



## Patient factors influence surgical options in gastroparesis

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### ABSTRACT

**Background:** Patient selection for the diverse surgical procedures for gastroparesis remains poorly defined. Our aim was to evaluate how patient factors have determined our surgical approach to gastroparesis.

**Methods:** 95 patients undergoing 105 surgical procedures for gastroparesis were reviewed. Patient factors were compared across six surgical procedures: gastric neurostimulator, pyloroplasty, neurostimulator plus pyloroplasty, sleeve gastrectomy, gastric bypass and gastrectomy. Global symptom severity was determined preoperatively and at last follow up.

**Results:** There were significant differences in etiology, BMI and gastroesophageal reflux across the various operations. Patients undergoing pyloroplasty and gastrectomy; were more likely to have a postsurgical etiology. ( $p < .05$ ) Patients undergoing sleeve gastrectomy and gastric bypass were more likely to have BMI  $>35$ . ( $p < .05$ ) Those undergoing sleeve gastrectomy were less likely to have gastroesophageal reflux preoperatively. ( $p < .05$ ) There was no difference in preoperative clinical stage across the procedures.

**Conclusion:** Patient factors influence choice of procedure in the surgical treatment of gastroparesis. Etiology of gastroparesis, BMI  $>35$  and gastroesophageal reflux are important determinants.

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### Introduction

Gastroparesis is defined as delayed gastric emptying in the absence of mechanical obstruction with attendant gastrointestinal symptoms, including early satiety and fullness, bloating, nausea and vomiting, and upper abdominal pain.<sup>1</sup> Diabetes mellitus and idiopathic are the most common etiologies, but postsurgical, neuronal and infiltrative disorders are other potential causes. The pathophysiology involves several mechanisms. These include impaired gastric accommodation, antral hypomotility, pylorospasm, duodenal dysmotility, autonomic dysfunction and visceral hypersensitivity.

The initial treatment of delayed gastric emptying involves medical treatment with antiemetic and prokinetic agents.<sup>1,2</sup> Nutritional support is also important. These patients frequently benefit from venting gastrostomy and feeding jejunostomy tubes.

However, progression of disease and attendant symptoms is the usual course. A variety of surgical procedures have been performed to enhance gastric emptying and/or improve symptoms. These include gastric electrical stimulation (GES), pyloroplasty, sleeve gastrectomy, gastric bypass and total gastrectomy.<sup>2</sup>

Patient selection for these diverse surgical procedures remains poorly defined.<sup>3–5</sup> Various patient factors have been suggested to be informative, including etiology of disease, obesity, presence of gastroesophageal reflux and need for nutritional support.<sup>2–4</sup> Patient symptomatology may also be an important determinant.<sup>5</sup> Response to therapeutic measures such as pyloric Botox injection, assessment of vagus nerve integrity and temporary endoscopic gastric stimulation have also been evaluated.<sup>6–8</sup> Our aim was to evaluate how patient factors have had a role in determining our surgical approach to gastroparesis.

### Methods

We reviewed the records of 95 patients evaluated at our institution over a 20 year period who had undergone 105 surgical

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procedures for gastroparesis. Gastroparesis was determined by an abnormal 4 h gastric emptying scintigraphy, presence of associated symptoms, and evaluation for mechanical obstruction by upper endoscopy and/or gastrointestinal contrast study. Patients with diffuse motility disorders e.g. intestinal pseudoobstruction were excluded. Records were reviewed to determine patient demographics, etiology of gastroparesis, contributing medical conditions, preoperative nutritional therapy and procedure performed.

Six operative procedures were performed: GES, pyloroplasty, GES and pyloroplasty, sleeve gastrectomy, gastric bypass, and total gastrectomy. For GES two electrodes are placed in the muscularis propria approximately 1 cm apart on the greater curve, 10 cm proximal to the pylorus. These leads are then led to a pocket in the anterior abdominal wall and connected to a pulse generator. Heineke-Mikulicz pyloroplasty is performed. Sleeve gastrectomy was performed as a longitudinal stapled resection beginning below the gastroesophageal junction and ending 5 cm proximal to the pylorus, leaving a 4 cm tube. Roux-en-y gastric bypass was performed. Near total gastrectomy was performed. The operation performed was determined by the treating physicians, taking into consideration patient preference and insurance considerations.

Assessment of global symptom severity was defined as grade I (mild gastroparesis) representing symptoms that are relatively easy to control and the ability of the patient to maintain weight and nutrition on a regular diet; grade 2 (compensated gastroparesis) representing moderate symptoms that are only partially controlled with the use of daily medications and the ability of the patient to maintain nutrition with dietary supplements; and grade 3 (gastric failure) representing refractory symptoms that are not controlled, the patient has frequent visits or hospitalizations, and/or the inability of the patient to maintain nutrition via an oral route.<sup>9</sup> Global symptom severity was determined by retrospective analysis by a physician reviewer preoperatively and at last follow up.

Data are displayed as counts and percentages. Follow-up time is reported as median and interquartile range (IQR). Fisher's exact test was used to look at associations between preoperative characteristics, treatments, and outcomes with type of surgery. Analyses were done using SAS 9.4 and a p-value <.05 was considered statistically significant.

## Results

Overall, there were 83% female patients and 74% patients less than fifty years of age (Table 1). Etiology of gastroparesis was idiopathic in 49%, diabetic in 34% and post-surgical in 17% of patients. Thirteen (41%) of the 32 diabetic patients had type 1 diabetes. Body mass index (BMI) was greater than 35 in 25% of patients. 23% of patients were current opioid users. 48% had moderate to severe gastroesophageal reflux.

Preoperative characteristics by procedure are compared in Table 1. There were significant differences in etiology, BMI, and the presence of gastroesophageal reflux disease across the various operations. Patients undergoing pyloroplasty and gastrectomy were significantly more likely to have a post-surgical etiology than GES ( $p < .05$ ). Patients undergoing sleeve gastrectomy and gastric bypass were more likely to have BMI >35 ( $p < .05$ ). Patients undergoing sleeve gastrectomy were less likely to have moderate to severe gastroesophageal reflux than the other procedure groups, except gastrectomy ( $p < .05$ ). Age, sex, current smoking, depression and current opioid use were similar.

Preoperative treatments are shown in Table 2. Overall 9% of patients had gastrostomy tubes, 24% had jejunostomy tubes, and 7% were receiving parenteral nutrition (PN). Patients undergoing gastrectomy were significantly more likely to be on PN than patients undergoing GES and pyloroplasty or sleeve gastrectomy.<sup>(p</sup>

<.05) Nine (9%) patients had undergone pyloric Botox injection. Eighteen (19%) patients had undergone fundoplication prior to a procedure for gastroparesis.

These patients were more likely to undergo pyloroplasty or gastrectomy than GES or sleeve gastrectomy. ( $p < .05$ ) Sixteen patients underwent simultaneous fundoplication. 11 (69%) of simultaneous procedures were performed with combined GES and pyloroplasty.

GES with or without pyloroplasty was the most frequently performed procedure in patients with idiopathic and diabetic gastroparesis (59% and 69%) (Table 3). Pyloroplasty was the most frequently performed procedure in post-surgical patients (38%). Patients with BMI >35 most frequently (51%) underwent a bariatric procedure, either sleeve gastrectomy or gastric bypass (Table 4).

Patient outcomes are shown in Table 5. There was no difference in preoperative clinical stages across the procedures. Postoperatively a lower percentage of patients undergoing pyloroplasty alone had improvement (23%) and clinical grade I score (15%). ( $p < .05$ ) Compared to other procedures, GES alone, and gastric bypass, had less improvement than sleeve gastrectomy. ( $p < .05$ ) Overall, based on changes in clinical scores, 53% patients improved, 37% had no change and 6% were worse postoperatively. Six of the seven patients on PN preoperatively remained on PN at follow up. There was no difference in the rate of reoperation among the procedures.

Rates of reoperation with another of the procedures for gastroparesis were not significantly different across the procedures. (Table 5). 54 patients underwent GES, 36 as the only procedure and 18 in combination with a pyloroplasty. Four of the patients undergoing GES alone underwent a subsequent pyloroplasty. Six devices have been replaced for battery failure. In addition, six devices were removed for complications and/or failure to improve symptoms. 13 patients underwent initial pyloroplasty alone. Subsequently three of these patients had another procedure; one gastric bypass, one GES and one gastrectomy. 18 patients underwent initial sleeve gastrectomy. Two of these patients underwent subsequent gastric bypass for severe gastroesophageal reflux. Six patients underwent initial gastric bypass. One patient underwent pyloroplasty for continued symptoms and then subsequently had reversal of the gastric bypass. Four patients have undergone total or subtotal gastrectomy as the initial procedure.

## Discussion

The pathophysiology of gastroparesis is complex and a variety of surgical procedures have been performed in an attempt to correct the pathophysiologic contributors and improve symptoms. Our approach has been to consider a range of potential procedures and tailor that to the individual patient.<sup>2</sup> This requires identification of factors which might lead to selection of the appropriate procedure for a specific patient. In the present study we found that etiology, BMI >35, and the presence of significant gastroesophageal reflux were important determinants of the procedure performed (Fig. 1).

Strategies for procedure selection have been recommended by others. Arthur et al.<sup>3</sup> recently analyzed 58 patients undergoing GES, pyloroplasty, sleeve gastrectomy and gastrectomy and suggested a structured approach. They favor GES as the initial procedure since GES had the greatest symptomatic improvement in their experience. Pyloroplasty was performed for patient preference, post-surgical gastroparesis or failure to improve after GES. They reserved gastrectomy as the last resort. Others have recommended pyloroplasty as the first line approach, including all etiologies.<sup>10,11</sup> Conversion of GES to gastrectomy has been reported in up to 10% of patients in another study.<sup>12</sup> Some recommend gastrectomy as primary therapy.<sup>13,14</sup>

Etiology of gastroparesis is an important determinant of surgical

**Table 1**  
Preoperative characteristics.

	GES	Pyloroplasty	GES and Pyloroplasty	Sleeve gastrectomy	Gastric Bypass	Gastrectomy	P
Number	36	13	18	18	6	4	
Age							
<50	27(75%)	12(92%)	13(72%)	10 (56%)	5(83%)	3(75%)	.33
>50	9(25%)	1(8%)	5(28%)	8 (44%)	1(17%)	1(25%)	
Sex							
F	29(81%)	11(85%)	15(83%)	14(78%)	6(100%)	4(100%)	.92
M	7(19%)	2(15%)	3(17%)	4(22%)	0(0%)	0(0%)	
Etiology							
Idiopathic	18(50%)	7(54%)	10(55%)	7(39%)	5 (83%)	0(0%)	<.0001
Diabetic	16(44%)	0(0%)	6(33%)	10(56%)	0 (0%)	0(0%)	
Post-surgical	2(6%)	6(46%)	2(11%)	1(5%)	1 (17%)	4(100%)	
Body Mass Index							
<30	23(64%)	11(84%)	8(45%)	3(17%)	1 (17%)	2(50%)	.001
30-35	9(25%)	1(8%)	6(33%)	4(22%)	2 (33%)	1(25%)	
>35	4(11%)	1(8%)	4(22%)	11(61%)	3 (50%)	1(25%)	
Current Smoking							
No	28(78%)	8(62%)	12(67%)	17(94%)	6(100%)	3(75%)	.13
Yes	8(22%)	5(38%)	6(33%)	1(6%)	0(0%)	1(25%)	
Depression							
No	21(58%)	6(46%)	10(56%)	10(56%)	3(50%)	3(75%)	.95
Yes	15(42%)	7(54%)	8(44%)	8(44%)	3(50%)	1(25%)	
Current Opioid Use							
No	28(78%)	8(62%)	14(78%)	16(89%)	4(67%)	3(75%)	.54
Yes	8(22%)	5(38%)	4(22%)	2(11%)	2(33%)	1(25%)	
Gastroesophageal Reflux							<.0001
None/Mild	14 (39%)	6(46%)	5(28%)	17(94%)	3(50%)	4(100%)	
Moderate/Severe	22(61%)	7(54%)	13(72%)	1(6%)	3(50%)	0(0%)	

procedure performed in our experience. Patients with idiopathic and diabetic gastroparesis were most likely to undergo GES. Sleeve gastrectomy was also frequently performed in the diabetic group. Pyloroplasty was more frequently performed in postsurgical patients. Strong et al.<sup>15</sup> recently reported endoscopic per-oral pyloromyotomy for post-surgical gastroparesis, finding significant improvement in symptoms and noting that only 2 (5%) patients progressed to total gastrectomy. They concluded that pyloric disruption should be the first procedure considered in this patient group.

Patients with BMI >35 were more likely to undergo a sleeve gastrectomy or gastric bypass in our experience. These procedures have the added advantage of producing weight loss. However, Sun et al.<sup>16</sup> reported 20 patients with BMI >35 who underwent GES. Initial symptom improvement occurred in 90% and 55% were improved long term. Four (20%) patients were converted to gastric

bypass. They suggest that GES is an appropriate initial procedure for obese gastroparesis patients with conversion to GBP if they fail to improve. Conversely Timratana et al.<sup>17</sup> recommended GBP in obese patients.

Gastric bypass and sleeve gastrectomy have also been performed in non-obese patients. Wakamatsu et al.<sup>18</sup> performed GES in 84% of patients and GBP in 16%. Gastric bypass was performed in patients with a higher BMI (mean 36 versus 24). They found that GES provided more symptom relief than GBP in non-obese patients (BMI<30). We have had an initial favorable response to sleeve gastrectomy in non-obese patients.<sup>19</sup> This includes patients with significant chronic gastric dilation.

Patients who had significant gastroesophageal reflux preoperatively were more likely to undergo GES and/or pyloroplasty in the present study. One fourth of these patients underwent a simultaneous fundoplication. We consider gastroesophageal reflux to be a

**Table 2**  
Preoperative treatment.

	GES	Pyloroplasty	GES and Pyloroplasty	Sleeve gastrectomy	Gastric Bypass	Gastrectomy	P
Number	36	13	18	18	6	4	
Gastrostomy Tube							.103
No	30 (83%)	12(92%)	18 (100%)	18 (100%)	15 (83%)	3 (75%)	
Yes	6 (17%)	1 (8%)	0 (0%)	0 (0%)	1 (17%)	1 (25%)	
Jejunostomy Tube							.105
No	23 (64%)	10 (77%)	15 (83%)	17 (94%)	5 (83%)	2 (50%)	
Yes	13 (36%)	3 (23%)	3 (17%)	1 (6%)	1 (17%)	2 (50%)	
Parenteral Nutrition							.028
No	33 (92%)	11 (85%)	18 (100%)	18 (100%)	6 (100%)	2 (50%)	
Yes	3 (8%)	2 (15%)	0 (0%)	0 (0%)	0 (0%)	2 (50%)	
Pyloric Botox injection							.52
No	31 (86%)	12 (92%)	15 (83%)	18 (100%)	6 (100%)	4 (100%)	
Yes	5 (14%)	1 (8%)	3 (17%)	0 (0%)	0 (0%)	0 (0%)	
Fundoplication							<.0001
No	30(83%)	4(31%)	5(28%)	17(94%)	4(67%)	1(25%)	
Previous	4(11%)	6(46%)	2(11%)	1(6%)	2(33%)	3(75%)	
Simultaneous	2(6%)	3(23%)	11(61%)	0(0%)	0(0%)	0(0%)	

**Table 3**  
Effect of etiology on surgical procedure.

	Idiopathic	Diabetic	Post-Surgical
GES	18 (38%)	16 (50%)	2 (13%)
Pyloroplasty	7 (15%)	0 (0%)	6 (38%)
GES and Pyloroplasty	10 (21%)	6 (19%)	2 (13%)
Sleeve Gastrectomy	7 (15%)	10 (31%)	1 (6%)
Gastric Bypass	5 (11%)	0 (0%)	1 (6%)
Gastrectomy	0 (0%)	0 (0%)	4 (25%)
Total	47	32	16

P < .0001.

**Table 4**  
Effect of body mass index on surgical procedure.

BMI	<30	30–35	>35
GES	23 (48%)	9 (39%)	4 (17%)
Pyloroplasty	11 (23%)	1 (4%)	1 (4%)
GES and Pyloroplasty	8 (17%)	6 (26%)	4 (17%)
Sleeve Gastrectomy	3 (6%)	4 (17%)	11(46%)
Gastric Bypass	1 (2%)	2 (9%)	3 (13%)
Gastrectomy	2 (4%)	1 (4%)	1 (4%)
Total	48	23	24

P = .0010.

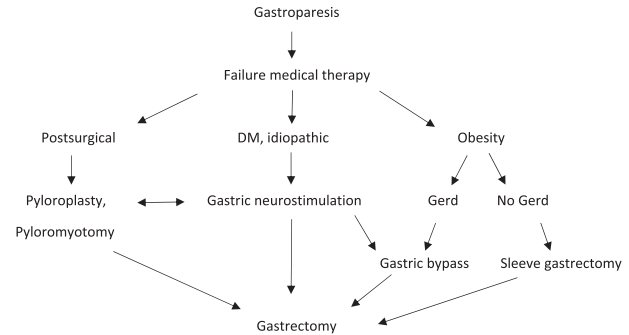
contraindication to sleeve gastrectomy but gastric bypass is another option in this patient group.

Severity of symptoms preoperatively, as determined by global symptom severity, was not a predictor of procedure performed in the present series. Almost 80% of patients with grade 3 (gastric failure) status preoperatively were treated with GES, pyloroplasty or the combination. However, patients undergoing gastrectomy were more likely to be on PN.

We had limited experience with pyloric Botox injection prior to operation in this group of patients. The efficacy of this treatment as primary therapy is in dispute.<sup>20</sup> However, it has been suggested that improvement after injection predicts a favorable response to pyloric disruption.<sup>7</sup> A recent meta-analysis of clinical efficacy of Gastric per-oral endoscopic myotomy (G-POEM) reported improvement in gastric emptying times in patients with idiopathic gastroparesis that underwent Botox injections or GES before their

**Table 5**  
Symptom severity and patient outcomes.

	GES	Pyloroplasty	GES and Pyloroplasty	Sleeve Gastrectomy	Gastric Bypass	Gastrectomy	P
Number	36	13	18	18	6	4	
Global Symptom Severity							
Preoperative							.102
Grade 1	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	
Grade 2	22(61%)	10(77%)	16(89%)	16(89%)	5(83%)	2(50%)	
Grade 3	14(39%)	3(23%)	2(11%)	2(11%)	1(17%)	2(50%)	
Postoperative							.027
Grade 1	14(39%)	2 (15%)	11(61%)	12(67%)	3(50%)	1(25%)	
Grade 2	12(33%)	7 (54%)	3(17%)	5(28%)	0(0%)	1(25%)	
Grade 3	8(22%)	4 (31%)	2(11%)	1(5%)	3(50%)	2(50%)	
Unknown	2(6%)	0(0%)	2(11%)	0(0%)	0(0%)	0(0%)	
Change							.006
Improved	18(50%)	3(23%)	11(61%)	14(78%)	3(50%)	1(25%)	
No Change	16(44%)	7(54%)	5(28%)	3(17%)	1(17%)	3(75%)	
Worse	0(0%)	3(23%)	0(0%)	1(5%)	2(33%)	0(0%)	
Unknown	2(6%)	0(0%)	2(11%)	0(0%)	0(0%)	0(0%)	
Re-operation							.34
No	32(89%)	10(77%)	18(100%)	16(89%)	5(83%)	4(100%)	
Yes	4(11%)	3(23%)	0(0%)	2(11%)	1(17%)	0(0%)	
Follow up (months)							.65
Median (IQR)	56(72)	36(56)	48(56)	45(25)	63(48)	84(94)	



**Fig. 1.** Surgical strategy for gastroparesis. DM, diabetes mellitus, GERD, gastroesophageal reflux disease.

pyloroplasty or G-POEM.<sup>21</sup> Gastroparesis is likely a multifactorial disorder and its treatment may need to address both neuro-modulation with GES and facilitating emptying with pyloric interventions. This will need further investigation.

While the present study was not designed to assess outcomes, we found that more than half of patients experienced significant clinical improvement from surgical procedures. Improvement was lowest for pyloroplasty alone. This finding suggests that pyloric dysfunction or pylorospasm is not present in most patients and disrupting the pylorus is not of routine benefit. Davis et al.<sup>22</sup> suggested that simultaneous GES and pyloroplasty improves outcomes compared to GES alone. We found that combining GES and pyloroplasty gave greater improvement than pyloroplasty alone but not compared to GES alone. Thus, it remains unclear if these procedures should be performed simultaneously or in a staged fashion.

There are several limitations to the present study. One of the limitations is that we do not know what procedures the patients were offered. Thus, patient preference for a given procedure is not reflected as a potential factor in choice of procedure. Another limitation is lack of a standard approach to surgical procedures in this diverse group of patients over the period of the study. Finally, in this retrospective study we do not have data about dominant symptoms to determine how that may have impacted procedure performed.<sup>23</sup>

In conclusion, patient factors influence choice of procedure in

the surgical treatment of gastroparesis. Etiology of gastroparesis, BMI >35, and presence of gastroesophageal reflux are important determinants. Severity of symptoms preoperatively was not a significant factor in choice of procedure.

### Conflicts of interest

None.

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