This review of the pathophysiologic basis for gastroparesis and recent advances in the treatment of patients with gastroparesis shows that there are several novel approaches to advance treatment of gastroparesis including diet, novel prokinetics, interventions on the pylorus, and novel forms of gastric electrical stimulation. The field of gastroparesis is likely to advance with further studies, with help from a guidance document from the Food and Drug Administration on gastroparesis, and with recent approval of the stable isotope gastric emptying test to ensure eligibility of participants in multicenter trials. Clinical experience and a formal, randomized, controlled trial provide insights on optimizing dietary interventions in patients with gastroparesis. This review addresses the biologic rationale of these different treatments, based on known physiology and pathophysiology of gastric emptying. The novel medications include the motilin agonist, camicinal; 5-HT₄ receptor agonists, such as velusetrag; and the ghrelin agonist, relamorelin. New approaches target pylorospasm by stent placement, endoscopic pyloric myotomy, or laparoscopic pyloroplasty. These approaches offer the opportunity to achieve more permanent reduction of resistance to flow at the pylorus over the intrapyloric injection of botulinum toxin, which typically has to be repeated every few months if it is efficacious. A novel device, deployed in porcine stomach, involved perendoscopic electrical stimulation. These promising approaches require formal, randomized, controlled trials and deployment in patients. The presence of concomitant antral hypomotility may be a significant factor in the responsiveness to interventions at the pylorus.

**Keywords:** Gastric Emptying; Motility; Pylorus; Myotomy; Stent; Prokinetics; Diet.

### Physiologic Basis for Emptying of Food from the Stomach

#### Gastric Emptying of Solids and Liquids

Different meals are emptied at different rates, based on the physical consistency, fat content, and total caloric load. This is well illustrated by the emptying profiles of different meals in Figure 1. In general, liquids of low caloric density empty under the pressure gradient between fundic tone and pylorus and little motor action of the distal stomach, and liquids empty exponentially from the stomach. Higher caloric liquids or homogenized solids empty almost linearly under the pressure gradient from the fundus and coordinated antpyloroduodenal motility. Digestible food of more solid consistency requires antral trituration until the particle size is reduced to $<2$ mm; after trituration occurs, food empties linearly from the stomach at a rate similar to that of a homogenized solid meal. Trituration involves establishing liquid shearing forces where solids and liquids are repeatedly propelled against a closed pylorus at the maximum frequency of 3 times per minute in humans. Until particles are reduced by these forces to $<2$ mm, there is a lag before emptying can start. Thus, gastric emptying occurs in 2 periods: the lag period and the post-lag, linear emptying period.

Nondigestible solids are usually emptied from the stomach with the interdigestive migrating motor complex (MMC). Because about one-third of MMCs, even in healthy humans, may not be associated with an antral component and because there is a wide range in the number of MMCs per day, it is possible for nondigestible solids to remain in the stomach for several hours, even in healthy stomachs. The clinical relevance of this physiological principle is that the finding of residual nondigestible food in the stomach at endoscopy after overnight fasting is not necessarily pathologic.

#### Definition of Gastroparesis

Gastroparesis is a syndrome of significantly delayed gastric emptying in the absence of mechanical obstruction and cardinal symptoms that include early satiety, postprandial fullness, nausea, vomiting, bloating, and upper abdominal pain. Diabetes, postsurgical, idiopathic or postviral gastroparesis are the most common associated conditions; more rarely, gastroparesis is associated with other conditions, such as extrinsic neurologic disorders including parkinsonism, paraneoplastic disease, and scleroderma.
Motor Mechanisms Deranged in Gastroparesis

In gastroparesis, there is an abnormal function of smooth muscle, enteric and extrinsic autonomic nerves, or the interstitial cells of Cajal (pacemakers in the stomach wall). However, the pathophysiological disturbances in these conditions resulting from diverse pathologic mechanisms seem to be uniform. \(^{10}\)

Myopathic disorders are typically infiltrative diseases, such as scleroderma or amyloidosis; degenerative disorders, such as hollow visceral myopathy; or mitochondrial cytopathy. When these disorders cause gastroparesis, they invariably present as a more generalized motility disorder affecting other regions, such as the small bowel, esophagus, and lower esophageal sphincter. \(^{11}\)

Gastric emptying delay in gastroparesis is associated with distal antral hypomotility, pylorospasm, or intestinal dysmotility. \(^{12,13}\) Measurement of gastric emptying does not differentiate neuropathic from myopathic disorders; \(^{11}\) the distinction requires appraisal for systemic, serologic, or biopsy manifestations of the underlying diseases (eg, features of scleroderma or mitochondrial cytopathy, serum and urine protein electrophoresis, fat or duodenal biopsy for amyloidosis) or, rarely, documentation of low-amplitude esophageal (typically <30 mm Hg), \(^ {14}\) lower esophageal resting pressure (typically <20 mm Hg), \(^ {15,16}\) antral (typically <40 mm Hg), or duodenal (typically <10 mm Hg) contraction amplitude by manometry. \(^ {11,17,18}\)

In general, antral hypomotility is usually present when there is pylorospasm (Figure 2). \(^ {19}\) This phenomenon is also observed under experimental conditions, such as when saline is replaced by hypertonic glucose in the liquid phase of the meal, or by the addition of high concentration of lipid by intraduodenal infusion. \(^ {20,21}\)

![Figure 1. Patterns of gastric emptying of liquids and solids in health and in gastroparesis. Gastric emptying curves for liquids and solids were derived from the published literature. Low-fat solid meal is a 2% fat, 255-kcal meal; high-fat meal is 32% fat, 296-kcal meal. Figure reproduced with permission from Camilleri and Shin.\(^ 2\)](figure1)

![Figure 2. Antroduodenal motility tracings in the postprandial period with sensors 1 cm apart. Note in the upper example the consistent phasic and tonic contractions at the pylorus with intermittent loss of distal antral contractions 1 and 2 cm proximal to the pylorus. In contrast, note the consistent antropyloric coordination in the normal example in the lower tracings.](figure2)
Decreased postprandial antral motility index prolongs the gastric emptying time for solids by prolonging the lag duration and lowering the rate of post-lag emptying; intestinal dysmotility retards the gastric emptying rate, typically without prolonging lag phase of gastric emptying (Table 1). Finding residual food in the stomach at the time of endoscopy after a period of fasting may occur in patients with gastroparesis.

Novel Diagnostics Approved for Gastroparesis

Gastric emptying by scintigraphy is still widely used. Measurement gastric emptying of low (2%) fat EggBeaters (chicken egg white) meal is regarded as the gold standard because of standardized procedures, methods, and well-established normal value. An alternative scintigraphic approach that is well validated with normal data from >300 healthy control subjects and reported performance characteristics uses a 30% fat, 320-kcal meal.22 Significant delay is documented by at least 10% retention at 4 hours with the EggBeaters meal, and >25% retention at 4 hours with the 320-kcal, 30% fat meal. Although these are well validated, they have distinct drawbacks: radiation exposure and they require specialized equipment, which is not available at the point of care. Recently, the Food and Drug Administration (FDA) approved the wireless motility capsule, which detects gastric emptying time at the point of care by identifying the sudden change in pH from entry into the duodenum and a stable isotope test to evaluate gastric emptying noninvasively without radiation hazard. Isotope is incorporated into a solid meal by growing the blue-green algae, Spirulina platensis, in 13CO2-enriched chambers. After being emptied from the stomach, the S. platensis is digested and absorbed in the proximal small intestine, metabolized by the liver, and excreted by the lungs, resulting in a rise in expired 13CO2 over baseline. This test assumes that the rate-limiting step in 13CO2 excretion is gastric emptying of the labeled test meal, and may be inaccurate in conditions associated with significant malabsorption, liver, or lung diseases. The test was evaluated with simultaneous scintigraphy in 38 healthy volunteers and 129 patients with suspicion of delayed gastric emptying. At 80% specificity, there was 89% sensitivity to correctly predict the gastric emptying category using breath test metrics compared with simultaneous scintigraphy. In addition, the gastric emptying breath test results agreed with scintigraphy 73%–97% of the time, when measured at various time points during the test.

Advances in Dietary Recommendations

Based on observations in their vast clinical experience, Parkman and colleagues have reported the foods that provoke symptoms and those that were tolerated by patients with gastroparesis. A study of 45 patients identified that foods provoking symptoms, such as orange juice, fried chicken, cabbage, oranges, sausage, pizza, peppers, onions, tomato juice, lettuce, coffee, salsa, broccoli, bacon, and roast beef, were generally fatty, acidic, spicy, and roughage-based. A high-fat solid meal significantly increased overall symptoms among individuals with gastroparesis. However, saltine crackers, Jell-O, and graham crackers moderately improved symptoms, and 12 additional foods were tolerated without provoking symptoms. These were ginger ale, gluten-free foods, tea, sweet potatoes, pretzels, white fish, clear soup, salmon, potatoes, white rice, popsicles, and applesauce.

Over the past 3 decades, patients have received dietary advice based on physiological principles rather than evidence. However, a randomized, controlled trial has demonstrated that a small particle size diet reduces upper gastrointestinal symptoms (nausea, vomiting, bloating, postprandial fullness, regurgitation, and heartburn) in patients with diabetic gastroparesis. Parkman and colleagues have reported the foods that provoke symptoms and those that were tolerated by patients with gastroparesis. A study of 45 patients identified that foods provoking symptoms, such as orange juice, fried chicken, cabbage, oranges, sausage, pizza, peppers, onions, tomato juice, lettuce, coffee, salsa, broccoli, bacon, and roast beef, were generally fatty, acidic, spicy, and roughage-based. A high-fat solid meal significantly increased overall symptoms among individuals with gastroparesis. However, saltine crackers, Jell-O, and graham crackers moderately improved symptoms, and 12 additional foods were tolerated without provoking symptoms. These were ginger ale, gluten-free foods, tea, sweet potatoes, pretzels, white fish, clear soup, salmon, potatoes, white rice, popsicles, and applesauce.

Current Medications and Novel Insights on Their Use

Currently approved drugs for treatment of gastroparesis target dopamine D2 receptors; metoclopramide (a D2-receptor antagonist with some 5-HT4 receptor agonism) is the only FDA-approved medication for the treatment of gastroparesis, and the recommendation is that treatment should be for no longer than 12 weeks. Domperidone is also a dopamine D2 receptor antagonist that can be prescribed through the FDA’s expanded

### Table 1. Relationship Between 2-Hour Postcibal Antral Motility Index and Gastric Emptying of Digestible Solids or Nutrient Liquids Relative to Healthy Control Subjects in Disease Groups (Which Excluded Myopathic Disorders) Based on Manometric Evaluation

<table>
<thead>
<tr>
<th>Neuropathic motility disorder</th>
<th>Duration of lag phase</th>
<th>Post-lag GE slope</th>
<th>GE solids</th>
<th>GE liquids</th>
</tr>
</thead>
<tbody>
<tr>
<td>AH Chronic intestinal dysmotility</td>
<td>Prolonged (and similar to AH)</td>
<td>Slower</td>
<td>Delayed</td>
<td>Delayed (and similar to AH)</td>
</tr>
</tbody>
</table>

NOTE. Data derived from Camilleri et al.13

AH, antral hypomotility; GE, gastric emptying.
access to investigational drugs. Metoclopramide received a black box warning from FDA because of the risk of tardive dyskinesia, although the actual prevalence of involuntary movements and especially tardive dyskinesia was probably overestimated, as discussed in detail elsewhere. A novel preparation of metoclopramide is in the form of nasal spray, which reduced symptoms of gastroparesis in women, but not in men, in a multicenter, double-blind study of 285 subjects (71% female) with type 1 or type 2 diabetes and a previous diagnosis of gastroparesis with diabetes.

Domperidone is associated with risk of sudden cardiac death based on evidence from case-control studies, particularly at higher systemic concentrations of the drug and especially in patients with a higher baseline risk of QT prolongation, and has restricted use in Europe.

Macrolide antibiotics are agonists at motilin receptors. Although not approved for gastroparesis, erythromycin and azithromycin are often used in practice, based on efficacy in the short term and similar efficacy in ameliorating gastric emptying. They improve gastric emptying, but are associated with tachyphylaxis caused by down-regulation of the motilin receptor, which typically starts after 2 weeks of the onset of therapy. Clarithromycin reduced symptoms in patients with Helicobacter pylori nonulcer dyspepsia and enhanced upper gastrointestinal motility, but it did not accelerate gastric emptying.

Coadministration of antiemetics and prokinetics may result in drug interactions because of induction or inhibition of cytochrome P-450 enzymes involved in drug metabolism, potentially causing high blood levels and drug toxicity. Erythromycin is extensively metabolized by cytochrome P-450 CYP3A. Many commonly used medications inhibit the effects of CYP3A (reviewed elsewhere) and may increase plasma erythromycin concentrations, increasing the risk of ventricular arrhythmias and sudden death.

A large National Institutes of Health–funded gastroparesis consortium trial attempted to relieve symptoms of gastroparesis by altering visceral sensitivity with nortriptyline, but proved to be not efficacious. In summary, there continues to be a significant unmet need for patients with gastroparesis, requiring prescribers of current medications to balance attempts to relieve patients’ symptoms with the potential for litigation, in view of the FDA black box warning on risk of tardive dyskinesia and the admonition to prescribe the only approved drug for gastroparesis for only 3 months, despite evidence the disease may persist over 25 years.

**New Medications**

**Novel Motilin Agonist**

Tachyphylaxis and the propensity for drug interactions point toward a need for a more selective motilin receptor agonist. A novel pharmacologic approach has significant promise, based on the theoretical ability to induce the motilin receptors to preferentially (biased agonism) activate the β-arrestin pathway, enhancing the ability to more quickly recover from desensitization of the receptor. GS962040 (or camical) is such a small molecule, selective motilin receptor agonist. It was shown to induce phasic contractions and increase gastrointestinal motility in conscious dogs, preferentially mediating cholinergic activity in the antrum relative to the fundus and the small intestine. Results from a phase II, 4-week clinical study in type 1 and type 2 diabetic gastroparesis are eagerly awaited (ClinicalTrials.gov NCT01262898).

**Ghrelin Agonist**

Relamorelin (RM-131) is a pentapeptide ghrelin receptor agonist that reversed postsurgical gastric ileus or delayed gastric emptying in rats and in healthy primates. Prokinetic efficacy in models of gastrointestinal disorders in rats showed relamorelin to be 600- to 1800-fold more potent compared with other ghrelin mimetics in increasing gastric emptying.

Relamorelin accelerated gastric half-emptying time of solids in patients with type 2 or type 1 diabetes who had prior documentation of delayed gastric emptying. In a phase II study of 4 weeks’ duration in patients with type 1 diabetes, relamorelin also accelerated gastric emptying and reduced upper gastrointestinal symptoms in patients with high baseline vomiting.

**New 5-HT4 Receptor Agonists**

In the past, the lack of selectivity of 5-HT4 receptor agonists, such as cisapride, which was widely used for upper gastrointestinal indications, was associated with rare cardiac dysrhythmias caused by effects on ion channels (delayed rectifier potassium channel) in cardiac muscle. New prokinetic agents currently under investigation have greater selectivity and specificity for 5-HT4 receptors in the gastrointestinal tract than for the rectifier potassium channel and have less intrinsic activity on cardiac muscle. In a preliminary study, Carbone et al have demonstrated efficacy of prucalopride in gastroparesis.

Velusetrag is a selective 5-HT4 receptor agonist. In the past, velusetrag (15, 30, or 50 mg daily) administered to patients with chronic idiopathic constipation for 4 weeks was well tolerated, and accelerated gastric emptying after 4–9 days of treatment; it is now undergoing clinical trials in patients with gastroparesis (ClinicalTrials.gov Identifier: NCT02267525). YKP10811 is a novel benzamide derivative, selective 5-HT4 receptor agonist. In patients with functional constipation, 10- and 20-mg doses accelerated gastric emptying, on per-protocol analysis, and orocecal transit. No significant adverse events were reported.
Pyloric Interventions

The rationale for interventions on the pylorus is based on the observation of pylorospasm in patients with gastroparesis or experimental conditions associated with delayed gastric emptying, such as the intraduodenal injection of lipid. There is reduced expression of neuronal nitric oxide synthase in pylorus of nonobese diabetic mice when they develop diabetes; the reduced expression is reversed by insulin treatment. In this model, the gastric emptying delay in both nonobese diabetic and streptozotocin diabetic mice was reversed with the phosphodiesterase 5 inhibitor, sildenafil (which increases intracellular cyclic guanosine monophosphate and mimics the effect of nitric oxide). Unfortunately, sildenafil had no significant effect on gastric emptying in gastroparesis associated with uremia.

Intrapyloric Injection of Botulinum Toxin

There is good experimental rationale for considering intrapyloric injection of botulinum toxin as treatment for pylorospasm. Thus, botulinum toxin directly inhibits smooth muscle contractility, as evidenced by a decreased contractile response to acetylcholine. Based on the results of the randomized, controlled trials comparing botulinum toxin with sham/placebo injection, a guideline on gastroparesis did not recommended intrapyloric injection of botulinum toxin for patients with gastroparesis. However, small observational studies suggested that intrapyloric botulinum toxin can improve gastric emptying and symptoms, and a retrospective, single-center, open-label study of 179 patients reported decreased symptoms of gastroparesis 1–4 months after intrapyloric botulinum toxin in 51.4% of patients, with greater benefit observed with a 200-unit compared with a 100-unit dose, female gender, age <50 years, and idiopathic gastroparesis; moreover, a clinical response to a second injection was observed in 73.4% of evaluable patients. This experience has led to testing other interventions on the pylorus to try to treat gastroparesis.

Endoscopic Placement of a Transpyloric Stent

The endoscopic placement of a through-the-scope, double-layered, fully covered Niti-S self-expandable metal transpyloric stent, which is anchored by suturing on the gastric side, has been tested in small, open-label studies, typically in patients with refractory gastroparesis. A guidewire is advanced into the distal duodenum, and the self-expandable metal stent delivery system is placed over the guidewire. The stent is deployed under endoscopic visualization, such that the proximal flared end is in the antrum and the distal flared end in the duodenum proximal to the duodenal papilla. Technical success was achieved during 98% of procedures. Best results (with no stent migration) during mean follow-up of 146 days were obtained when the stent was anchored with endoscopic suturing, although even that group had 52% stent migration.

Although data are incomplete, there were improvements in gastric emptying and clinical outcomes in 75% of patients with adequate follow-up, with greater efficacy in those with predominant nausea and/or vomiting (79% response) rather than those with predominant pain (21% response).

Laparoscopic Pyloroplasty

Prior literature had documented that pyloroplasty may relieve symptoms in gastroparesis and is often combined with operative jejunal tube placement to support nutrition. Recently, laparoscopic pyloroplasty was evaluated in a retrospective study of 46 patients: gastric emptying normalized in 60%, and the Gastroparesis Cardinal Symptom Index showed statistically significant reduction in symptom severity for all 9 categories, and total symptom score.

Gastric Per-Oral Endoscopic Myotomy

Individual case reports of endoscopic pyloromyotomy (gastric per-oral endoscopic myotomy) have been reported from the United States and Europe, and the experience has been extended to include patients with gastroparesis secondary to vagal injury. In 7 patients with idiopathic (n = 5) or postsurgical (n = 2) gastroparesis, gastric per-oral endoscopic myotomy was performed under laparoscopic guidance, because the patients also required concurrent laparoscopic cholecystectomy or fundoplication. Within 30 days of the procedure, 1 patient had bleeding from a 1-cm pyloric channel ulcer with an exposed vessel that was clipped; and within 60 days, 1 patient had mild pancreatitis thought to be unrelated. At average patient follow-up of 6.5 months (range, 2–11 months), 6 of 7 patients reported improvement of nausea and epigastric burning, but not of vomiting, early satiety, postprandial fullness, or pain. The seventh patient went on to laparoscopic pyloroplasty. In the 5 of 7 patients with follow-up gastric emptying data, the mean t1/2 gastric emptying of solids decreased from 124 minutes to 58 minutes (P = .018).

Appraisal of Pyloric Interventions, Novel Medications, Devices, and Surgical Approaches

Randomized sham- or placebo-controlled trials are required to establish the role of these approaches in patients with gastroparesis. Their success may be influenced by concomitant antral hypomotility. Addition of an effective and safe prokinetic that stimulates antral motor function may be beneficial.
**Gastric Electrical Stimulation**

In the United States, the gastric electrical neuro-stimulator (Enterra Therapy System, Medtronic, Inc, Minneapolis, MN) has been approved as a humanitarian exemption device for diabetic and idiopathic gastroparesis, typically in those with persistence of symptoms despite antiemetic and prokinetic drug therapy for at least 1 year. A guideline on gastroparesis recommended that gastric electrical stimulation may be considered for compassionate treatment in patients with refractory symptoms, particularly nausea and vomiting. Symptom severity and gastric emptying have been shown to improve in patients with diabetic gastroparesis, but not in patients with idiopathic or postsurgical gastroparesis (conditional recommendation, moderate level of evidence). The National Institute of Health and Care Excellence issued guidelines in 2014 stating that current evidence is adequate to support the use of gastric electrical stimulation (conditional recommendation, moderate level of evidence).

Since that recommendation, effectiveness in clinical practice was reported in 151 patients from a single center; at mean 1.4 years of follow-up, 43% reported at least moderately improved symptoms. Recently, efforts have focused on endoscopic deployment of the gastric stimulator.

**Endoscopic Gastric Stimulator Implantation**

Temporary gastric stimulators placed endoscopically have been used to determine response to gastric electrical stimulation before permanent implantation through a surgical approach; however, there was no permanent endoscopic approach possible until recently. Deb et al developed a novel, wirelessly powered miniature gastric electrical stimulation device implanted into the pig stomach through an overtube and attached to the gastric mucosa with endoclips. Electrogastrogram recordings have demonstrated more consistent gastric slow wave amplitudes compared with no stimulation. The method still needs to be deployed and validated in humans.

**Food and Drug Administration Draft Guidance for Clinical Evaluation of Drugs for Treatment of Gastroparesis**

The FDA has issued recommendations regarding trial design, trial populations, outcome assessment measures, and trial end points for gastroparesis. The following summarizes the draft guidance, which is currently open for comments:

1. **Trial design** generally should consist of a randomized, double-blind, placebo-controlled trial and should include a 1- to 2-week screening period.

2. **Treatment period** of at least 12 weeks’ duration, followed by a 2- to 4-week randomized withdrawal period, to address the need for maintenance treatment to prevent sign or symptom recurrence.

3. **Daily diaries** should be collected throughout the entire study. In addition, a placebo-controlled, long-term safety study of 12 months’ duration, with appropriate prespecified provisions for rescue medications, should be performed.

4. Patients with idiopathic and diabetic gastroparesis should be studied in separate trials; Patients with diabetic gastroparesis should have controlled and stable blood glucose levels, and patients on opioids should be excluded.

5. Outcome should be assessed with patient response outcomes for 5 core signs and symptoms of gastroparesis: nausea, vomiting, early satiety, abdominal pain, and postprandial fullness. Further validation in well-controlled clinical trials was recommended.

6. Patient response outcomes measure of signs and symptoms of gastroparesis should form the basis of the primary efficacy assessment in therapeutic trials for diabetic and idiopathic gastroparesis, with primary end point measuring change in signs and symptoms from baseline.

7. Definition of clinically meaningful changes in sign and symptom scores using a global measure: “How would you rate your overall severity of gastroparesis signs and symptoms over the past 30 days?” Responses would range from 0 = no signs and symptoms; 1 = mild; 2 = moderate; 3 = severe; and 4 = very severe.

It is important to note that Revicki et al have extensively validated a daily diary for measurement of gastroparesis signs and symptoms as recommended by the FDA.

**Conclusion**

There are several novel approaches to advance treatment of gastroparesis. The field is likely to advance with the helpful guidance document from the FDA on gastroparesis, the recent approval of stable isotope gastric emptying test to ensure eligibility of participants in multicenter trials, and the validation of patient response outcomes for trials in gastroparesis based on daily diaries.

**References**


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1. Erythromycin and azithromycin
   a. improve gastric emptying by increasing fundus to pylorus pressure gradient
   b. are motilin receptor agonists
   c. exhibit tachyphylaxis due to down-regulation of motilin receptor
   d. regulate antral pressure activity

2. Foods recommended for patients with gastroparesis include
   a. gluten-free foods
   b. lettuce, onions and peppers
   c. graham crackers, salmon and pizza
   d. white fish, potatoes, white rice, applesauce

True or False

3. Nondigestible solids are emptied from the stomach by forceful antral contractions soon after the meal ends
4. Nortriptyline is effective in decreasing the symptoms associated with gastroparesis
5. Relamorelin, a ghrelin receptor agonist, accelerates gastric emptying and reduced UGI symptoms in diabetics with gastroparesis
6. The antral contractions are the primary determinant of low caloric liquid emptying from the stomach
7. Nondigestible solids found in the stomach after an overnight fast indicates the presence of gastroparesis
8. Once solids reach the antrum, emptying starts immediately
9. Botulinum toxin injection of the pylorus may be effective when using higher dose in females with idiopathic gastroparesis
10. Gastric emptying studies cannot differentiate myopathic from neuropathic causes of gastroparesis