has a reported incidence of 26–42% and is of significant detriment to patients' quality of life [4]. Prior studies have surmised that the source of leaks and strictures at the anastomosis is due to the relative ischemia of the tip of the gastric conduit, which solely relies on the right gastroepiploic artery for its blood supply [4]. This ischemia hypothesis is based on body mass index (BMI) and cardiovascular disease as both represent independent risk factors for stricture formation and were felt to be surrogate markers of poor vasculature condition in the gastric conduit [4]. In this issue of *Digestive Diseases and Sciences*, Wang et al. [5] provide convincing diagnostic evidence to support the hypothesis that local tissue ischemia in the gastric conduit is associated with an increased incidence of anastomotic strictures. The significance of this finding, especially if determined to be a modifiable risk factor, would be to reduce a substantial source of morbidity and the need for additional invasive procedures in this population.

This article addresses the issue of local tissue ischemia and its association with stricture formation by directly measuring the local blood supply near the tip of the gastric conduit utilizing a laser-Doppler contact probe. Additionally, they measured the local gastric intramucosal pH with a tonometer as a surrogate marker for ischemia and its resultant anaerobic metabolism. Together, these diagnostic modalities create an overall perfusion index for each patient. Each patient was subsequently evaluated 3 months postoperatively with a barium esophagram and an upper endoscopy in order to assess for objective evidence of stricturing at the anastomotic site. The perfusion index for patients with objective evidence of stricture was then compared to those without objective evidence of stricture formation. The authors reported that there was a statistically significant correlation between perfusion index and the occurrence of anastomotic strictures, subsequently claiming that this provides objective support that decreased blood supply in the anastomotic portion of the gastric conduit is a risk factor for postoperative anastomotic strictures.

The strength of this article lies primarily in the real-time measurement of gastric conduit vascular perfusion prior to the creation of the esophago-gastric anastomosis and the ability to alter operative behavior based on the information gathered. In an attempt to minimize morbidity related to the gastro-esophageal anastomosis, surgeons have attempted to assess the vascular competence of the gastric conduit in esophagectomy patients for years. The group from the University of Southern California utilized laser-assisted angiography with indocyanine green (ICG) dye to determine the region within the gastric conduit that was adequately perfused, assessing the risk of postoperative leaks when the anastomosis was created in the under-perfused region [6]. They found a leak rate of only 2% when the anastomosis was created in an area of adequate perfusion, compared to a leak rate of 45% when created in an area of poor perfusion [6]. A follow-up study demonstrated that intra-operative vascularity could be assessed robotically with the use of ICG and the "firefly" functionality of the Intuitive da Vinci® system [7]. These studies, however, rely on the surgeon's subjective

✉ Jon O. Wee
jwee@bwh.harvard.edu

Matthew M. Rochefort
mrochefort@partners.org

[1] Division of Thoracic Surgery, Brigham and Women's Hospital, 75 Francis Street, Boston, MA 02115, USA

assessment of the visualized perfusion. The group in Tokyo then utilized the laser-Doppler flowmeter, demonstrating that decreased perfusion was associated with an increased risk of anastomotic leak [8], and the group from Oregon utilized optical fiber spectroscopy to assess the perfusion of the stomach before, during, and after conduit construction, noting that the decrease in conduit oxygen saturation correlated with the risk of anastomotic complications [9]. Since these prior studies primarily assessed for postoperative leaks rather than for stricture formation, the current study uniquely shifts to an alternative endpoint for analysis within the same clinical framework.

The primary weaknesses of this article, that limit its ability to be applicable to a wider range of patients, include limiting the study to patients with squamous cell carcinoma, while in the USA approximately 80% of new esophageal cancer cases are adenocarcinoma [1]. Additionally, the utilization of a 21-mm EEA™ stapler may have also artificially exaggerated the rate of stricture formation as prior studies have demonstrated stricture rate in excess of 60% with a 21-mm EEA™ stapler [10]. Finally, while stricture occurrence was assessed both endoscopically and radiographically, there was no mention of arguably the most clinically relevant endpoint, the patient's subjective dysphagia symptoms, and how these correlated to the objective findings.

This study provides excellent data to support the hypothesis that local tissue ischemia is, at least in part, responsible for the formation of strictures occurring at surgically created anastomoses [4]. The study provides a method for real-time objective assessment of the blood supply to the gastric conduit at the site of the anastomosis. Moving forward, it would be most interesting to assess perfusion before and after the creation of the anastomosis, as the twisting or kinking of the blood supply following the connection of the stomach to the esophagus could contribute to ischemia and postoperative stricture formation. Finally, as mentioned above, the incidence of stricture formation following the creation of an esophago-gastric anastomosis is primarily of interest in terms of how it affects the patient's ability to tolerate a diet and maintain a healthy weight. Therefore, an assessment of the subjective dysphagia of the patients in the study would be invaluable.

Compliance with ethical standards

Conflict of interest Rochefort has no conflict of interest; Wee is a consultant for Medtronic.

References

1. Napier KJ, Scheerer M, Misra S. Esophageal cancer: a review of epidemiology, pathogenesis, staging workup and treatment modalities. *World J Gastrointest Oncol*. 2014;6:112–120.
2. Pennathur A, Gibson MK, Jobe BA, Luketich JD. Oesophageal carcinoma. *Lancet*. 2013;381:400–412.
3. Gallo G, Zwaveling S, Groen H, Van der Zee D, Hulscher J. Long-gap esophageal atresia: a meta-analysis of jejunal interposition, colon interposition, and gastric pull-up. *Eur J Pediatr Surg*. 2012;22:420–425.
4. van Heijl M, Gooszen JA, Fockens P, Busch OR, van Lanschot JJ, van Berge Henegouwen MI. Risk factors for development of benign cervical strictures after esophagectomy. *Ann Surg*. 2010;251:1064–1069.
5. Wang X, Pei X, Li X, et al (2019) Predictive value of anastomotic blood supply for anastomotic stricture after esophagectomy in esophageal cancer. *Dig Dis Sci*. (Epub ahead of print). https://doi.org/10.1007/s10620-018-5451-3.
6. Zehetner J, DeMeester SR, Alicuben ET, et al. Intraoperative assessment of perfusion of the gastric graft and correlation with anastomotic leaks after esophagectomy. *Ann Surg*. 2015;262:74–78.
7. Hodari A, Park KU, Lace B, Tsiouris A, Hammoud Z. Robot-assisted minimally invasive Ivor Lewis esophagectomy with real-time perfusion assessment. *Ann Thorac Surg*. 2015;100:947–952.
8. Ikeda Y, Niimi M, Kan S, Shatari T, Takami H, Kodaira S. Clinical significance of tissue blood flow during esophagectomy by laser Doppler flowmetry. *J Thorac Cardiovasc Surg*. 2001;122:1101–1106.
9. Pham TH, Perry KA, Enestvedt CK, et al. Decreased conduit perfusion measured by spectroscopy is associated with anastomotic complications. *Ann Thorac Surg*. 2011;91:380–385.
10. Petrin G, Ruol A, Battaglia G, et al. Anastomotic stenoses occurring after circular stapling in esophageal cancer surgery. *Surg Endosc*. 2000;14:670–674.