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The GI Surgeon and Gastroparesis



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Gastroparesis is a complex chronic disorder of delayed gastric emptying with a variety of etiologic factors. Treatment of gastroparesis is primarily medical and optimally provided by an experienced gastroenterologist. The role of surgical intervention for patients with gastroparesis is not well defined with little evidence-based data. Some severely refractory patients may undergo surgical procedures for several reasons including nutritional support, gastric stimulation, or rarely, definitive surgical treatment. The complexity of the disease makes it a challenge to define the role of surgical intervention in a way that provides benefit for patients while minimizing the risk. This manuscript reviews the current indications and options for surgical interventions, supportive and definitive, available for patients with gastroparesis.

OVERVIEWS OF GASTROPARESIS

Gastroparesis is characterized by delayed or impaired passage of gastric contents in the absence of mechanical obstruction. Symptoms vary and include nausea, vomiting, bloating, and abdominal pain. The symptoms and clinical presentation of gastroparesis is reflective of its pathogenesis, severity, and association with predisposing or associated conditions.

Gastroparesis is related to a variety of underlying disorders. The most common causes of gastroparesis

are diabetic, postsurgical and idiopathic (1). The true prevalence of gastroparesis is unknown. It is thought to occur in 20%–40% of patients with Type I diabetes mellitus and about 20% of patients with type II diabetes. Delayed gastric emptying occurs in about 25% of patients with functional dyspepsia, a disorder which includes a constellation of abdominal complaints that affects up to 20% of the U.S. population (2). Patients may develop gastroparesis after undergoing foregut surgery with or without vagotomy. One study noted that up to 8% of patients with postsurgical gastroparesis had developed symptoms after cholecystectomy (3). An increasing awareness is being paid to post-Nissen gastroparesis. Finally, the third most common

(continued on page 57)

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(continued from page 54)

cause of gastroparesis is characterized as idiopathic and has been postulated in some patients to occur after a viral infection (4,5).

The general principles for treating symptomatic gastroparesis are: 1) to correct and prevent fluid, electrolyte, and nutritional deficiencies; 2) to reduce symptoms; and 3) to identify and rectify the underlying cause of gastroparesis, if possible. Care of patients generally relies on dietary modification, medications that stimulate gastric motor activity, and antiemetic drug therapy. Our rudimentary understanding has not yet allowed effective treatment of the underlying cause in the majority of cases (6).

Gastroparesis may be one of the most crippling of the disorders of gastrointestinal motility. Its multifactorial pathogenesis and lack of definitive, effective treatments render patients who suffer with refractory gastroparetic symptoms clinically challenging. Patients with gastroparesis are frequently debilitated physically and emotionally. Many patients may be subject to potential complications such as dehydration, electrolyte imbalance, and in the diabetic patient, poor glycemic control. Not only do patients with gastroparesis have difficulty leading “normal” functional lives; they consume a significant amount of resources.

Treatment costs of patients with gastroparesis can be high; those receiving parenteral nutrition average approximately \$7,000 monthly (7).

THE GI SURGEON AND PATIENTS WITH GASTROPARESIS

Traditionally, invasive surgery is avoided in patients with gastroparesis. However, the gastrointestinal surgeon may play an important role in the ongoing care of patients with medically refractory symptoms. Surgical treatment is contemplated when other treatment options have not been successful. It should be recognized, however, that the current armamentarium of surgical treatment options for gastroparesis is not well understood or studied.

The experienced GI surgeon should be an integral part of the multidisciplinary team in the group of gastroparetic patients requiring surgical intervention. Better outcomes may result when open lines of communication are maintained with the surgeon, gastroenterologist, nutritionist, and the patient. In addition to the inherent risks/ benefits and limitations of the planned surgical procedure, physicians must be aware of the significant surgical comorbidities many gastro-

Table 1.
Overview of Surgical Treatment Modalities—“Supportive” Therapy

<i>Treatment</i>	<i>Indication</i>	<i>Morbidity</i>	<i>Studies</i>	<i>Outcomes</i>
Venous Access	Fluids/Medications Short Term (<6 weeks) Nutritional Support	6%–60% Infection DVT Complic. TPN	Multiple Prospective Randomized	Complic. 33%–54% Infectious, DVT PICC <u>LESS</u> cost effective
Gastrostomy	Venting/ Decompression	24.4% Infectious Tube Related	2 Nonrandomized N = 8, 18	Subjective relief of Sx, in 18/18 Weight Gain, DC Meds in 8/8
Jejunostomy	Enteral Feeding Access, Nutritional Support	>50% Infectious Tube Related Obstruction	2 Nonrandomized N = 2, 4 Retrospective N = 26	All Subjective: Improved Nutrition Decreased Sx Improved Glycemic Control

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Table 2.
Overview of Surgical Treatment Modalities—“Definitive” Therapy

<i>Treatment</i>	<i>Indication</i>	<i>Morbidity</i>	<i>Studies</i>	<i>Outcomes</i>
Drainage: Pyloroplasty Pyloromyotomy Gastrojejunostomy	Eliminate Pylorospams, Gastric Continnence	<10% (Risk of Procedure)	Case series (1) Retrospective (2) N = 2, 2, 4	Subjective improvement No change N/V
Resectional Therapy Completion Gastreotomy	Remove End Organ Near Total Gastreotomy	Up to 40% Frequent subsequent Surgeries 194 amd/33 pts	2 Retrospective N = 52, 60	78% Subjective Improvement 43% Improve Visick grade
Gastric Electrical Stimulation	Refractory Gastroparesis	<5% (Risk of Procedure)	Prospective, Randomized N = 33	~60% Symptom Reduction: Diabetic Group Greatest Effect

paretic patients pose. Up to one third of patients are diabetic and many may be malnourished. Both of these conditions contribute to generalized immunosuppression, impaired wound healing, and increased risk of postoperative infection. Furthermore, patients with gastroparesis may be prone to gastroesophageal reflux, retained gastric contents, and even bezoars which increase the risk of perioperative aspiration.

Surgical intervention is often aimed at support or symptom control. Soykan, et al found that 21% of patients seen at a tertiary medical center received nutri-

tional support via enteral or parenteral feeding and 26% were considered “nonresponders” to prokinetic therapy and eventually underwent surgical intervention (3). Surgical intervention is often considered for refractory patients to provide “supportive” therapy including intravenous or enteral access for nutritional support (Table 1). In several centers, the surgeon places the Enterra gastric electric stimulator for electrical stimulation treatment. Occasionally, patients may be evaluated for “definitive” therapy such as gastric decompression, surgical drainage procedures, and resective surgery (Table 2).

Table 3.
Intravenous and Central Venous Catheters

<i>Catheter Type</i>	<i>Site</i>	<i>Expected Duration of Use</i>
Peripheral Catheter, Short	Forearm, Hand	Days
Nontunneled Polyurethane CVC	Subclavian, Internal Jugular, Femoral Vein	Days to Week(s)
Nontunneled Silicone CVC	Subclavian, Internal Jugular Veins	Weeks to Month
Peripherally Inserted CVC (PICC)	Basilic, Cephalic, or Brachial Veins	Weeks to Month(s)
Tunneled CVC (Hickman)	Subclavian, Internal Jugular Veins	Months
Totally Implantable Port	Subclavian, Internal Jugular	Months

SUPPORTIVE INTERVENTION FOR GASTROPARESIS

Intravenous Access: PICC lines, CVC, Hickman Catheters, Infusaports

There are numerous methods of establishing central venous access if total parenteral alimentation is needed (Table 3). Central venous catheters (CVC) may be placed in the operating room, at the bedside or in an appropriate ambulatory setting. Central catheters can be divided into two types: short- and long-term, depending upon patient needs and (contra)indications (Table 3).

Nontunneled or subcutaneously tunneled short-term catheters are intended to remain in place for a week to a month. Nontunneled CVC's are placed in the subclavian or internal jugular veins and tunneled are peripherally inserted central venous catheters (PICC) placed in the basilic, cephalic, or brachial veins. Short term CVC's may be placed at the bedside: complications such as pneumothorax and hematoma are unusual, occur in 0.5% to 1% of cases and are minimized by use of ultrasound or fluoroscopy to image the vein. Nontunneled CVC's have a slightly higher infection rate because of the proximity of the skin insertion site to the vein, yet catheter associated bacteremia and infection occur in 0.1% to 0.3% of cases (8). Peripheral CVC's because of their placement in a smaller vein have increased longevity and lower rate of infection.

Long-term catheters are used for outpatients requiring central venous access for periods up to several months and include peripherally inserted central catheters (PICC), tunneled CVC's (Hickman), and totally implantable intravascular devices (Ports). Implantable and tunneled CVC's have the lowest rate of infection because the portal of entry for bacteria is minimized although a subcutaneous or "pocket" infection may occur. Placement of long term CVC's requires either an operative or interventional procedure; complications of which are hematoma, and pneumothorax are less than 1% (9).

Both short- and long-term CVC's may be associated with infection. Site infection, catheter-related infection, or sepsis should be considered in the presence of signs of local infection, or bacteremia. Uncomplicated site infections or even bacteremia may be

treated without removing the CVC depending upon severity and causative organism; however, elective replacement is advised if ongoing central access is needed. More serious infections or identification of resistant organisms mandate removal of the catheter.

Another frequent complication is catheter-related thrombosis that occurs in 6% to 60% of patients based upon comorbid risk factors. Venous thrombosis presents as a swollen painful arm and should be treated by catheter removal and consideration of thrombolytic therapy or anticoagulation.

Many options are available for gastroparetic patients requiring intravascular access. Judicious consideration of patient needs, including the indications and possible complications of CVC's along with the deleterious long-term effects of hyperalimentation are essential when choosing the type of device and placement site.

Gastrostomy

Decompressing gastrostomy tubes have been utilized to provide relief of nausea, vomiting and bloating by venting or suctioning retained gastric liquid or gas. Generally, gastrostomy tubes should not be used for nutritional feedings, as these patients have delayed gastric emptying. In the gastroparetic patient population, gastrostomy tubes may be paired with a separate feeding jejunostomy tube to provide simultaneous enteral alimentation. Occasionally combination gastrostomy/jejunostomy tubes are used. These are multi-lumen tubes designed to consolidate both decompression and enteral feeding into a single tube placed into the gastric lumen and fed through the pylorus well into the proximal small intestine. A drawback to this type of tube is the frequent migration of the jejunal tube back into the stomach and a tendency to increased tube dysfunction and a consistently higher incidence of perioperative and short-term tube related complications. In a prospective comparative study of PEG and combination gastrojejunostomy tubes with seven-year follow-up, the tubes had an equivalent lifetime. However, early and late complications occurred in 6.2% of PEG treated and 22.4% of gastrojejunal tube treated patients (10). Two separate tubes provide decompression of the stomach and maintenance of enteral feeding as an adjunct to oral

intake or even as a primary source of nutrition with a lower incidence of tube related complications.

Gastrostomy tubes may be placed by various methods—endoscopically, fluoroscopically, or surgically utilizing either open or laparoscopic technique. The most widely used technique of gastrostomy placement is the various modifications of the “PEG” method originally introduced by Gauderer and Ponsky in 1980 (11). For patients with contraindications to the percutaneous endoscopic approach, surgical gastrostomy, either open or laparoscopic is an alternative. This method is also used for those who require simultaneous placement of feeding jejunostomy tubes. Both percutaneous and surgical techniques have been established as safe and effective means of accessing the gastric lumen.

Decompressing or venting gastrostomy has been utilized effectively in post-surgical and malignant mechanical obstruction (12). Less well studied in the gastroparetic population, the technique has nevertheless been identified as a safe and effective procedure though little data exist for patients with gastroparesis (13). Nonprospective data from one study over a follow-up period of up to 41 months suggest venting gastrostomy qualitatively reduces symptoms of nausea, vomiting, and bloating and allows for improved nutrition via both the oral and the alimentary (jejunal) route (14). Patients experienced symptom improvement, weight gain and were able to return to work or school.

Gastrostomy tubes are not innocuous. Procedure related mortality is essentially the anesthetic risk of 0.3% to 1%. Overall gastrostomy complication rates for both percutaneous and surgical techniques are similar and have been cited as 17% to 24%, with 3% to 5% regarded as being serious or life threatening (15). These complications are often infectious; wound infection, fasciitis, peritonitis, and stomatitis from leakage, bowel perforation or fistula. The other common category of complication is tube dysfunction; occlusion, fracture, dislodgement, irritation/erosion into an adjacent organ or abdominal wall. Gastrostomy has been shown to be durable: tube lifetime in one series is cited as a median of 363 days with a range from 1 to 1,732 days (4.7 years) (13). It is notable that in several series, the overall mortality rate of patients with gastrostomy tubes during the study period of up to four years was substantial, cited from 38% to 53% and was related to complica-

tions of underlying disease, most often diabetes (13,16). Thus patients preselected to require this type of supportive therapy often have significant comorbid disease. Gastrostomy tubes are a useful adjunct in the care of gastroparetic patients. Once safely placed, tubes should be followed closely and maintained by the operating surgeon, gastroenterologist, or experienced Allied Health Professional as approximately one in five patients experience tube related difficulties during the lifetime of the tube. A properly maintained gastrostomy can provide symptomatic relief for years.

Feeding Jejunostomy

Patients with gastroparesis might be unable to tolerate oral intake or meet their nutritional needs. Patients who need nutritional supplementation for greater than four to six weeks may benefit from the placement of an enteral feeding tube. Enteral alimentation denotes jejunal feeding in gastroparetic patients, as gastric feeding is usually not feasible. Alimentary nutrition obviates the cost, complications and adverse nutritional sequelae of total parenteral nutrition (TPN) while providing trophic benefits and better glycemic control that have been well described (17). Feeding jejunostomy tubes may be placed by several methods: endoscopically, or surgically utilizing open or laparoscopic technique. Endoscopic placement requires either conversion of a preexisting gastrostomy or primary placement of percutaneous endoscopic jejunostomy tube. Fraught with technical difficulty for placement and prone to tube related dysfunction, endoscopically placed tubes are less often used with this patient population (18).

Surgically placed jejunostomy using either open or laparoscopic technique is the more common method. Needle-catheter jejunostomy has been described and may be placed fluoroscopically however the small bore tube required for this procedure renders it prone to occlusion and less useful for long-term enteral alimentation.

Patients' ability to tolerate jejunostomy feedings may be predicted clinically using a trial of nasojejunal feedings preceding definitive surgical placement of a permanent jejunostomy. Surgical feeding jejunostomy can be accomplished using either open or laparoscopic technique with equivalent perioperative morbidity

(continued on page 63)

(continued from page 60)

(19). Care must be taken by the operating surgeon to ensure that the accessed jejunal limb or tube is not unduly twisted or angulated and that the tube itself does not narrow the bowel lumen. Such technical errors cause early tube dysfunction and occlusion or proximal mechanical bowel obstruction.

Within 24 hours after placement infusion may be initiated at low infusion rates (approximately 20 mL per hour) with dextrose/water or dilute nutrient and advanced slowly until the caloric goal is reached. If tolerable, nocturnal cycling of feeding permits somewhat more normal daytime work and function. Similar to decompressing gastrostomy, jejunostomy feeding tubes are frequently used for nutritional support in the gastroparetic patient but have not been well studied. It is clear that jejunostomy tubes and feeding are associated with a high incidence of major and minor morbidity. In studies of patients not able to tolerate oral feeding not restricted to gastroparesis, authors reported overall patients complication rates greater than 50%. Adams, et al reported 53 complications in 34 patients with neurologic disease including seven deaths: Cogan, et al noted 62 complications in 36 nursing home patients (20,21). In his study of gastroparetic patients, Fontana described 70 overall complications in 26 patients with a four-year mortality of 38% (19). Common complications include infectious; either tract or wound infection, or tube dysfunction such as occlusion or dislodgement. Clearly patients who require jejunal feeding have severe dysfunction associated with multiple other risk factors.

Despite significant complications associated with the use of feeding jejunostomy, it has been shown to improve overall nutrition and reduce hospitalizations and symptoms such as nausea and vomiting (19). Over 83% of the patients in Fontana's group experienced improved overall health. For patients who can continue some oral intake the tube acts as a good back-up system for nutrition, hydration, and medications. Although often needed by patients with severe gastroparesis and multiple other comorbidities and prone to frequent tube related complications, feeding jejunostomy is an excellent adjunct for nutritional support. Placed equally effectively by several methods jejunostomy tubes should be followed closely by the treating physician or experienced Allied Health Professional.

DEFINITIVE THERAPY

Drainage Procedures: Pyloromyotomy, Pyloroplasty, Gastrojejunostomy

Antral hypomotility, pyloric dysfunction or pylorospasm have been implicated in gastroparesis primarily of diabetic origin. It has been hypothesized that elimination of the relative gastric outlet resistance would accelerate emptying and improve symptoms of nausea and vomiting. A less invasive "medical pyloroplasty" is feasible: botulinum toxin, a potent inhibitor of cholinergic neuromuscular transmission has been used successfully to treat spastic disorders of striated and smooth muscle and has been injected locally into the pyloric sphincter. In several studies, 43% of diabetic gastroparetic patients receiving botulinum toxin experienced symptom reduction lasting approximately five months (22,23).

A surgical drainage procedure, pyloromyotomy, pyloroplasty, or gastrojejunostomy, might therefore provide permanent relief of symptoms by alleviating or bypassing the same contributory factors (Table 2). Drainage procedures alter gastric emptying primarily through maintenance of gastric continence. Both types of drainage procedures result in decreased resistance to outflow and little to no change in contractile force. Studies in normal patients have shown drainage procedures result in normal to increased emptying of both solids and liquids. Larger solid particles and indigestible food tend to empty prematurely due to reduced outflow resistance. Pyloroplasty or pyloromyotomy minimally alters emptying of solids however, while liquid emptying is only mildly accelerated (24). Figure 1 depicts the Heineke-Mikulicz classic pyloroplasty—longitudinal pyloroplasty, transverse closure.

Gastrojejunostomy, depending upon its location, may provide more profound effects due simply to the effects of gravity; the functional or mechanical gastric outlet obstruction is bypassed. More extensive drainage procedures such as those involving a Roux-Y limb may actually impede gastric emptying further due to antiperistaltic activity and enterogastric reflux from the jejunal Roux limb. The role of surgical drainage procedures in the treatment of gastroparesis has been poorly defined and studied; there are no systematic controlled studies. The benefits of surgical

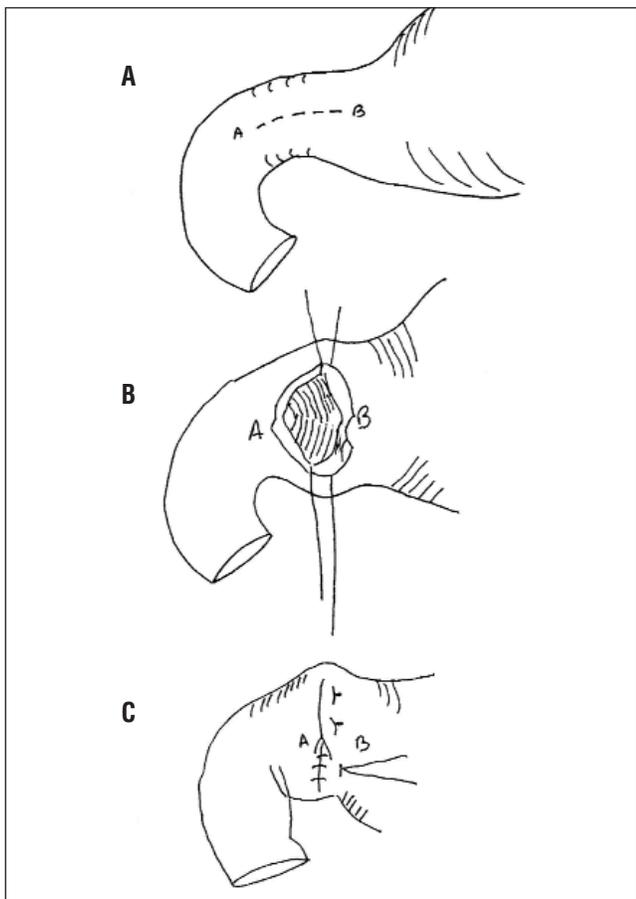


Figure 1. Pyloroplasty. Depiction of Heineke-Mikulicz classic pyloroplasty: longitudinal pyloroplasty, transverse closure.

drainage procedures for the gastroparetic patient must be mitigated against the risk of surgery and known limitations of the procedure.

Resectional Therapy for Gastroparesis

Resectional therapy for severe gastroparesis is a particularly surgical approach and entails near complete removal of the offending organ, in this case the stomach. Completion gastrectomy has been proposed and performed for all types of gastroparesis but studied in a meaningful way only in the post-surgical, post-vagotomy patient population. In the diabetic group, completion gastrectomy has been applied successfully but studied only in case report or small retrospective reviews with few patients (25,26). It has been hypoth-

esized that multiple factors cause gastric stasis in the post-surgical patient. Gastric surgical procedures may inherently result in dysmotility; from 10% to 30% of patients experience chronic gastric stasis following vagotomy or distal gastric resection (27). Gastric dysmotility may be worsened if a Roux-en-Y gastrojejunostomy was used for reconstruction of the gastric remnant. Ill-defined motor abnormalities in the Roux limb itself have been implicated as an additional source of impaired gastric emptying (28). The proposed surgical procedure for patients with refractory post-surgical gastroparesis is thus extensive subtotal or near completion gastrectomy (approximately 70%–80%) leaving a small, approximately 1cm remnant of proximal stomach coupled with reconstruction using a long (approximately 60 cm) Roux-en-Y limb to prevent enterogastric reflux.

Two studies, reviewing 81 and 62 patients respectively, have examined surgical therapy using this treatment modality. Eckhauser, et al were able to follow-up 52 of 81 patients who underwent completion gastrectomy over a 56-month period. They used questionnaires based outcome data and determined that 78% of patients' symptoms had improved since surgery but 15% (8 pts.) actually felt worse (29). It is also notable that this group of patients tended to have multiple operations; 89 surgical procedures were performed in 52 patients. Forstner-Bartbell, et al studied 62 patients who had undergone completion gastrectomy over an 11-year period. Their study group had a median of four prior operations and objective evidence of gastric stasis. Patient outcomes were rigidly determined using the Visick grading scale pre- and postoperatively (Table 2) (30). Postoperatively, nausea, vomiting, and postprandial pain were all reduced but only 43% experienced symptom relief while 57% remained as Visick grade 3 or 4 without symptomatic relief. Patients were found to have no change in chronic abdominal pain, diarrhea, and dumping. Objective measures such as nutritional status and gastric emptying were not studied and although nutritional status was reported as stabilized, 16 patients remained on TPN after the procedure (31).

Completion gastrectomy is a significant undertaking. Patients have severe underlying nutritional and medical comorbid factors and surgical intervention almost always entails reoperation with increased risk

of perioperative morbidity and mortality. Based on the small amount of existing data, this radical approach can be carried out in well-selected patients with an expectation for symptom improvement in 43% to 78% of cases. The moderate success of the procedure must be weighed against the magnitude of the intervention.

Gastric-Electrical Stimulation

A substantial group of patients, up to 40%, experience adverse side effects from prokinetic therapy or are refractory to treatment (32). In an effort to treat the underlying cause of gastroparesis, electrical stimulation of the stomach has been investigated and is now utilized with some success. Studies in dogs and subsequently in humans have shown that it is possible to utilize high-energy, low-frequency electrical stimulation that entrains and eventually paces gastric-myoelectric activity (33,34). Currently, however, gastric electric stimulation with Enterra gastric stimulator uses high-frequency, low-energy stimulation to treat gastroparesis. Gastric electrical stimulation (GES) has been shown to improve symptoms such as nausea, vomiting, and abdominal pain and modestly accelerate gastric emptying (35–37).

The gastric electric stimulator apparatus is placed surgically utilizing either open or laparoscopic technique. Two electrical stimulator leads are placed in the muscularis of the anterior greater curvature of the stomach one cm apart and 10 cm proximal to the pylorus. The pair of electrodes are connected to a neurostimulator generator positioned subcutaneously usually in the right lower quadrant abdominal wall. Intraoperatively, the electrodes are tested for acceptable electrical impedance and neurostimulator programmed to preset parameters. Intraoperative upper endoscopy is routinely performed to confirm correct placement of stimulator electrodes as acceptable electrical impedance between the two leads is essential. Controlled prospective data from several single-institution studies with smaller patient populations met with promising results. Success with this technique led to a multi-institutional prospective randomized study investigating the efficacy, symptom reduction, and quality of life for patients treated with GES. The study, entitled the Worldwide Anti-Vomiting Electrical Stim-

ulation Study (WAVESS) led to FDA approval of GES as a Humanitarian Use Device (HUD) (38). Shortcomings of the study included a small sample size (N=33) and the fact that Medtronic Inc., a manufacturer of neurostimulators, co-sponsored the study. Nevertheless, the clinical success of this study has been borne out; patients undergoing GES placement report significant improvement in symptomatology as well as reduction in abdominal pain. Gastric emptying however as measured by scintigraphic methods, was only moderately improved after GES placement. Symptom reduction occurred in approximately 60% of patients with diabetic gastroparesis but was less effective for patients with idiopathic or post-surgical etiology (39). Advantages for surgical placement of GES are that it is a procedure of significantly less magnitude and morbidity than completion gastrectomy; gastrostomy and jejunostomy tubes may be used in parallel with GES for concomitant support if needed. Adverse events relate mainly to surgical placement of GES and include subcutaneous pocket infection, erosion of leads or generator, and less often, incisional hernia. Bowel obstruction caused by the leads is certainly possible and has rarely occurred. Complications resulting in device removal have been necessary in approximately 5% of cases (40). GES has been promising in a well-selected group of patients with refractory gastroparesis and has afforded encouraging success with minimal surgical morbidity. Continued controlled investigation is warranted and on going.

CONCLUSION

Continued basic science and clinical studies have expanded the understanding of gastric motility and its disorders. Gastroparesis has been found to be associated with a variety of nonsurgical and postoperative etiologies. Patients who suffer with this complex disorder may require surgical intervention at some time during the course of their disease. The variety of possible surgical interventions for gastroparesis spans the entire continuum of magnitude and risk. This review has provided an overview of current surgical treatment modalities for gastroparesis. Since the role of surgery and its optimal use remain poorly defined, the gastroenterologist and GI surgeon must thoughtfully

weigh the risks and limitations of surgery against its potential benefits. ■

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