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Gastric electric stimulator versus gastrectomy for the treatment of medically refractory gastroparesis

Jamil S. Samaan[1] · Omar Toubat[2,3] · Evan T. Alicuben[3] · Sean Dewberry[2,3] · Adrian Dobrowolski[3] · Kulmeet Sandhu[3] · Joerg Zehetner[3] · John C. Lipham[3] · Kamran Samakar[3]

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Abstract

Background Gastric electrical stimulation (GES) and laparoscopic gastrectomy (LG) are known therapeutic options for medically refractory gastroparesis (MRG) although there are limited data comparing their outcomes. We aim to compare clinical outcomes between patients undergoing GES vs upfront LG for the treatment of MRG while examining factors associated with GES failure and conversion to LG.

Methods We retrospectively analyzed 181 consecutive patients who underwent GES or LG for MRG at our institution from January 2003 to December 2017. Data collection consisted of chart review and follow-up telephone survey. Statistical analysis utilized Chi-squared, ANOVA, and multivariable logistic regression.

Results Overall, 130 (72%) patients underwent GES and 51 (28%) LG as primary intervention. GES patients were more likely to have diabetic gastroparesis (GES 67% vs LG 39%, $p < 0.001$), while primary LG patients were more likely to have post-surgical gastroparesis (GES 5% vs LG 43%, $p < 0.001$). Postoperatively, primary LG patients had higher rates of major in-hospital morbidity events (GES 5% vs LG 18%, $p = 0.017$) and longer hospital stays (GES 3 vs LG 9 days, $p < 0.001$). However, over a mean 35-month follow-up period, there were no differences in the rates of major morbidity, readmissions, or mortality. Multivariable regression analysis revealed patients undergoing GES as a primary intervention were less likely to report improvement in symptoms on follow-up compared to primary LG patients OR 0.160 (95% CI 0.048–0.532). Additionally, patients who converted to LG from GES were more likely to have post-surgical gastroparesis as the primary etiology.

Conclusion GES as a first-line surgical treatment of MRG was associated with worse outcomes compared to LG. Post-surgical etiology was associated with an increased likelihood of GES failure, and in such patients, upfront gastrectomy may be a superior alternative to GES. Further studies are needed to determine patient selection for operative treatment of MRG.

Keywords Gastroparesis · Gastrectomy · Gastric stimulator · Gastric pacer · Outcomes

Gastroparesis (GP) is a syndrome characterized by symptomatic delayed gastric emptying in the absence of gastric outlet obstruction. While clinical presentation varies among patients, the most common symptoms include nausea, vomiting, postprandial fullness, bloating, early satiety, and abdominal pain [1]. The most common etiologies of GP include diabetes mellitus, post-surgical, and idiopathic. Treatment is usually not curative and is aimed at optimizing comorbidities and treatment palliation to improve quality of life. Patients are initially managed nonoperatively with pharmacotherapy and lifestyle modifications, although it has been estimated that these therapies alone fail to effectively control symptoms in up to 25% of patients [2]. For patients who fail medical therapy, there are multiple minimally invasive treatment options, such as botox injections, laparoscopic pyloroplasty, jejunostomy, gastric electrical stimulator (GES) placement, and laparoscopic gastrectomy (LG).

There is a growing body of evidence demonstrating the efficacy of LG and GES in improving symptoms and outcomes in patients who suffer from medically refractory gastroparesis (MRG) [2–13]. While the mechanism of action

✉ Kamran Samakar
kamran.samakar@med.usc.edu

[1] Department of Medicine, Cedars Sinai Medical Center, Los Angeles, CA, USA

[2] Keck School of Medicine of USC, Los Angeles, CA, USA

[3] Division of Upper GI and General Surgery, Department of Surgery, Keck School of Medicine of USC, 1510 San Pablo St., Suite 514, Los Angeles, CA, USA

is not completely understood, it is hypothesized that GES modulates vagal tone, and in turn, alleviates nausea and vomiting, increases gastric accommodation, and decreases sensitivity [2]. Several randomized controlled trials have demonstrated GES to be an effective treatment for MRG, ultimately resulting in FDA approval in the year 2000 [3–7]. Similarly, LG has also been shown to be an effective treatment for MRG [2, 8–13]. Despite the efficacy of these treatments, there are no clear guidelines that establish which GP patients are best suited for GES or LG. This is in part due to the paucity of studies directly comparing these two different treatment options.

In a previous analysis of our institutional experience with GES and LG, we showed LG to be an effective treatment option for MRG [14]. In particular, our work suggested that upfront LG may be more effective than GES, validating the concept of early utilization of LG [14]. Since our report, little research has been conducted comparing these two effective procedures and, more importantly, how patient selection may impact their success. Therefore, the primary objective of the present study is to provide a more contemporary analysis comparing upfront LG and GES for the management of MRG. In addition, we aim to determine patient characteristics associated with GES failure and conversion to LG.

Materials and methods

Patient selection and data collection

We retrospectively analyzed 181 consecutive patients with MRG managed at our institution from January 2003 to December 2017. Study methodology and protocols were approved by our Institutional Review Board. Demographic and clinical characteristics were retrospectively collected from patient records. Relevant operative variables were collected from surgeon notes. Data gathered from inpatient, discharge, clinic, and readmission notes were used to evaluate clinical outcomes associated with treatment. Follow-up was obtained through chart review and a standardized telephone survey. Follow-up outcomes included a subjective global assessment of the patient's symptomatic improvement by an "improved" or "not improved" binary question.

From this cohort, patients were classified according to initial treatment received (Fig. 1). Those who underwent upfront LG (including sleeve, subtotal, or total gastrectomy) were categorized as "Primary Gastrectomy (PG)" and those who underwent initial GES placement were categorized as "GES." A subgroup analysis was performed on patients that converted to LG following the failure of GES treatment and were classified as "Secondary Gastrectomy (SG)."

Gastric electrical stimulator (GES) placement

Placement of the gastric electrical stimulator is performed by mini-laparotomy or laparoscopy. If laparoscopic, three trocars are positioned—one camera trocar superior to the umbilicus and two working trocars laterally. When using a mini-laparotomy technique, an upper-midline incision is made to insert the electrode leads into the stomach. After the pylorus of the stomach is identified, electrodes are implanted 10 cm proximal to the pylorus along the greater curvature, estimating the location of the migrating motor complex. Endoscopy is used to confirm that the leads are not intraluminal. These leads are then connected to a subcutaneous neurostimulator. Using the same incision site previously made for lead placement, a subcutaneous pocket is created on top of the fascia to insert the neurostimulator. The Enterra Therapy system (Medtronic, Minneapolis, MN) was used to promote gastric stimulation in all GES patients. This device administers bursts of high-frequency and low-energy waves

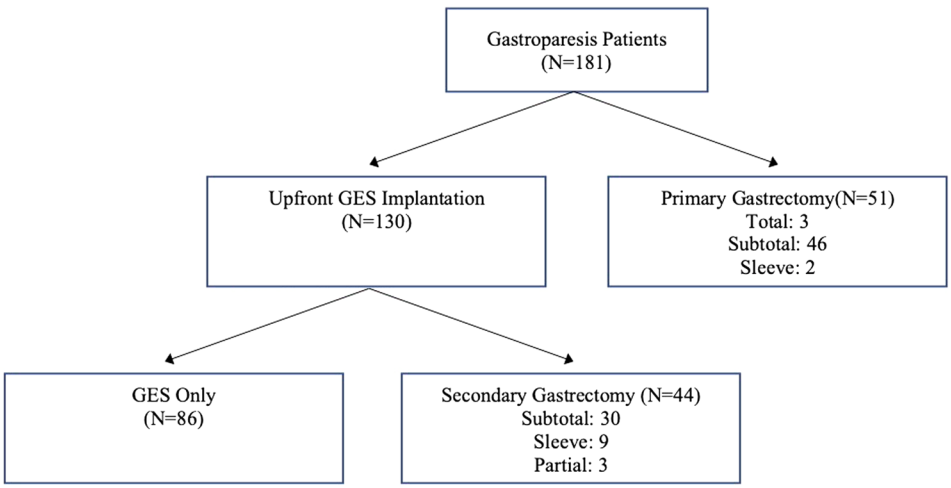

Fig. 1 Flowchart illustrating the therapeutic management of gastroparesis patients

three to four times the rate of normal gastric cycling. Device adjustments were made as necessary in a clinical setting two and four weeks after surgery and thereafter as indicated.

Laparoscopic subtotal gastrectomy

A minority of patients underwent total gastrectomy, which is described in our previous publication [14]. In laparoscopic subtotal gastrectomy, a camera trocar is placed via optical port to the left laterally and superiorly of the umbilicus. A liver retractor is positioned after placement of additional trochars. First, the gastrohepatic ligament is divided to enter the lesser sac. The right gastroepiploic vessels must be located and ligated. The proximal extent can then be approximated by the lesser curvature incisura, identified where the left gastric vessels pierce the stomach. The distal extent of the dissection is the pylorus, requiring division and ligation of the right gastric vessels. Using an endo-GIA stapler, the distal resection is performed by identifying the duodenal bulb distal to the pylorus. Also using an endo-GIA stapler, the proximal resection is done following the previously outlined dissection limits of the lesser and greater curvature of the stomach. Approximately 20 cm from the ligament of Treitz, the jejunum is divided and the alimentary limb is raised and a stapled anastomosis is performed. Widening the previously made camera port site allows placement of a wound protector and the gastrectomy specimen is extracted. Finally, using the same mini-incision, a stapled side-to-side jejunojejunostomy is performed between the biliary limb and the distal jejunum. This anastomosis can be performed laparoscopically prior to specimen extraction as well.

For sleeve gastrectomy, a similar approach is used except the longitudinal gastrectomy is performed starting at approximately 3–5 cm proximal to the pylorus and extending all the way up to the Angle of His. The final firing is just lateral to the Angle of His in order to prevent narrowing of the GE junction or incorporating esophageal fibers. A 40-French bougie is secured along the lesser curve to aid in creating a standardized sleeve.

Statistical analysis

Descriptive statistics for demographics and clinical variables were summarized according to initial treatment (GES vs PG). Analysis of differences in complications and perioperative outcomes between patients who underwent initial GES placement vs PG was performed. Frequency counts and percentages were used to report categorical variables. Means with standard deviations and medians with interquartile ranges were used to report parametric and nonparametric continuous variables, respectively. Differences between treatment groups were analyzed by Chi-square test for categorical variables, and student's t test and Wilcoxon test were used for continuous variables.

To compare the efficacy of GES and PG as primary interventions for the improvement of symptoms for patients with MRG, a multivariable logistic regression model was constructed. Patients who underwent SG were categorized as "not improved" for this analysis. Symptomatic status of patients who underwent GES only and PG was obtained from their latest follow-up. Covariates were determined based on clinical relevance and magnitude of effect on the association between symptomatic improvement and primary surgical intervention. Model fit was assessed using Hosmer and Lemeshow Test.

To determine factors associated with undergoing SG, we conducted a bivariate analysis using demographics, comorbidities, and symptoms on initial evaluation. Categorical variables were compared by Chi-squared test, while continuous variables were compared by student's *t* test. A significance threshold of < 0.05 was used for all analysis and statistically significant values are bolded in all tables. All statistical analyses were performed using IBM SPSS 24.0.

Results

A total of 181 patients were included in this analysis. Of these, 130 (71.8%) underwent GES placement and 51 (28.2%) underwent PG at our institution as initial therapy (Fig. 1). Both GES and PG cohorts had a greater percentage of female patients (GES female 68.5%; PG female 74.5%). Gastroparesis etiology was found to be significantly different between the two treatment groups, with PG patients more likely to have the diagnosis of post-surgical gastroparesis and GES patients more likely to have the diagnosis of diabetic and idiopathic gastroparesis ($p < 0.0001$). Previous foregut surgery was more common in PG than GES patients (66.7% vs 43.1%, $p < 0.0050$). Age, comorbidity burden (with the exception of gastrointestinal reflux disease), use of supplemental nutrition, and the quality and duration of self-reported preoperative symptoms did not differ between the two groups (Table 1).

There were no intraoperative complications or deaths among GES or PG patients. After surgery, major in-hospital morbidity events were greater in the PG cohort (GES 5.4% vs 17.6%, $p = 0.0167$) (Table 2). In addition, PG patients also demonstrated a longer hospital length of stay (GES 3 days, [IQR 4.0 days] vs PG 9 days [IQR 4.5 days], $p < 0.0001$). There were no unplanned re-interventions or mortalities in either cohort prior to discharge. A complete list of morbidity events during the index hospitalization is listed in Table 2.

After discharge, GES and PG patients were followed for an average of 37.3 months (range 0.3–176.8 months) and 33.0 months (range 0.25–137.7 months), respectively.

Table 1 Demographic and clinical characteristics of patients receiving gastric electric stimulator (GES) or primary gastrectomy (PG) as treatment

Characteristic	No. (%)		*P*-value
	GES ($N=130$)	PG ($N=51$)	
Sex			
Male	41 (31.5)	13 (25.5)	0.474
Female	89 (68.5)	38 (74.5)	
Median age, years, (IQR)	42 (20)	44 (20)	0.081
Etiology			
Diabetic	87 (66.9)	20 (39.2)	**< 0.001**
Post-surgical	6 (4.6)	22 (43.1)	
Idiopathic	37 (28.5)	9 (17.6)	
Comorbidities			
Hypertension	70 (53.8)	25 (49.0)	0.621
Coronary artery disease	10 (7.7)	8 (15.7)	0.164
Hyperlipidemia	39 (30.0)	12 (23.5)	0.464
COPD	1 (0.8)	1 (2.0)	0.485
GERD	48 (36.9)	35 (68.6)	**< 0.001**
Previous foregut surgery	56 (43.1)	34 (66.7)	**0.005**
History of pyloroplasty	4 (3.1)	1 (2.0)	0.691
Supplemental nutrition			
G-tube	8 (6.2)	5 (9.8)	0.673
TPN	9 (6.9)	3 (5.8)	
Preoperative symptoms			
Nausea	71 (54.6)	28 (54.9)	0.999
Vomiting	69 (53.0)	22 (43.1)	0.251
Epigastric Pain	56 (43.1)	18 (35.3)	0.402
Malnutrition/weight loss	37 (28.5)	11 (21.6)	0.454
Dehydration	13 (10.0)	2 (3.9)	0.239
Bloating	5 (3.8)	2 (3.9)	0.999
Early satiety	5 (3.8)	2 (3.9)	0.999
Median duration of symptoms, y, (IQR)	3 (1–6)	2 (1–4)	0.259

IQR Interquartile range, *COPD* Chronic obstructive pulmonary disease, *GERD* Gastroesophageal reflux disease, *TPN* Total parenteral nutrition

During this period, there were no differences in late morbidity events (GES 5.4% vs PG 2.0%, $p=0.4446$) or deaths (GES 3% vs PG 0%, $p=0.5782$) between groups. There were no differences in the average number of hospital readmissions. With regards to reasons for readmission, patients who underwent PG were significantly more likely to be readmitted for malnutrition/weight loss (GES 0.6% vs PG 5%, $p=0.0022$). The most common causes of readmission among GES patients were vomiting (33.5%), nausea (31.2%), epigastric pain (27.3%), GES management (22.8%), and per os (PO) intolerance (17.2%). In comparison, the most frequent causes of readmission among PG patients were nausea (29.7%), epigastric pain (29.7%), vomiting (28.7%), and PO intolerance (10.9%).

To assess symptomatic changes with intervention, we evaluated patient self-reported symptomatic status in the follow-up period (Fig. 2). We found that 56% of patients who only underwent GES reported symptomatic improvement, while 50% of PG patients reported an improvement in symptoms. We then performed a subgroup analysis of symptomatic improvement among those patients who failed upfront GES and underwent SG. Despite experiencing poor symptomatic status initially with GES, 42% of SG patients reported an improvement in symptoms following salvage gastrectomy.

Factors associated with symptomatic improvement and GES failure

A multivariable logistical analysis was performed to compare the efficacy of GES and PG as primary interventions for the improvement of symptoms for all patients (Table 3). Primary outcome was improvement in symptoms and covariates included gastroparesis etiology, history of GERD and history of foregut surgery, and type of primary intervention (GES vs PG). Patients who underwent GES as the initial intervention were significantly less likely to report improvement in symptoms compared to patients who underwent PG (OR 0.16 (95% CI 0.05–0.53)) (Table 3).

Of the 130 patients that underwent GES placement, 44 (33.8%) underwent GES removal and subsequent SG for clinically significant persistence of gastroparesis symptoms. When examining difference in demographics, comorbidities, and symptoms on initial presentation, patients who underwent conversion were more likely to suffer from post-surgical gastroparesis compared to patients who did not convert (11.9% vs 1.1%, $p=0.025$) (Table 4). Furthermore, patients who did not convert were more likely to suffer from diabetic gastroparesis (69.0% vs 61.9%, $p=0.025$) and idiopathic gastroparesis (29.9% vs 26.2%, $p=0.025$) (Table 4).

Discussion

Gastroparesis is a challenging disease encountered by clinicians with no clear guidelines for surgical management after failure of medical therapy [15]. GES and PG are known surgical therapeutic options for medically refractory gastroparesis. While many have examined clinical outcomes associated with GES and PG individually, few studies have directly compared their treatment efficacy. To our knowledge, the present analysis is the largest study to directly compare the therapeutic efficacy of GES vs PG for medically refractory gastroparesis.

Given the lack of evidence-based treatment guidelines, therapeutic decisions for the management of medically refractory gastroparesis are often non-standardized and

Table 2 Outcomes of patients treated with initial gastric electrical stimulation (GES) versus primary gastrectomy (PG)

Outcomes	No. (%)		*P*-value
	GES ($N=130$)	PG ($N=51$)	
In-hospital morbidity	7 (5.4)	9 (17.6)	**0.017**
Atrial fibrillation	1 (0.8)	–	
DVT	–	1 (2.0)	
Wound infection	3 (2.3)	5 (9.8)	
Small bowel infarction	1 (0.8)	–	
Cardiac event/MI	1 (0.8)	1 (2.0)	
Sepsis	1 (0.8)	1 (2.0)	
Gastric or small bowel obstruction	–	1 (2.0)	
Median length of stay, d, (IQR)	3 (4)	9 (4.5)	**< .001**
Mortality (< 30 days)*	1 (0.8)	–	0.999
Mortality ≥ 30 days	4 (3.0)	–	0.578
Mean follow-up, m, (range)	37.3 (0.3—176.8)	33.0 (0.25—137.7)	0.519
Morbidity (after discharge)**	7 (5.4)	1 (2.0)	0.445
GES infection	5 (3.8)	–	
Small bowel obstruction	2 (1.5)	1 (2.0)	
Total number of readmissions	337	101	
Mean number of readmissions (SD)	2.6 (2.9)	2.0 (2.2)	0.177
Causes of readmissions			
Nausea	105 (31.2)	30 (29.7)	0.781
Vomiting	113 (33.5)	29 (28.7)	0.364
Epigastric Pain	92 (27.3)	30 (29.7)	0.636
Malnutrition/weight loss	2 (0.6)	5 (5.0)	**0.002**
Dehydration	7 (2.1)	1 (1.0)	0.474
PO intolerance	58 (17.2)	11 (10.9)	0.126
GES management	77 (22.8)	–	

*Includes in-hospital mortality

**Does not include in-hospital morbidity

DVT Deep vein thrombosis, *MI* Myocardial infarction, *SD* Standard deviation, *IQR* Interquartile range, *PO* By mouth

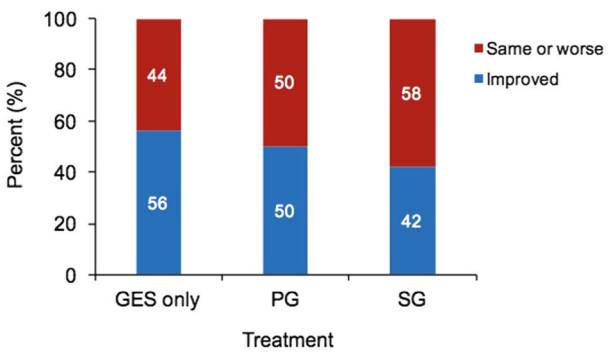

Fig. 2 Postoperative symptomatic assessment of gastroparesis patients treated with gastric electrical stimulation (GES), primary gastrectomy (PG), and secondary gastrectomy (SG)

largely determined by institutional, surgeon, and/or patient preference. In this context, it is often expected that less invasive interventions, such as GES, are preferred as first-line therapies. Management strategies should, however, also consider therapeutic success. Our study aimed to examine the safety profile of each procedure and conduct an analysis to compare outcomes and complication rates among the surgical options. As expected, we found a higher rate of in-hospital morbidity and length of stay in patients who underwent PG vs upfront GES. However, there was no difference in 30-day mortality rate, ≥ 30 days mortality rate, or long-term morbidity after discharge between the two treatments groups (Table 2). Therefore, despite similar long-term complication rates and mortality rates between PG and GES, early differences in morbidity and longer length of hospitalization should be considered when determining optimal procedure selection.

Next we aimed to compare symptomatic outcomes for these two procedures. We examined the efficacy in achieving symptomatic improvement in patients by constructing a multivariable regression model. Our analysis

Table 3 Multivariable regression model examining the association of symptomatic improvement with upfront gastric electric stimulator (GES) vs primary gastrectomy (PG)

Characteristic	Univariate				Multivariable			
		95% C.I				95% C.I		
	OR	Lower	Upper	*P*	OR	Lower	Upper	*P*
Post-surgical GP vs								
Diabetes Mellitus GP	3.66	0.77	17.50	0.10	5.79	0.86	39.19	0.07
Idiopathic GP	4.77	0.94	24.13	0.06	**8.45**	**1.19**	**60.20**	**0.03**
History of GERD	0.70	.32	1.52	0.36	0.47	0.18	1.20	0.11
History of Foregut Surgery	**0.36**	**.16**	**0.79**	**0.01**	0.49	0.20	1.21	.012
Upfront GES*	0.43	0.18	1.01	0.053	**0.16**	**0.05**	**0.53**	**< 0.01**

*Upfront GES vs PG

($n = 120$)

C.I. Confidence interval, *GP* Gastroparesis, *GERD* Gastroesophageal reflux disease

Table 4 Summary of analysis comparing demographics, past medical history, and initial presenting symptoms of patients who underwent primary gastric electrical stimulator (GES) vs patients who underwent GES and converted to gastrectomy, secondary gastrectomy (SG)

	GES Only	SG	P
Average age (years)	42.5	40.7	0.476
Female sex	58 (66.7%)	31 (73.8%)	0.543
Hypertension	50 (57.5%)	20 (47.6%)	0.347
Diabetes mellitus	57 (65.5%)	28 (66.7%)	1.000
Coronary artery disease	6 (6.9%)	4 (9.5%)	0.727
Hyperlipidemia	27 (31.0%)	12 (28.6%)	0.840
COPD	0 (0.0%)	1 (2.4%)	0.326
GERD	30 (34.5%)	18 (42.9%)	0.437
Autoimmune disease	22 (25.3%)	15 (35.7%)	0.299
Number of comorbidities (avg)	2.2	2.4	0.654
History of foregut surgery	33 (37.9%)	23 (54.8%)	0.089
Post-surgical Gastroparesis	**1 (1.1%)**	**5 (11.9%)**	**0.025**
Diabetic Gastroparesis	**60 (69.0%)**	**26 (61.9%)**	
Idiopathic Gastroparesis	**26 (29.9%)**	**11 (26.2%)**	
Nausea	46 (93.9%)	24 (88.9%)	0.660
Vomiting	42 (85.7%)	26 (96.3%)	0.247
Epigastric pain	38 (77.6%)	18 (66.7%)	0.415
Dehydration	8 (16.3%)	5 (18.5%)	1.000
Malnutrition	22 (44.9%)	15 (55.6%)	0.473
Early satiety	4 (8.2%)	1 (3.7%)	0.650
Bloating	3 (6.1%)	2 (7.4%)	1.000

COPD Chronic obstructive pulmonary disease, *GERD* Gastroesophageal reflux disease

showed patients who underwent GES were more than 6 times less likely to report improvement in symptoms compared to patients who underwent PG. This may, in part, be explained by our institutions previous practice to offer GES to patients with idiopathic gastroparesis as demonstrated by the statistically higher rates of idiopathic GP patients in the GES group. We have since stopped offering GES to these patients given the emerging evidence for its reduced efficacy for idiopathic GP. We believe our regression model, which adjusts for etiology as a covariate, minimizes the effects of this bias on the overall analysis. An additional explanation for our finding is the lack of evidence-based guidelines to help clinicians in selection of the best initial surgical option for patients. As patients and surgeons favor less invasive procedures due to perceived relative safety, procedure selection may be influenced by avoidance of adverse surgical outcomes rather than obtaining the best possible therapeutic outcomes. The results of our analysis have multiple implications: Should PG be considered as a first-line intervention? Are there predictive factors associated with GES failure?

While both therapies can be used as primary interventions, Gastrectomy may be utilized by clinicians as salvage therapy for patients who fail GES. In our cohort of patients, 42% (13/31) experienced improvement in symptoms after conversion from GES to gastrectomy. Given the significant number of patients with improvement in symptoms following conversion to gastrectomy, we examine factors that may be associated with undergoing SG. Our analysis showed that patients who presented with post-surgical gastroparesis were significantly more likely to undergo SG as shown in Table 4. Previous studies have examined etiology of gastroparesis as a predictive factor for outcomes in patients who underwent GES placement. Patients with diabetic gastroparesis have been reported to have superior outcomes compared to patients with idiopathic gastroparesis [16, 17]. This trend has been previously attributed to the heterogeneous disease processes observed in idiopathic GP patient cohorts [16, 17]. Still, a study by Mccallum and colleagues found that in patients who underwent GES therapy, those with idiopathic GP had worse outcomes compared to patients with post-surgical and diabetic GP [2, 18]. Given insufficient data in the literature and our study findings, it is difficult to make definitive conclusions regarding optimal patient selection for

GES based on etiology without further evidence. We also examined the association between preoperative symptoms and patient demographics with undergoing SG and found no significant difference.

Our study provides potentially valuable and clinically relevant recommendations, raising important questions that can be addressed by future studies. Selection of GES as the primary intervention in the absence of evidence guiding patient selection does not appear to be effective in achieving improvement in patient symptoms. In order to improve patient selection, future studies are needed to better understand factors associated with patient success for each respective therapy. This can best be accomplished by designing studies with head-to-head comparison of surgical options utilizing effective adjusted statistical analysis in order to ascertain factors associated with treatment success. Etiology of gastroparesis may be an ideal variable to explore as a predictive factor of treatment success although preoperative symptoms, imaging, and endoscopic findings should be also considered in future studies.

Limitations.

Our study has limitations inherent to its design being a retrospective single-center study. Postoperative telephone surveys include the potential for recall bias as patients are contacted multiple years after surgery. There is also potential for selection bias, as our cohort consisted of individuals who were willing to comply with the survey and follow-up requirement of the study. The rates of the types of gastroparesis etiologies significantly varied among the GES and PG groups. While regression analysis was used to adjust for this difference in our analysis, future studies examining disaggregate patient cohorts would be helpful in further delineating differences in efficacy and predictive factors among different etiologies if sample size allows for it. The majority of the PG patient cohort underwent subtotal gastrectomy making comparison of symptom improvement between the various gastrectomy types not possible and limiting the strength of our conclusions. Future studies examining the difference in efficacy of various types of gastrectomy on symptom improvement are warranted. Furthermore, only 6 patients with postoperative gastroparesis underwent upfront GES, limiting the strength of our conclusions regarding the optimal procedure for this patient population.

Conclusion

In a large cohort analysis of medically refractory gastroparesis patients, we found choosing GES as a primary intervention by default may not be the optimal approach to improving gastroparesis symptoms for all patients. Our regression analysis suggests that primary gastrectomy may be more beneficial than upfront GES for some patients, especially those that fall into the category of post-surgical gastroparesis. Our study also suggests that the decision between selecting GES or gastrectomy as the primary intervention is a complex and multifactorial process which warrants future studies examining optimal patient selection.

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Declarations

Disclosures Jamil S. Samaan, Omar Toubat, Evan T. Alicuben, Sean Dewberry, Adrian Dobrowolski, Kulmeet Sandhu, Joerg Zehetner, John C. Lipham, and Kamran Samakar have no conflicts of interest or financial ties to disclose. Omar Toubat is supported in part by the National Heart, Lung, and Blood Institute of the National Institutes of Health under award number F30HL154324 outside of the submitted work.

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