Techniques and devices for the endoscopic treatment of gastroparesis (with video)

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Background and Aims: Gastroparesis is a symptomatic chronic disorder of the stomach characterized by delayed gastric emptying in the absence of mechanical obstruction. Several endoscopic treatment modalities have been described that aim to improve gastric emptying and/or symptoms associated with gastroparesis refractory to dietary and pharmacologic management.

Methods: In this report we review devices and techniques for endoscopic treatment of gastroparesis, the evidence regarding their efficacy and safety, and the financial considerations for their use.

Results: Endoscopic modalities for treatment of gastroparesis can be broadly categorized into pyloric, nonpyloric, and nutritional therapies. Pyloric therapies such as botulinum toxin injection, stent placement, pyloroplasty, and pyloromyotomy specifically focus on pylorospasm as a therapeutic target. These interventions aim to reduce the pressure gradient across the pyloric sphincter, with a resultant improvement in gastric emptying. Nonpyloric therapies, such as venting gastrostomy and gastric electrical stimulation, are intended to improve symptoms. Nutritional therapies, such as feeding tube placement, aim to provide nutritional support.

Conclusions: Several endoscopic interventions have shown utility in improving the quality of life and symptoms of select patients with refractory gastroparesis. Methods to identify which patients are best suited for a specific treatment are not well established. Endoscopic pyloromyotomy is a relatively recent development that may prove to be the preferred pyloric-directed intervention, although additional and longer-term outcomes are needed. (Gastrointest Endosc 2020;92:483-91.)

This video can be viewed directly from the GIE website or by using the QR code and your mobile device. Download a free QR code scanner by searching “QR Scanner” in your mobile device’s app store.
such as “endoscopy” or “endoscopic” combined with “gastroparesis” and “stomach motility,” among others. Technology Status Evaluation Reports are scientific reviews provided solely for educational and informational purposes. Technology Status Evaluation Reports are not rules and should not be construed as establishing a legal standard of care or as encouraging, advocating, requiring, or discouraging any particular treatment or payment for such treatment.

Gastroparesis is a symptomatic chronic disorder of the stomach characterized by delayed gastric emptying in the absence of mechanical obstruction. A population-based study of Olmsted County, Minnesota suggested an estimated prevalence of 9.6 and 37.8 per 100,000 in men and women, respectively. Although multiple conditions have been associated with gastroparesis, the most common causes are idiopathic, diabetic, and postsurgical. Patients with gastroparesis may report a combination of symptoms including nausea, vomiting, early satiety, belching, bloating, or upper abdominal discomfort.

Management of symptomatic gastroparesis is challenging for both patients and clinicians. A thoughtful approach is required that ensures a proper diagnosis, considers the etiology and associated medical conditions, and uses a comprehensive treatment strategy, including dietary and pharmacologic interventions. Several endoscopic treatment modalities have been described that aim to improve gastric emptying and/or symptoms associated with gastroparesis in patients refractory to medical management. These endoscopic techniques and related devices are reviewed in this technology report.

MECHANISM OF ACTION

Current understanding of the underlying pathophysiologic mechanisms for gastroparesis is incomplete and continues to evolve. However, it is generally acknowledged that a diverse set of etiologies leads to a common clinical presentation. Loss of interstitial cells of Cajal, neuropathy, and myopathy are believed to play a central role in the pathophysiology of gastroparesis. These structural abnormalities may be associated with varied states of compromised function, including impaired gastric accommodation, antral hypomotility, pylorospasm, duodenal dysmotility, autonomic dysfunction, and/or visceral hypersensitivity.

Endoscopic treatment modalities for gastroparesis can be broadly categorized into pyloric, nonpyloric, and nutritional therapies. Pyloric therapies such as botulinum toxin injection, stent placement, pyloroplasty, and pyloromyotomy specifically focus on pylorospasm as a therapeutic target. These interventions aim to reduce the pressure gradient across the pyloric sphincter, with a resultant improvement in gastric emptying. Nonpyloric therapies such as venting gastrostomy and gastric electrical stimulation (GES) are intended to improve symptoms. Nutritional therapies, such as feeding tube placement, aim to provide nutritional support.

PYLORIC THERAPIES

Identification of patients who are best suited for pyloric therapies is difficult. Manometry of the pylorus is invasive, requires expertise for performance and interpretation, and lacks standardized control data. Impedance planimetry with the use of an endoscopic functional luminal imaging probe (EndoFLIP; Crospion Inc, Galway, Ireland) is a technology that has been used to measure tissue distensibility. Its utility in detection of patients with pylorospasm remains poorly studied. Currently there is no consensus to standardize patient selection for various forms of pyloric therapy.

Intrapyloric botulinum toxin injection

Botulinum toxin A (BTA) is a protein produced by the bacterium Clostridium botulinum. When injected into striated or smooth muscle, the toxin blocks neuromuscular conduction, leading to temporary paralysis of the affected muscle. This effect has been exploited clinically to treat various disorders including gastroparesis. In the United States BTA is available in powder form in 50- or 100-U vials. The powder is usually diluted in 5 mL normal saline solution, yielding a solution containing 10 or 20 U/mL. Before intrapyloric botulinum toxin injection, a diagnostic upper endoscopy is performed to exclude structural abnormalities that could cause delayed gastric emptying. Aliquots of 1 to 2 mL BTA solution (10-40 U) are injected into each of the 4 quadrants of the pylorus using a 23- or 25-gauge injection needle. Total doses of 80 to 200 U have been reported. Patients are discharged home after routine postsedation criteria are met and can eat a light meal later on the same day.

Initial open-label studies of intrapyloric BTA injections in patients with gastroparesis reported symptomatic improvement in 90% to 100% of patients lasting several months. However, 2 randomized controlled trials (RCTs) with 23 and 32 patients, respectively, did not find any differences in symptoms or gastric emptying time after intrapyloric injections of BTA compared with placebo. Weaknesses of these RCTs include the small size and heterogeneity of the patient populations. A 2013 clinical guideline from the American College of Gastroenterology did not recommend intrapyloric BTA injection as a treatment for gastroparesis. However, some nonrandomized, open-label studies have suggested a role for intrapyloric BTA injection in selected patient groups with gastroparesis.
Transpyloric stent placement

Covered self-expandable metallic stents placed across the pylorus have been used for treatment of refractory gastroparesis. The stents used in published reports are marketed for use in the esophagus. During upper endoscopy a long guidewire is advanced distal to the second portion of the duodenum under endoscopic and/ or fluoroscopic guidance. Reports have described the use of both standard and through-the-scope esophageal stent delivery systems. Stent deployment is performed under endoscopic visualization, with or without fluoroscopy, such that the proximal flared end is in the antrum and the distal flared end is in the duodenum proximal to the ampulla. Anchoring of the stent to the wall of the antrum to potentially decrease the rate of migration has been reported using through-the-scope or over-the-scope clips or endoscopic suturing.

Transpyloric placement of a covered self-expandable metallic stent was initially reported in a case series of 3 patients with refractory gastroparesis. All patients had improvement in gastric emptying parameters and significant symptomatic benefit during a mean follow-up time of 4.5 months. A subsequent retrospective analysis from the same institution described 30 patients with refractory gastroparesis (16 idiopathic, 8 diabetic, 6 postsurgical) who were treated with transpyloric stent placement. The authors reported symptomatic improvement in 75% of the patients during a mean follow-up of 5 months. However, stent migration was very frequent, occurring in 59% of all patients and in 48% of patients whose stents were anchored to the stomach wall with endoscopic suturing. Given the high frequency of stent migration, the optimal stent dwell time and whether benefits persist after stent migration or removal are unknown.

Pyloric balloon dilation

Pyloric dilation using a 20-mm through-the-scope balloon under endoscopic visualization has been described as a treatment for gastroparesis in a single prospective series of 10 refractory gastroparesis patients with low fasting pyloric compliance as measured with impedance planimetry. In this trial, the transpyloric balloon was inflated to 20 mm for a duration of 1 minute, with 2 subsequent balloon inflations in the same endoscopic session for a total of 3 dilations. The dilations resulted in an increase in pyloric compliance when measured 10 days later and improvement in symptoms and quality of life.

Peroral pyloromyotomy

Peroral pyloromyotomy (POP), also known as gastric peroral endoscopic myotomy (POEM), uses a technique similar to esophageal POEM with minor modifications for use in the gastric antrum. The distal end of a gastroscope is fitted with a transparent cap to facilitate submucosal access and tunnel creation. A routine diagnostic upper endoscopy using carbon dioxide insufflation is performed, and any fluid and debris in the stomach is suctioned. Subsequently, the antral mucosa is injected with a lifting agent at a site 3 to 7 cm proximal to the pylorus, typically along the lesser or greater curve. When an endoscopic submucosal dissection knife is used, a 1.5- to 4-cm transverse or longitudinal incision is made into the lifted mucosa. Once the mucosal incision is complete, the cap-fitted endoscope is advanced into the submucosal space.

Submucosal tunneling is performed using repeated injections and dissection using an endoscopic submucosal dissection knife. The tunnel is extended just beyond the pyloric muscle. Once exposed, the inner circular fibers of the pyloric muscle are divided, and subsequently the myotomy is extended a short distance (1-2 cm) proximally into the gastric antrum. After the myotomy is completed and hemostasis is ensured, the endoscope is removed from the submucosal tunnel and the mucosotomy site is closed with endoscopic clips or suturing. A demonstration of POP technique is shown in Video 1 (available online at www.giejournal.org). Devices used for POP are similar to those used for esophageal POEM and have been described in detail in an American Society for Gastrointestinal Endoscopy technology report.

After POP, most reports describe hospital admission for overnight observation. Patients are typically maintained nil per os until a water-soluble contrast upper GI series is obtained and excludes a leak. A clear liquid diet is then initiated and advanced toward a low residue diet as tolerated by the patient. Proton pump inhibitor therapy is frequently used to assist in healing of the mucosotomy. Some centers have used intraprocedural and postprocedural (eg, 3-5 days) broad-spectrum antibiotics.

A single-center prospective study evaluated 100 consecutive patients with refractory gastroparesis of various etiologies (56 idiopathic, 21 diabetic, 19 postsurgical, and 4 other) who were treated with POP. Most patients (67%) had undergone prior endoscopic or surgical interventions for gastroparesis. The mean Gastroparesis Cardinal Symptom Index at 90 days postprocedure was 2.4 ± 1.2, as compared with a mean Gastroparesis Cardinal Symptom Index of 3.8 ± 0.9 before POP (absolute difference, 1.4; P < .001). In 53 patients who underwent both a pre-POP and 90-days post-POP 4-hour solid-phase gastric emptying study, the mean percentage of retention at 4 hours improved from 39.9% to 16.3% (P < .001). In another prospective study, 20 patients with refractory gastroparesis (10 diabetic and 10 non-diabetic) underwent POP. Compared with baseline values, POP significantly improved symptoms, quality of life, and gastric emptying at 3 months. Other studies have reported similar results with improvement in symptoms and a reduction in the number of emergency department visits and hospitalizations among gastroparesis patients who underwent POP. Clinical studies evaluating POP that have been published to date are summarized in Table 1.

A retrospective study of 60 matched patients compared the outcomes of POP (n = 30) with laparoscopic
pyloroplasty (n = 30) for the treatment of refractory gastroparesis.32 The authors reported equal efficacy with regard to improvement in the Gastroparesis Cardinal Symptom Index score at 30 and 90 days as well as in postprocedure scintigraphic gastric emptying. Length of hospital stay, operative time, estimated blood loss, and adverse events were increased in patients undergoing laparoscopic pyloroplasty.

**NONPYLORIC THERAPIES**

**Venting PEG**

PEG tubes have been used for gastric decompression (“venting”) and symptom relief in patients with refractory gastroparesis.31 Various techniques for PEG placement have been described in detail elsewhere.33 Placement of a PEG with a concomitant jejunal extension tube allows gastric venting and jejunal feeding.

Data regarding the clinical benefits of venting PEG placement are limited to a single small series of 8 female patients with refractory idiopathic gastroparesis.4 In all patients, 20F PEG tubes were placed endoscopically using a standard pull technique. Patients were instructed to relieve symptoms by aspirating gastric contents with a 60-mL syringe as needed. Over a mean follow-up of 29 months (range, 8–41), the authors observed significant improvements in patient symptom scores as well as weight gain (mean of 4.5 kg at 1 year) and successful cessation of prokinetic agents in all patients. Venting PEG tubes were removed in 3 patients during follow-up, of whom 1 remained symptom free and 2 experienced some return of gastroparesis symptoms.

### TABLE 1. Characteristics of peroral pyloromyotomy studies

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study design</th>
<th>Country</th>
<th>No. of patients</th>
<th>Age (y)</th>
<th>Technical Success (%)</th>
<th>Procedural time (min)</th>
<th>Follow-up time (mo)</th>
<th>Clinical response (%)</th>
<th>Preprocedure GCSI score</th>
<th>Postprocedure GCSI score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shlomovitz</td>
<td>Retrospective</td>
<td>USA</td>
<td>7</td>
<td>51 ± 11.7</td>
<td>100</td>
<td>90-120</td>
<td>6.5</td>
<td>86</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Khashab 2017</td>
<td>Retrospective</td>
<td>USA</td>
<td>30</td>
<td>47 ± 13</td>
<td>100</td>
<td>72 ± 42</td>
<td>6</td>
<td>85</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Rodriguez 2017</td>
<td>Retrospective</td>
<td>USA</td>
<td>47</td>
<td>43.7 ± 14.8</td>
<td>100</td>
<td>41.2 ± 28.5</td>
<td>3</td>
<td>—</td>
<td>4.6 ± .9</td>
<td>3.3 ± 1.4</td>
</tr>
<tr>
<td>Gonzalez 2017</td>
<td>Retrospective</td>
<td>France</td>
<td>29</td>
<td>52.8 ± 17.7</td>
<td>100</td>
<td>47 ± 21.2</td>
<td>3 and 6</td>
<td>79 (3 mo)</td>
<td>69 (6 mo)</td>
<td>3.3 ± .9</td>
</tr>
<tr>
<td>Dacha 2017</td>
<td>Retrospective</td>
<td>USA</td>
<td>16</td>
<td>44.8 ± 14.8</td>
<td>100</td>
<td>49.7 ± 22.1</td>
<td>1, 6, and 12</td>
<td>81</td>
<td>3.40 ± .50</td>
<td>1.48 ± .95</td>
</tr>
<tr>
<td>Malik 2018</td>
<td>Retrospective</td>
<td>USA</td>
<td>13</td>
<td>45.7 ± 10.3</td>
<td>100</td>
<td>119 ± 23</td>
<td>3</td>
<td>72.7%</td>
<td>2.1 ± .8</td>
<td>1.9 ± 1.0</td>
</tr>
<tr>
<td>Mekaroonkamol 2019</td>
<td>Retrospective</td>
<td>USA</td>
<td>30</td>
<td>47.0 ± 15.7</td>
<td>100</td>
<td>48.3 ± 16.5</td>
<td>1, 6, 12, and 18</td>
<td>80 (1 mo)</td>
<td>71.4 (6 mo)</td>
<td>1.8 ± 1.0</td>
</tr>
<tr>
<td>Jacques 2018</td>
<td>Prospective</td>
<td>France</td>
<td>20</td>
<td>—</td>
<td>100</td>
<td>56.5 ± 13.7</td>
<td>1 and 3</td>
<td>90</td>
<td>3.5 ± 1.0</td>
<td>1.8 (1 mo)</td>
</tr>
<tr>
<td>Rodriguez 2018</td>
<td>Prospective</td>
<td>USA</td>
<td>100</td>
<td>45 ± 14.6</td>
<td>100</td>
<td>33.8 ± 21.6</td>
<td>3</td>
<td>—</td>
<td>3.8 ± .86</td>
<td>2.4 ± 1.2</td>
</tr>
<tr>
<td>Xu 2018</td>
<td>Retrospective</td>
<td>China</td>
<td>16</td>
<td>63.5 ± 15.8</td>
<td>100</td>
<td>45.25 ± 12.96</td>
<td>14.5</td>
<td>81.25</td>
<td>2.7 ± .6</td>
<td>.7 ± .1</td>
</tr>
<tr>
<td>Kahaleh 2018</td>
<td>Retrospective</td>
<td>USA</td>
<td>33</td>
<td>52 (21-85)</td>
<td>100</td>
<td>77.6 (37-255)</td>
<td>11.5</td>
<td>85</td>
<td>3.3</td>
<td>.8</td>
</tr>
<tr>
<td>Landreneau 2019</td>
<td>Retrospective</td>
<td>USA</td>
<td>30</td>
<td>44.1 ± 13.5</td>
<td>100</td>
<td>33.9 ± 18.8</td>
<td>3</td>
<td>—</td>
<td>4.0 ± .8</td>
<td>2.4 ± 1.5</td>
</tr>
</tbody>
</table>

GCSI, Gastroparesis Cardinal Symptom Index; mo, months; —, not reported.
Endoscopic GES

The mechanism of action for GES in gastroparesis remains poorly understood. An effect on gastric accommodation resulting in symptomatic benefit has been suggested. Although currently nearly all GES devices are inserted surgically, endoscopic implantation of electrodes has been reported as a proof of concept.

In a prospective study, 20 consecutive patients with refractory gastroparesis underwent endoscopic placement of temporary electrodes either through a pre-existing PEG tube (n = 14) or the esophagus (n = 6). The electrodes were connected to an external generator. Stimulation led to significant improvement in a composite symptom score with a mean time to improvement (>50% reduction in vomiting frequency) of approximately 2.5 days. In a double-blinded RCT, 58 gastroparesis patients underwent endoscopic placement of temporary gastric electrodes and were randomized to stimulation or sham with crossover after 4 days. Although overall treatment effects were not significant, differences in favor of stimulation were suggested in a per-protocol analysis. This trial was hindered by small sample size, frequent electrode dislodgement (22%), and a greater than expected placebo effect from electrode placement alone. A miniature GES with a generator placed endoscopically into the gastric submucosa has been developed but has not been studied in humans.

Temporary endoscopic feeding tubes

Enteral nutritional support may become necessary in patients with severe gastroparesis who are unable to sustain adequate oral calorie intake. Enteral nutrition is preferably delivered via postpyloric feeding, bypassing the dysfunctional stomach. Nasoduodenal or nasojejunal feeding tubes are often placed before more invasive forms of access as a trial to ensure postpyloric feeding will be tolerated. Various endoscopic techniques for placement of nasoduodenal/nasojejunal feeding tubes have been described.

In an RCT, 73 patients in an intensive care unit with poor gastro-duodenal motility as evidenced by large gastric residual volumes were randomized to receive enteral nutrition via an endoscopically placed nasojejunal tube (n = 34) or a nasogastric tube (n = 39). Enteral nutrition delivered via a nasojejunal tube was associated with a significant reduction in gastric residual volumes and improved tolerance of enteral nutrition. A clinical guideline from the American College of Gastroenterology advocates nasojejunal rather than nasogastric feeding in patients with gastroparesis.

Long-term endoscopic feeding tubes

Although used frequently for short-term feeding, nasoenteric tubes have disadvantages that limit their use for long-term management. In patients who tolerate postpyloric feeding via nasoenteric tubes, PEG with a jejunal extension tube (PEG-J) or direct percutaneous endoscopic jejunostomy (DPEJ) offers a long-term solution for postpyloric feeding. Although PEG-J tubes allow gastric venting in addition to jejunal feeding, the jejunal extension tube can migrate back into the stomach, and thus DPEJ tubes may be more reliable.

DPEJ placement technique is similar to pull-type PEG placement. An enteroscope or a pediatric colonoscope is advanced beyond the ligament of Treitz. Endoscopic transillumination and finger indentation are used to select a proper site. The 21-gauge needle used for local anesthesia is advanced through the anterior abdominal wall at the site of maximal transillumination directly into the jejunum and is captured with a snare. This stabilizes the jejunal loop for subsequent advancement of the trocar alongside the smaller needle. Once trocar access is achieved, a standard pull-type gastrostomy tube is deployed. Although similar to PEG placement, DPEJ placement is technically more challenging; a large cohort study of 307 consecutive attempts at DPEJ placement reported a technical success rate of 68%. Use of balloon-assisted enteroscopy has been suggested to yield higher DPEJ placement success rates in 2 small case series of 10 and 11 patients.

For patients with gastroparesis who are unable to maintain adequate nutrition with oral intake, placement of a feeding jejunostomy may decrease symptoms and reduce hospitalizations. No studies compare the effectiveness of DPEJ to PEG-J for nutritional treatment of gastroparesis. However, PEG-J is associated with higher rate of tube dysfunction. In a retrospective study of 105 patients, DPEJ (n = 56) was associated with significantly lower rate of endoscopic reintervention and longer feeding tube patency compared with PEG-J (n = 49). DPEJ is considered to be preferable if durable small-bowel feeding is required.

EASE OF USE AND LIMITATIONS

Pyloric therapies

Pyloric BTA injection and balloon dilation use standard endoscopic techniques and do not require additional training. Transpyloric covered self-expandable metallic stent placement requires proficiency in endoluminal stent placement and knowledge of design, deployment characteristics, and potential risks associated with various types of stents. Performance of POP requires special training and equipment. No published studies assess the learning curve for performance of POP; however, the learning curve for technical proficiency with esophageal POEM has varied from 13 to 100 cases.

Nonpyloric and nutritional therapies

Endoscopic pacing of the stomach is not widely available, and nearly all studies have been performed by a few expert investigators, typically in the setting of a
research protocol. Technically, endoscopic placement of nasoenteric feeding tubes is straightforward and may be performed with or without the use of fluoroscopy. Placement under fluoroscopic guidance allows immediate adjustment if the final position of the tube is not satisfactory and obviates the need for postprocedure radiologic confirmation of the tube position. Endoscopic placement of a PEG-J is technically easier than DPEJ and associated with higher rate of success. However, a higher rate of tube dislodgement is associated with PEG-J.

SAFETY

Pyloric therapies

BTA injection of the pylorus appears to be safe. No adverse events have been described with pyloric BTA injection, although the cumulative number of patients in the available literature is limited. In 2 small RCTs comparing intrapyloric injections of BTA with placebo, no differences occurred in adverse events between the study groups. Data on safety of transpyloric stent placement and pyloric balloon dilatation are limited because of the number and size of available studies. Transpyloric stent placement is frequently associated with stent migration despite anchoring attempts; however, stent retrieval has been routinely possible in cases of proximal stent migration into the stomach, and no adverse events or need for intervention has been reported with distal stent migration. Reported adverse events associated with POP include tension capnoperitoneum, ulcer formation, bleeding, abscess formation, and perforation. Asymptomatic capnoperitoneum is common after POP and typically requires no intervention.

Nonpyloric and nutritional therapies

In a study of 58 patients with gastroparesis who underwent endoscopic placement of orogastric temporary electrodes to facilitate GES, the only observed adverse event was electrode dislodgement, occurring in 13 patients (22%). Possible adverse events associated with PEG and DPEJ tubes are peristomal infection, leakage, bleeding, buried bumper syndrome, peritonitis, tube blockage, tube displacement, and inadvertent removal. Potential adverse events associated with nasoenteric tubes are blockage, dislodgment, sinusitis, gastroesophageal reflux, esophagitis, and esophageal stricture.

FINANCIAL CONSIDERATIONS

Endoscopic devices for the treatment of gastroparesis and their costs are summarized in Table 2. Relevant current procedural technology codes for endoscopic BTA injection include 43236 (EGD with submucosal injection of any substance) with the Healthcare Common Procedure Coding System level II code J0585 (botulinum toxin injection). Code 43266 (EGD with enteral stent placement; including pre- and postdilation and guidewire passage) is used for pyloric stent placement, and codes 43245 or 43249 are used for EGD with balloon dilation.

Currently, there is no specific current procedural technology code for POP. Most centers report using 43235 (EGD), 43236 (EGD with submucosal injection of any substance), or 43999 (unlisted procedure, stomach). Any reimbursement, however, is variable and payer dependent. When reporting unlisted or “miscellaneous” codes, supporting documentation should be included with each claim. The information should detail the nature, extent, and need for the procedure and the time, effort, and equipment necessary to provide the procedure. Additional items to include are the complexity of symptoms, final diagnosis, pertinent patient findings, diagnostic and therapeutic procedures, concurrent problems, and follow-up care. It is helpful in such a cover letter to compare the work relative value units (RVU) or total RVU for the procedure to an existing code of similar intraservice time and intensity. Payers also often find it helpful to

| Table 2. Commonly used devices for endoscopic treatment of gastroparesis |
|-----------------------------|------------------|
| **Device**                  | **Price**        |
| **Pyloric therapies**       |                  |
| Intrapyloric botulinum toxin injection |                  |
| Botulinum powder vial       | 500              |
| Injection needle            | 30-40            |
| Transpyloric stent placement |                  |
| Self-expandable metallic enteral stent | 1600-2600       |
| Pyloric balloon dilation    |                  |
| Dilating balloon            | 140-180          |
| Peroral pyloromyotomy       |                  |
| Injection needle            | 30-40            |
| Submucosal lifting agent    | 80               |
| Various endoscopic knives   | 490-770          |
| Hemostatic forceps          | 220              |
| Distal attachment           | 20               |
| Endoscopic clip             | 100-230          |
| Endoscopic suturing system  | 850              |
| Tissue helix                | 185              |
| Suture cinch                | 65               |
| Suture                      | 50               |
| **Nonpyloric therapies**    |                  |
| PEG tube kit                | 80-140           |
| **Endoscopic nutritional therapies** |          |
| Nasojejunal tube            | 90               |
| Jejunal tube                | 140              |

*Most listed devices are available from multiple manufacturers.
†Approximate cost per item in U.S. dollars.
review copies of paid invoices. For enteral feeding procedures, relevant current procedural technology codes include 43246 (EGD with PEG placement), 43752 (nasogastric or nasoduodenal tube placement) and 44372 (DPEJ) or 44373 (small-intestinal endoscopy with conversion of percutaneous gastrostomy tube to percutaneous jejunostomy tube).

**AREAS FOR FUTURE RESEARCH**

Further development and evaluation of diagnostic tools that identify pathophysiologic mechanisms in gastroparesis are needed. Studies to identify subgroups of patients that respond better to various treatment options would be useful. This would permit tailored treatment where possible. Further studies are needed to assess the durability and long-term safety of endoscopic treatments.

**SUMMARY**

Gastroparesis is a chronic, debilitating disorder, often with a poor response to dietary modifications and pharmacologic intervention. Various endoscopic interventions have shown utility in improving the quality of life and symptoms of select patients with refractory gastroparesis. The best timing and selection of endoscopic interventions in the overall care plan for these patients is not well established. POP is a relatively recent development that may prove to be the preferred pyloric-directed intervention, although additional and longer-term outcomes are needed.

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**REFERENCES**

Endoscopic treatment of gastroparesis


Abbreviations: BTA, botulinum toxin A; DPLJ, direct percutaneous endoscopic jejunoectomy; GES, gastric electrical stimulation; POEM, peroral endoscopic myotomy; POP, peroral pyloromyotomy; RCT, randomized controlled trial.


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