Obesity Surgery (2019) 29:2350–2354
https://doi.org/10.1007/s11695-019-03893-6

BRIEF COMMUNICATION

Gastric Per-Oral Endoscopic Myotomy (G-POEM) for the Treatment of Gastric Stenosis Post-Laparoscopic Sleeve Gastrectomy (LSG)

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Published online: 19 April 2019

Abstract
Laparoscopic sleeve gastrectomy (LSG) has become the most common form of bariatric surgery performed worldwide. However, it is associated with potentially debilitating adverse events such as post-operative stenosis. Finding effective and minimally invasive treatments for such complications is of paramount importance. Gastric per-oral endoscopic myotomy (G-POEM) is a novel procedure developed over the past decade to treat conditions that delay gastric emptying. We present a case demonstrating the use of G-POEM in the successful endoscopic management of post-LSG gastric stenosis.

Keywords Gastric stenosis · G-POEM · Reflux · Balloon dilation · Sleeve gastrectomy

Introduction

As a global epidemic with devastating long-term consequences, obesity has garnered quite some attention from the medical community in terms of prevention and management. Mirroring the increasing prevalence of obesity, bariatric surgeries have been trending up in popularity. Since 2013, laparoscopic sleeve gastrectomy (LSG) has become the most common bariatric procedure performed in the USA [1]. Despite this ubiquity, LSG still suffers from a number of post-op adverse events. Gastric stenosis is a known complication of LSG with an incidence of up to 4% [2].

Gastric stenosis is manifested clinically through a multitude of symptoms like dyspepsia, regurgitation, early satiety, abdominal pain, dysphagia, nausea, and vomiting. This stenosis is secondary to two separate anatomical entities that occur post-LSG; it is either mechanical in nature usually occurring in the proximal sleeve, or secondary to axial deviation that almost exclusively targets the incisura angularis [3]. After establishing the diagnosis of axial deviation and/or sleeve stenosis through endoscopic or fluoroscopic investigations, various treatment modalities can be offered. Gastric per-oral endoscopic myotomy is a recent innovation that allows for the creation of a tunnel and subsequent myotomy from the gastric cardia to the gastric pylorus. The overall data regarding the application of this procedure to post-surgical forms of gastric stenosis is still very limited; thus, we report the use of gastric per-oral endoscopic myotomy (G-POEM) in the treatment of gastric stenosis post-laparoscopic sleeve gastrectomy.

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Materials and Methods

Study: Case Report

Case

A 43-year-old female with a history of LSG 4 months prior to presentation was admitted to the hospital with dysphagia, nausea, vomiting, dehydration, and an inability to tolerate solid food that worsened progressively until her diet became limited to liquids. She was in moderate distress with a distended abdomen, but without rebound tenderness or guarding. The patient was maintained on high-dose proton pump inhibitors (PPIs) twice daily since the LSG. Two months after the LSG, she presented with a similar clinical picture, upon which a diagnostic endoscope revealed a helical stricture at the level of the incisura angularis. At that time, she accordingly underwent endoscopic pneumatic dilation using a 30-mm achalasia balloon to a PSI of 10 mmHg for 1 min. During dilation, higher pressures (usually proceeding to 20 mmHg) were not possible because the entire sleeve in contact with the balloon became ischemic (Fig. 1a). The patient did not receive a measurable clinical response and refused conversion to a Roux-en-Y gastric bypass. Therefore, a decision was made to proceed with the G-POEM to relieve the stenosis after a thorough discussion of the risks, benefits, and alternatives of the procedure.

The Procedure

The patient was placed supine and was under general anesthesia plus paralysis. The EndoFLIP® (endolumenal functional lumen imaging probe) (Crospon Medical Devices, Galway, Ireland) balloon, mounted on a thin catheter, was placed transorally (Fig. 2b). The latter uses high-resolution impedance planimetry during volume-controlled distension to measure luminal geometry and pressure. EndoFLIP (50 mL) measurements pre-myotomy were as follows: diameter (16.5 mm), cross-sectional area (213 mm^2), pressure (64.9 mmHg), distensibility (3.4 mm^2/mmHg), and compliance (76.2 mm^3/mmHg). A diagnostic gastroscope fitted with a clear 4-mm straight cap was advanced to the descending duodenum. A helical stricture at the level of incisura was noted and which the scope easily traversed (Fig. 2b). A mucosal bleb was created 5 cm proximal to the stricture by injecting 20 mL of 1% indigo carmine diluted in normal saline into the submucosa. A 1.5-cm mucosectomy was made with a triangle tip (TT) (Olympus, Tokyo, Japan) using the dry-cut mode. The submucosa was stained using a saline solution mixed with indigo carmine injected via the pump (Fig. 2d). The submucosal fibers were then dissected with spray coagulation (Fig. 2e), and the endoscope entered the submucosal space. Whenever the submucosal dissection plane became difficult to define, the aforementioned solution was repeatedly injected to stain the submucosal fibers, thus enhancing the demarcation between the submucosal layer and muscularis propria. Afterwards, an 8-cm submucosal tunnel (3 cm distal to the stricture) was created using spray coagulation (Fig. 2e). Moreover, when vessels were identified, they were treated with soft coagulation via a coagulation grasper. During dissection, the endoscope was repeatedly withdrawn from the submucosal tunnel to ascertain that the direction of the tunnel was heading towards the posterior wall of the stomach and stricture. Once the tunnel was completed, a 6-cm myotomy was performed using a combination of an insular-tip (IT) (Olympus, Tokyo, Japan) and triangular-tip (TT) (Olympus, Tokyo, Japan) needle knives (Fig. 2g). In order to objectively compare changes in luminal geometry and pressure, the EndoFLIP (50 mL) was reintroduced immediately post-myotomy (Fig. 2i). The post-myotomy measurements reflected an increase in the diameter (18.1 mm), cross-sectional area (258 mm^2), and compliance (88.9 mm^3/mmHg), in addition to a concomitant decrease in the pressure (62.1 mmHg). Using the overstitch device (Apollo Endosurgery, Austin, TX), interrupted sutures were placed resulting in successful mucosectomy site closure (Fig. 2h). The scope was then completely withdrawn from the patient. The procedure was completed without complications as evidenced by an upper GI series performed 1 day later, which showed no leaks. The patient was discharged home on high-dose PPI twice daily for 4 weeks.

Results

The laparoscopic sleeve gastrectomy procedure is prone to complications that results in obstructive symptoms secondary to gastric sleeve stenosis. The lack of a validated algorithm for the management of this complication has left the field open for a multitude of different therapeutic options. One of the proposed endoscopic treatment algorithms for gastric stenosis post-LSG consists of serial dilations with an achalasia balloon, followed by the placement of a fully covered self-expanding metal stent (FCSEMS) if dilations failed [4].

Other endoscopic procedures include endoscopic balloon dilation and endoscopic stricturoplasty [5]. Surgical intervention might be necessary when the area of stenosis is too long. Amongst the surgical options available are laparoscopic seromyotomy, gastric wedge resection, and laparoscopic conversion to a Roux-en-Y gastric bypass (RYGB) [6, 7]. Per-oral endoscopic myotomy (POEM) is a minimally invasive endoscopic procedure whereby an incision is made into the mucosa to create a tunnel through the submucosal layer of the esophagus and proximal stomach. This allows for a myotomy to be carried out without the need for external access incisions in the abdomen as seen in laparoscopic Heller myotomy, for example. POEM is indicated in primary idiopathic achalasia

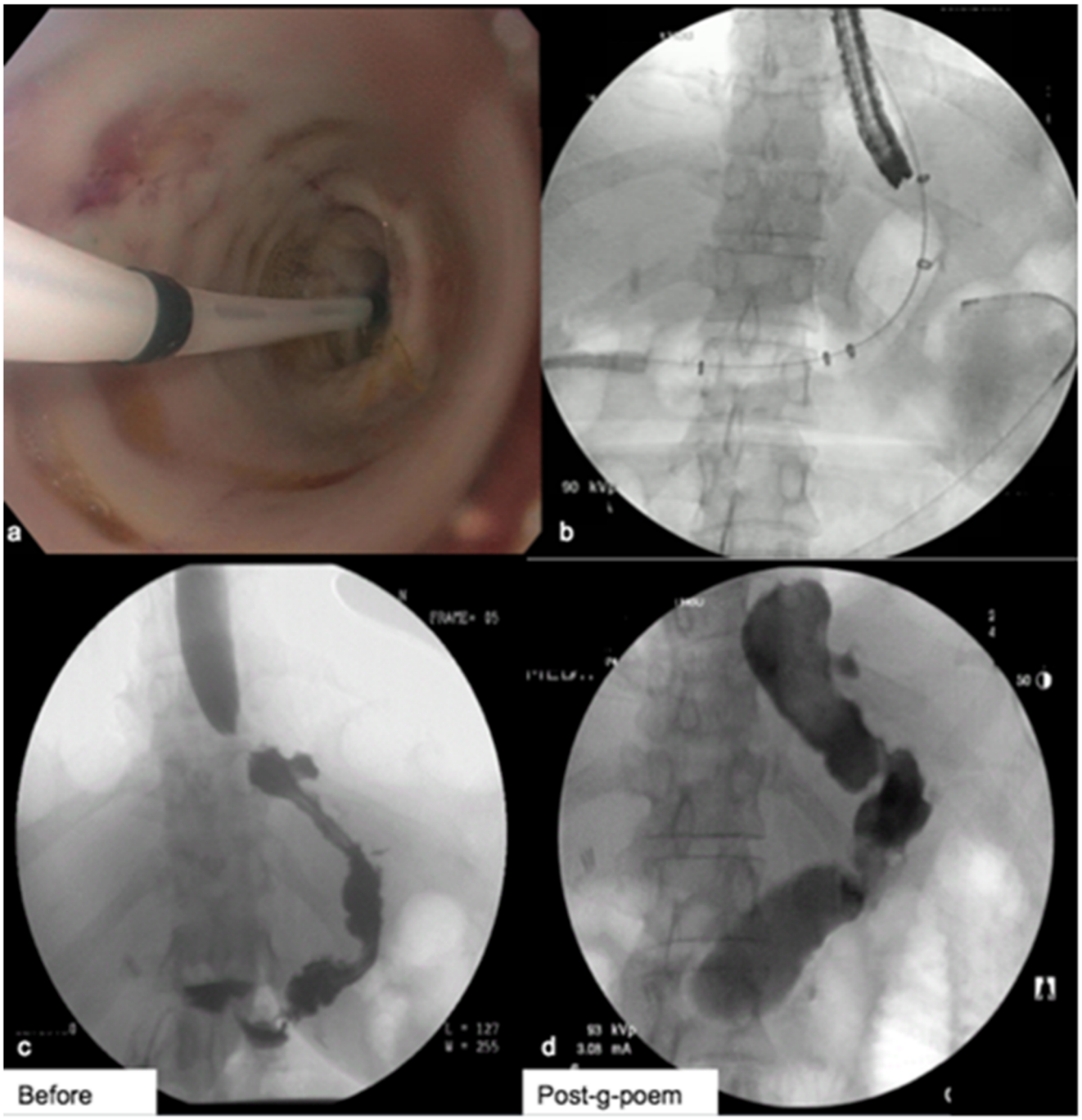
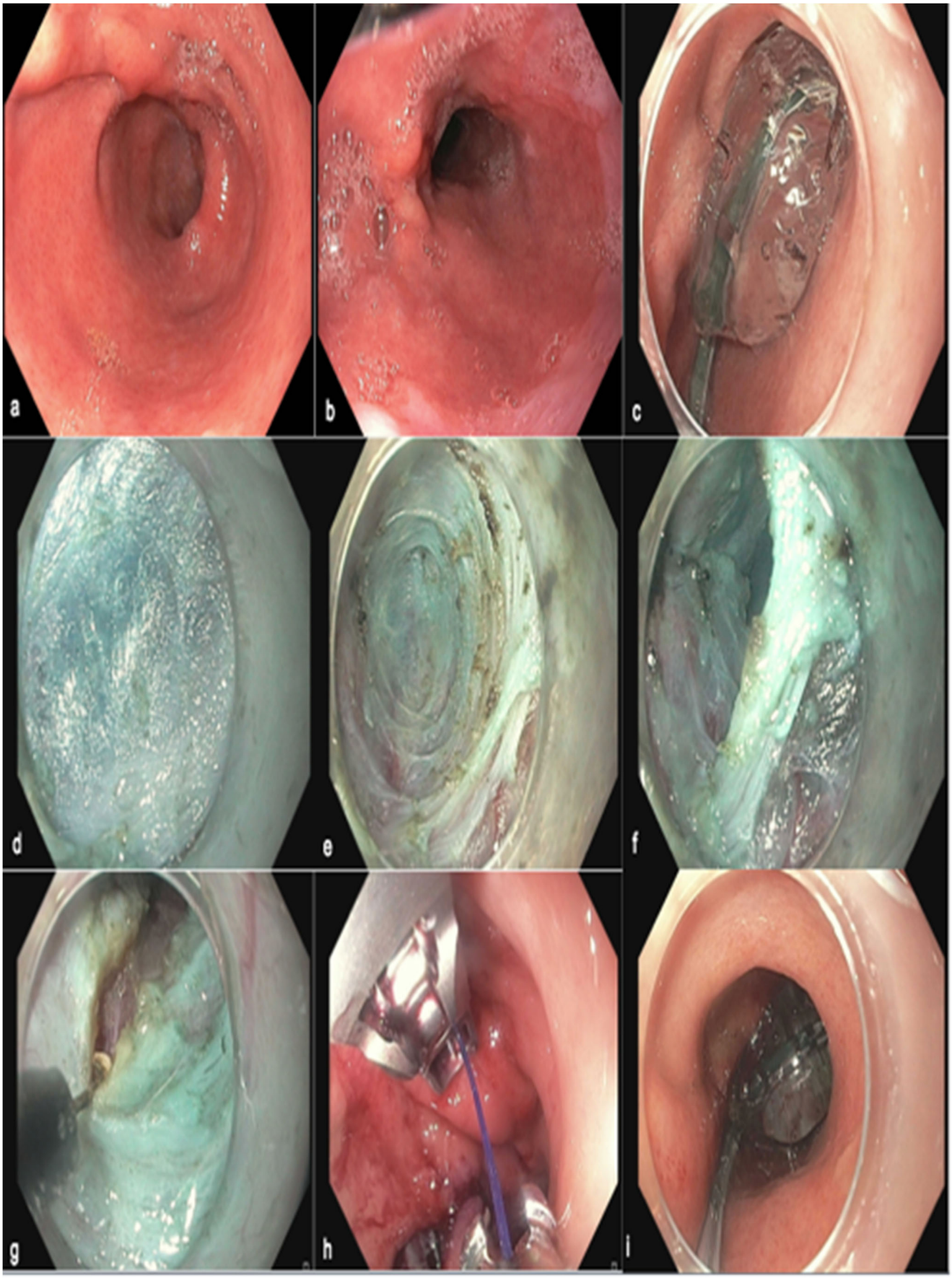


Fig. 1 **a.** The balloon dilation image shows that her sleeve is too small to allow for balloon dilation as the entire stomach becomes ischemic as opposed to simply seeing a single ring-like ischemic area. Further dilation would result in perforation. **b.** The fluoroscopic image shows a waist just to the right and above of the double lines seen fluoroscopically on the balloon. **c**. Before: upper GI series showing stenosis at the incisura angularis. Note the hold-up of contrast in the esophagus due to the downstream obstruction. **d.** Post-G-POEM: upper GI series 5 weeks Post-G-POEM showing normal flow of contrast from the esophagus into the stomach

targeting esophageal alimentary tract diseases. More recently, the POEM has been introduced to tackle different anatomical sites including the stomach in the treatment of gastroparesis [8]. There have been case reports describing the use of G-POEM in the treatment of gastroparesis after surgeries like the Nissen fundoplication and the esophagectomy [9, 10]. Building on this concept, the G-POEM is trending towards becoming a viable alternative in the treatment of post-LSG gastric stenosis. In this case, we describe G-POEM to treat gastric stenosis post-LSG after failed endoscopic balloon dilation. On follow-up, the patient reported a significant improvement in her symptoms. She underwent an endoscopy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◀ **Fig. 2** **a.** Endo-image shows rotation of the staple line and a rotated stomach such that the antrum cannot be seen. **b.**Endo-image shows that the downstream stenosis (effectively a partial obstruction) has caused high proximal gastric pressure, and hence, the GEJ is persistently wide open. Hence, she suffers from reflux and regurgitation. **c.** EndoFLIP balloon (Crospon Medical Devices, Galway, Ireland) measuring the pressures and dimensions at the site of gastric stenosis prior to performing the gastric per-oral endoscopic myotomy. **d.** The submucosal layer of the stomach stained in blue after injecting saline solution mixed with indigo carmine. **e.** The 8-cm submucosal tunnel created using spray coagulation. **f**. After completion of the submucosal tunnel, the muscularis propria is visualized as the white fibrous band. **g.** After completion of the submucosal tunnel, the muscularis propria is dissected using a combination of an insular-tip (IT) (Olympus, Tokyo, Japan) and triangular-tip TT (Olympus, Tokyo, Japan) needle knives. **h.** Using the overstitch device (Apollo Endosurgery, Austin, TX), interrupted sutures were placed resulting in successful mucosectomy site closure. **i.** Resolution of the gastric stenosis after performing the gastric per-oral endoscopic myotomy with the EndoFLIP balloon measuring the pressures and dimensions

at 5 weeks post-G-POEM which showed mild luminal stenosis at the level of the mucosectomy closure site. The gastric stenosis had markedly improved with resolution of the tortuosity (Fig. 1d); as such, no further intervention was performed. The patient was then followed up 3 months later with repeat endoscopy and upper GI series. The stomach anatomy was noted to be far straighter with no stenosis present at the incisura angularis. Objectively, anatomic relief of the obstruction after the G-POEM was represented by an increase in the diameter (18.1 mm), cross-sectional area (258 mm^2), and compliance (88.9 mm^3/mmHg), in addition to a concomitant decrease in the pressure (62.1 mmHg). The patient's symptoms significantly improved as reflected by her use of PPIs only twice weekly and her ability to tolerate solid food.

Conclusion

G-POEM provides a non-invasive novel approach for the treatment of gastric stricture post-laparoscopic sleeve gastrectomy. This form of endoscopic myotomy potentially is an alternative for patients not responding to repeated endoscopic balloon dilations. We have described a case demonstrating the use of G-POEM in the successful endoscopic management of post-LSG gastric stenosis after a failed pneumatic dilation. However, optimal patient selection is critical, as yet we have not ascertained which patients are most likely to benefit from this therapy.

Compliance with Ethical Standards Informed consent was obtained from the patient for the publication of their information and imaging.

Conflict of Interest Mouen A. Khashab is on the medical advisory board for Boston Scientific and Olympus America and is a consultant for Boston Scientific, Olympus America, and Medtronic.

Anthony N Kalloo is a founding member, equity holder, and consultant for Apollo Endosurgery.

Vivek Kumbhari is a consultant for Medtronic, Reshape Lifesciences, Boston Scientific, Pentax Medical, and Apollo Endosurgery. He also receives research support from ERBE USA and Apollo Endosurgery.

All other authors have no conflicts of interest to declare.

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