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Overview of Diagnosis and Treatment Approaches of Gastroparesis

[1]Hassan Awad Al-Raba'ie, [2]Osamah Abdulaziz Ali Alsalmh, [3]Turki Mohammad Abdullah Alshehri, [4]Abdulrahman Mubarak Alahmari, [5]Ahmed Mohammed Awadh AL-Antar, [6]Faisal Abdullah Hassan Alshehri, [7]Mohammad Hassan AlShehri

Abstract: **Gastroparesis (GP) is a chronic neuromuscular disorder of the upper intestinal tract, likewise called delayed gastric emptying, which is a motility condition of the stomach that is identified by slowed emptying of food in the absence of mechanical obstruction. The objective of this study was to review the evidence of diagnosis and treatment of Gastroparesis (GP) in general, we intended to demonstrate the different diagnostic procedures used in this manner, and to overview the impact of this disorder in internal care unit of GI. Systematic detailed search was conducted through several databases including; PubMed/MIDLINE, Google scholar, and Embase, searching the literature for relevant studies discussing the Gastroparesis (GP) and especially those articles concerning diagnosis and treatment of GP. Then for more evidence the references of each article was manually searched for more relevant studies to be included in our review, English language restriction was applied in this current search, and with only human subject's articles. Clinical features and underlying diseases may suggest the existence of gastroparesis. Gastric discommendation or accelerated gastric emptying might result in dyspeptic symptoms such as early satiety, nausea, and bloating, which may suggest gastroparesis, and, thus, formal measurement of gastric emptying is key before beginning therapy whenever this kind of test is offered. Several tests consisting of gastric emptying scintigraphy and stable isotope breath tests are available for the assessment of patients with believed gastroparesis. New prokinetic agents that seem much safer and to preserve efficacy may be offered in the next couple of years. Endoscopic venting and feeding tubes placed in accordance with signs and dietary requirements lead to decreased need for hospitalization in patients with refractory gastroparesis.**

Keywords: : **Gastroparesis (GP), chronic neuromuscular disorder.**

1. INTRODUCTION

Gastroparesis (GP) is a chronic neuromuscular disorder of the upper intestinal tract, likewise called delayed gastric emptying, which is a motility condition of the stomach that is identified by slowed emptying of food in the absence of mechanical obstruction [(1,2)]. The occurrence of GP is not well described; nevertheless, the number of people impacted by signs of GP in the United States is estimated to be over 4 million. The etiology of GP varies. Approximately 25% of cases are related to diabetes, whereas almost 50% are classified as idiopathic; a number of these latter cases most likely represent a post-infectious process [(3)].

Symptoms of gastroparesis are variable and nonspecific, however the most typical consist of queasiness, vomiting, bloating, early satiety, and abdominal pain [(4)]. As the intensity of gastroparesis advances, other disorders or issues, such as esophagitis, Mallory-Weiss tear, peptic ulcer disease, and bezoar development, can establish [(1,5)]. Stomach pain is an often under-appreciated symptom in gastroparesis. In a multicenter research study from an NIH consortium on gastroparesis, 72 % of patients with gastroparesis had stomach pain, however was the dominant symptom in only 18 % [(6)], reflecting the heterogeneous patient population in this associate. A tertiary referral research study revealed that stomach pain was reported in 90 % of 68 patients with delayed gastric emptying (18 DG and 50 IG). Pain was caused by consuming (72 %), was nighttime (74 %), and hindered sleep (66 %). Intensity ranking of stomach pain was in the exact same variety as other signs (e.g., fullness, and bloating) was not correlated with gastric emptying rate, however was related to impaired lifestyle. The preponderance of the idiopathic group and large percentage of everyday (43 %) or even continuous pain (38 %) in this accomplice of patients might show the kind of referred patients typically seen in tertiary scholastic centers [7]. The presence of stress and anxiety or depression has been related to more severe symptoms [8,9].

The etiology of GP varies. GP can develop secondary to long-standing diabetes, connective tissue disorders, prior surgical treatment, ischemia, medications, radiation, and a range of inflammatory, transmittable, or neurological conditions (**Table 1**) [3,10]. Unfortunately, an underlying cause cannot be identified in roughly 50% of patients who are hence categorized as having idiopathic GP [11].

TABLE 1. Etiology of Gastroparesis [3,10]

Common causes
• Idiopathic Diabetic
• Postsurgical (eg, Nissen fundoplication)
Less common causes
• Viral (eg, Norwalk)
• Connective tissue disorders (eg, scleroderma)
• Para-neoplastic syndrome (eg, small cell lung cancer)
• Infiltrative disorders (eg, amyloidosis)
• Neurological disorders (eg, Parkinson's disease)
• Vascular (eg, mesenteric ischemia)

The objective of this study was to review the evidence of diagnosis and treatment of Gastroparesis (GP) in general, we intended to demonstrate the different diagnostic procedures used in this manner, and to overview the impact of this disorder in internal care unit of GI.

2. METHODOLOGY

Systematic detailed search was conducted through several databases including; PubMed/MIDLINE, Google scholar, and Embase, searching the literature for relevant studies discussing the Gastroparesis (GP) and especially those articles concerning diagnosis and treatment of GP. Then for more evidence the references of each article was manually searched for more relevant studies to be included in our review, English language restriction was applied in this current search, and with only human subject's articles.

3. RESULTS

- ***Physiological Gastric emptying:***

The proximal stomach serves as the tank for food, however likewise controls the gastroduodenal flow rate and provides the area and time for pepsin and hydrochloric acid to initiate food digestion [12]. Based upon gastric barostat research studies in human volunteers, over a liter of nutrients can be ingested without increased intragastric pressure [13]. 3 main mechanisms involved in the policy of the proximal stomach include the receptive relaxation reflex, the lodging reflex, and enterogastric reflexes [14]. In the distal stomach, which functions as the grinder, there are 2 kinds of waves: the sluggish wave, controlled by the pacemaker cell (i.e., the interstitial cells of Cajal), [15] and phasic contractions, managed by the moving motor complex [16]. Neurohumoral factors play a necessary function in the above systems to control gastric motility [17]. The physical nature, particle size, fat, and caloric material of food determine its clearing rate. Solid nutrients usually empty in 2 stages over 3 to 4 hours [18]. An initial lag duration (i.e., the retention stage) is followed by a propellant phase of reasonably constant emptying. Throughout the very first phase, food gets churned [19] while antral contractions propel particles to the closed pylorus. Once they have been broken down to particles of around 2 mm in size, foods are emptied. Liquid foods are generally cleared quicker, specifically in cases of large volumes. Emptying is fairly continuous over time if there are increased calories in the liquid. Neurohumoral factors include glucose controling hormonal agents, which are launched when food arrives in various regions of the gut and play an important function in the above systems to control both gastric motility and postprandial glycemia [20].

- ***Diagnostic procedures of GP:***

The gold standard test to diagnose gastroparesis is scintigraphy. Other methods are also readily available, such as ultrasonography, ^{13}C breath testing, magnetic resonance imaging, swallowed pill telemetry, antroduodenal manometry, and electrogastrography (Table 2) [21]. Initial laboratory testing is generally not useful in detecting patients with presumed gastroparesis, but routine blood tests should be customized toward the outcome of the history and physical exam. They can likewise be performed to dismiss other differentials. For instance, pancreatitis needs to be thought about in patients presenting with stomach pain in the epigastric area, and a serum lipase would be most practical. When other conditions are ruled out, then gastroparesis must be provided more consideration [13,21].

Diagnostic examinations typically including an esophagogastroduodenoscopy initially. This endoscopy is to dismiss structural conditions of the upper intestinal system and to envision any source of mechanical blockage, such as malignancy or peptic ulcer disease. Those specific disorders will require to be treated if this upper endoscopy yields natural etiologies. Otherwise, if the endoscopy yields unfavorable findings, patients will need additional screening to evaluate their rate of gastric emptying [13,21].

TABLE 2: Types of diagnostic modality [21]

Scintigraphy	Gold standard
^{13}C breath test	Ideal alternative
Antroduodenal manometry	Distinguish between neuropathic and myopathic diseases
Electrogastrography	Focuses on the underlying myoelectrical activity
Swallowed capsule telemetry	Broadcasts in real time, intraluminal pH, phasic gastric pressure activity and ambient temperature
Magnetic resonance imaging	Measure gastric emptying and accommodation using sequential transaxial abdominal scans

Gastric-Emptying Scintigraphy:

Gastric-emptying scintigraphy (GES) is considered the gold standard to establish the medical diagnosis of GP.1 Patients going through gastric scintigraphy ingest a radiolabeled meal that is followed by serial gamma video camera images as the labeled meal profits through the upper GI tract. Gastric emptying is computed using electronic software, which calculates the area of radiolabeled tissue attenuation. Scintiscanning at 15-minute periods for 4 hours after food intake is thought about the gold standard for determining gastric emptying in detail. A streamlined approach including hourly scans to measure recurring gastric material is often utilized in practice [20]. The technique typically employs technetium-99 m (99mTc) sulphur colloid, included or bound to a consistent test meal. The calorie and nutritional content of the test meal must be standardized [22,23]. Retention of more than 10% of the meal after 4 hours is considered irregular [24]. Compared with the gold basic approach, the simplified method has a specificity of 62% and a sensitivity of 93% (**Figure 1**) [25]. As it offers the actual percentage of food emptied and needs fewer scans, the streamlined approach is usually chosen. Further, scintiscanning needs special devices and know-how, and involves exposure to radiation, supplying additional reasons that the simplified approach might be preferable [25].

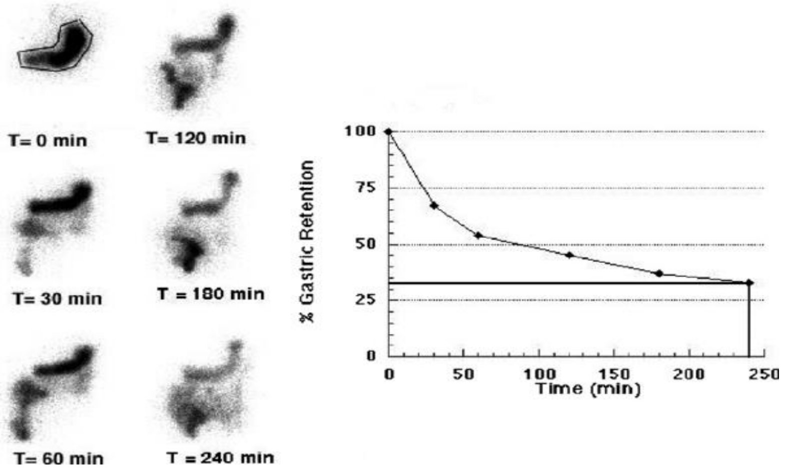

Figure 1: Abnormal results from a gastric-emptying scintigraphy.

Wireless Motility Capsule (WMC) for diagnosis of GP:

WMC (SmartPill, Given Imaging) is an FDA authorized gadget for the evaluation of gastric emptying in patients with thought GP. The gadget is a 2.6-mm ingestible capsule that transmits pressure, temperature, and PH data to a cordless gadget worn by the patient. The pill typically goes through the digestive tract in 2 to 5 days, after which the information is downloaded. This indigestible pill offers a nonradioactive and similar option to GES. After the pill is swallowed, it determines gastric-emptying time by picking up luminal pH, pressure, and temperature as it traverses through the digestive tract (26,27). Gastric emptying is demarcated when there is a sudden change in pH from the acidity of the stomach to the alkaline environment of the duodenum (28). Using miniaturized wireless sensor technology, the pill relays details to a receiver that can be worn on the patient's belt or around his/her neck. The SmartPill is excreted from the intestinal tract after 1 or 2 days, when the patient returns to center, information from the receiver is downloaded to a computer to be evaluated. Gastric emptying by cordless pill motility appears to associate with the T-90% GES and the return of phase III of the migrating motor complex (MMC) of the fasting duration (29).

Figure 2: Image of the SmartPill (SmartPill Corporation, Buffalo, NY). The SmartPill is often described as the size of a large multivitamin pill. It measures approximately 1.3 cm by 2.6 cm.

^{13}C breath test:

Breath tests that measure gastric emptying involve intake of a meal improved with a steady isotope, followed by the collection of breath samples; these are examined for co2, using the isotope, at a referral lab. The profile of 13CO2 excretion is utilized to estimate the half-time of gastric emptying (30). Compared with detailed scintiscanning, the breath test has a specificity of 80% and a sensitivity of 86% (31). Significant lung disease and small bowel maldigestion and malabsorption may influence the test, and patients with lung, little bowel, pancreatic, and liver diseases are thought about unsuitable candidates (32). Breath screening has actually been utilized in both clinical and scientific research studies for figuring out gastric emptying (33). These breath tests utilizing 13 C-octanoate or -spirulina (34) offer reproducible outcomes that associate with outcomes on gastric emptying scintigraphy, including responsiveness to pharmacological treatment. The optimization of mathematical designs for measurement of gastric emptying originated from breath excretion profiles has actually been thoroughly taken a look at in the literature (35).

Imaging strategies:

Transabdominal ultrasonography and magnetic resonance imaging (MRI) are two other research studies that can evaluate gastric emptying in patients, but are less often used. Ultrasonography is an easy and noninvasive technique that can evaluate structural and practical irregularities of gastric motility. Two-dimensional ultrasound can indirectly offer details about gastric emptying by measuring changes in antral location over time (36). A study has revealed that diabetics have a larger antral location in fasting and postprandial states than healthy individuals (37). Three-dimensional ultrasound offers more detailed information by having the ability to assess intragastric meal distribution and volume, but needs an operator with considerable technical experience (38). MRI of gastrointestinal function is a recently establishing tool that is comparable to GES in reliably assessing the gastric emptying of combined solid and liquid meals (39). Due to the fact that it can compare gastric air and fluid, its high-resolution imaging abilities can at the same time determine gastric emptying, gastroduodenal motility, and gastric secretions (40). Drawbacks of this MRI method include its fairly pricey expense, require for specific devices, and absence of standardization throughout institutions. Presently, transabdominal ultrasonography and MRI are used more as medical research tools, rather than conclusive diagnostic tests, in the workup of patients with gastroparesis (40).

- ***Treatment approaches of GP:***

Managing patients with diabetic gastroparesis requires a multidisciplinary method, and typically involves gastroenterologists, dietitians, diabetologists, social workers, and diabetes teachers. An essential preemptive technique is avoidance, which can be attempted by managing glucose levels; this has been proposed in numerous trials of intense hyperglycemia (41,42). There is an absence of clinical trials revealing that the remediation of euglycemia or correction of electrolyte derangement normalizes gastric emptying or ameliorates symptoms, medical experience and observational information recommend that enhanced metabolic control is useful in the prevention of gastroparesis in patients with diabetes. Further preemptive techniques involve the avoidance of other exacerbating factors, such as electrolyte disturbances and improving dietary status (41,42).

Nutrition assessment for GP patients:

Meals with low-fat material and with low residue need to be recommended for gastroparesis patients, given that both fat and fiber have the tendency to delay gastric emptying. Since the stomach might only empty an ~ 1- 2 kcal/ minutes, little meal size is a good idea. Therefore, little, low-fat, low-fiber meals, 4 - 5 times a day, are appropriate for patients with gastroparesis. Increasing the liquid nutrient element of a meal ought to be promoted, as gastric emptying of liquids is typically normal in patients with delayed clearing for solids (43,44). Poor tolerance of a liquid diet is predictive of poor outcome with oral nutrition (44). High calorie liquids in small volumes can provide energy and nutrients without exacerbating symptoms. The calorie requirement of a patient can be computed by multiplying 25 kcal by their current body weight in kilograms (45).

For patients with gastroparesis who are unable to maintain nutrition with oral intake, a feeding jejunostomy tube, which bypasses the afflicted stomach, can improve signs and decrease hospitalizations (45). Positioning of a jejunal feeding tube, if required for alimentation, must be preceded by a successful trial of nasojejunal feeding. Periodically, small bowel dysfunction might happen in patients with gastroparesis causing intolerance to jejunal feeding.

In appropriate patients with normal little bowel function, jejunal feeding preserves nutrition, alleviates signs, and lowers the frequency of health center admissions for acute exacerbation of symptoms (47). Little intestinal motility/transit can be assessed before placement of jejunostomy tube with antroduodenojejunal manometry, WMC, and small intestinal transit scintigraphy. Provided the large coefficient of variation of small bowel transit time, and the problem in interpretation of orocecal transit measurements in the setting of gastroparesis, a practical way to examine small bowel function is by a trial of nasojejunal feeding. Nutrient feeds are begun with diluted infusions and advanced slowly to iso-osmolar preparations at relatively low infusion rates (e.g., 20 ml/h) increasing to the target infusion rate to support nutrition and hydration generally to at least 60 ml/h over 12 - 15 h/day. Regulated enteral nutrition might enhance glycemic control in diabetic patients with frequent vomiting and unforeseeable oral consumption. Issues consist of infection, tube migration, and dislodgement (48).

Pharmacologic treatment for GP:

The aim of therapy is to improve the efficiency of the gastric pump and to ease signs of nausea, bloating, throwing up, and pain. Selection of drugs is decided empirically. 2 classes are readily available for dealing with affected patients, particularly, antiemetic and prokinetic (**Table 3**) (49).

TABLE 3: Management options

Pharmacologic therapy	
Prokinetic agents	Little evidence from clinical trials to support the use of specific prokinetic regimens
Antiemetic agents	
Botulinum toxins	Restricted to clinical trials
Gastric electrical stimulation	Further studies are needed to define the best stimulation strategy and the mechanisms responsible for clinical improvement
Surgery	Insufficient data
Acupuncture	Insufficient data

4. CONCLUSION

Clinical features and underlying diseases may suggest the existence of gastroparesis. Gastric discommendation or accelerated gastric emptying might result in dyspeptic symptoms such as early satiety, nausea, and bloating, which may suggest gastroparesis, and, thus, formal measurement of gastric emptying is key before beginning therapy whenever this kind of test is offered. Several tests consisting of gastric emptying scintigraphy and stable isotope breath tests are available for the assessment of patients with believed gastroparesis. New prokinetic agents that seem much safer and to preserve efficacy may be offered in the next couple of years. Endoscopic venting and feeding tubes placed in accordance with signs and dietary requirements lead to decreased need for hospitalization in patients with refractory gastroparesis. Treatment should be tailored inning accordance with the intensity of gastroparesis, and 25% to 68% of symptoms are controlled by prokinetic agents. Typically prescribed prokinetics include domperidone, erythromycin, and metoclopramide.

REFERENCES

[1] Parkman HP, Hasler WL, Fisher RS, et al. American Gastroenterological Association technical review on the diagnosis and treatment of gastroparesis. Gastroenterology 2004;127(5):1592-622.

[2] Friedenberg FK, Parkman HP. Advances in the management of gastroparesis. Curr Treat Options Gastroenterol 2007;10(4):283-93.

[3] Stein B, Everhart KK, Lacy BE. Gastroparesis: A Review of Current Diagnosis and Treatment Options. Clin Gastroenterol. 2015 Aug;49(7):550-8.

[4] Soykan I, Sivri B, Sarosiek I, et al. Demography, clinical characteristics, psychological and abuse profiles, treatment, and long-term follow-up of patients with gastroparesis. Dig Dis Sci 1998;43(11):2398-404.

[5] Parkman HP, Schwartz SS. Esophagitis and gastroduodenal disorders associated with diabetic gastroparesis. Arch Intern Med 1987;147(8):1477-80.

[6] Hasler WL, Wilson L, Parkman HP, et al. Importance of abdominal pain as a symptom in gastroparesis:relation to clinical factors, disease severity, quality of life,gastric retention, and medication use. Gastroenterology. 2010;138(Suppl 1) S-461.

[7] Cherian D, Sachdeva P, Fisher RS, et al. Abdominal pain is a frequent symptom of gastroparesis. Clin Gastroenterol Hepatol. 2010;8:676–681.

[8] Hasler WL, Parkman HP, Wilson LA, et al. Psychological dysfunction is associated with symptom severity but not disease etiology or degree of gastric retention in patients with gastroparesis. Am J Gastroenterol. 2010;105:2357–2367.

[9] Maleki D, Locke GR, III, Camilleri M, et al. Gastrointestinal tract symptoms among persons with diabetes mellitus in the community. Arch Intern Med. 2000;160:2808–2816.

[10] Camilleri M, Parkman HP, Shafi MA, et al. American College of Gastroenterology. Clinical guideline: Management of gastroparesis. Am J Gastroenterol. 2013;108:18–37, quiz 38.

[11] Parkman HP, Yates K, Hasler WL, et al. Clinical features of idiopathic gastroparesis vary with sex, body mass, symptom onset, delay in gastric emptying, and gastroparesis severity. Gastroenterology. 2011;140:101–115.

[12] Haans JJ, Masclee AA. Review article: The diagnosis and management of gastroparesis. Aliment Pharmacol Ther. 2007;26:37–46.

[13] Ahluwalia NK, Thompson DG, Barlow J. Effect of distension and feeding on phasic changes in human proximal gastric tone. Gut. 1996;39:757–61.

[14] Mizumoto A, Monchiki E, Suzuki H, Tanaka T, Itoh Z. Neuronal control of motility changes in the canine lower esophageal sphincter and stomach in response to meal ingestion. J Smooth Muscle Res. 1997;33:211–22.

[15] Meyer JH, Ohashi H, Jehn D, Thomson JB. Size of liver particles emptied from the human stomach. Gastroenterology. 1981;80:1489–96.

[16] Hirst GD, Edwards FR. Role of interstitial cells of Cajal in the control of gastric motility. J Pharmacol Sci. 2004;96:1–10.

[17] Camilleri M. Integrated upper gastro-intestinal response to food intake. Gastroenterology. 2006;131:640–58.

[18] Hunt JN, Pathak JD. The osmotic effects of some simple molecules and ions on gastric emptying. J Physiol. 1960;154:254–69.

[19] Meyer JH, Ohashi H, Jehn D, Thomson JB. Size of liver particles emptied from the human stomach. Gastroenterology. 1981;80:1489–96.

[20] Camilleri M. Clinical practice. Diabetic gastroparesis. N Engl J Med. 2007;356:820–9.

[21] Aljarallah BM. Management of Diabetic Gastroparesis. *Saudi Journal of Gastroenterology : Official Journal of the Saudi Gastroenterology Association*. 2011;17(2):97-104.

[22] Kim DY, Myung SJ, Camilleri M. Novel testing of human gastric motor and sensory functions: rationale, methods, and potential applications in clinical practice. Am J Gastroenterol. 2000;95:3365–73.

[23] Tougas G, Eaker EY, Abell TL, Abrahamsson H, Boivin M, Chen J, et al. Assessment of gastric emptying using a low fat meal: establishment of international control values. Am J Gastroenterol. 2000;95:1456–62.

[24] Tougas G, Chen Y, Coates G, Paterson W, Dallaire C, Pare P, et al. Standardization of a simplified scintigraphic methodology for the assessment of gastric emptying in a multicenter setting. Am J Gastroenterol. 2000;95:78–86.

[25] Camilleri M, Zinsmeister AR, Greydanus MP, Brown ML, Proano M. Towards a less costly but accurate test of gastric emptying and small bowel transit. Dig Dis Sci. 1991;36:609–15.

[26] Kuo B, McCallum RW, Koch KL, et al. Comparison of gastric emptying of a nondigestible capsule to a radio-labelled meal in healthy and gastroparetic subjects. Aliment Pharmacol Ther 2008;27(2):186-96.

[27] Rao SS, Kuo B, McCallum RW, et al. Investigation of colonic and whole gut transit with wireless motility capsule and radioopaque markers in constipation. Clin Gastroenterol Hepatol 2009;7(5):537-44.

[28] Parkman HP, Camilleri M, Farrugia G, et al. Gastroparesis and functional dyspepsia: excerpts from the AGA/ANMS meeting. Neurogastroenterol Motil 2010;22(2):113-33.

[29] Cassilly D, Kantor S, Knight LC, et al. Gastric emptying of a non-digestible solid: assessment with simultaneous SmartPill pH and pressure capsule, antroduodenal manometry, gastric emptying scintigraphy. Neurogastroenterol Motil 2008;20(4): 311-9.

[30] Choi MG, Burton DD, Zinsmeister AR, Forstrom LA, Nair KS. [13C] octanoic acid breath test for gastric emptying of solids: accuracy, reproducibility, and comparison with scintigraphy. Gastroenterology. 1997;112:1155–62.

[31] Choi MG, Camilleri M, Burton DD, Zinsmeister AR, Forstrom LA, Nair KS. Reproducibility and simplification of 13C-octanoic acid breath test for gastric emptying of solids. Am J Gastroenterol. 1998;93:92–8.

[32] Patrick A, Epstein O. Review article: gastroparesis. Aliment Pharmacol Ther. 2008;27:724–40.

[33] Fraser R, Horowitz M, Dent J. Hyperglycaemia stimulates pyloric motility in normal subjects. Gut. 1991;32:475.

[34] Barnett J, Owyang C. Serum glucose concentration as a modulator of interdigestive gastric motility. Gastroenterology. 1988;94:739.

[35] Fraser R, Horowitz M, Maddox AF, Harding PE, Chatterton BE, Dent J. Hyperglycaemia slows gastric emptying in type 1 (insulin-dependent) diabetes mellitus. Diabetologia. 1990;33:675–80.

[36] Hausken T, Odegaard S, Matre K, et al. Antroduodenal motility and movements of luminal contents studied by duplex sonography. Gastroenterology 1992;102(5): 1583-90.

[37] Undeland KA, Hausken T, Svebak S, et al. Wide gastric antrum and low vagal tone in patients with diabetes mellitus type 1 compared to patients with functional dyspepsia and healthy individuals. Dig Dis Sci 1996;41(1):9-16.

[38] Tefera S, Gilja OH, Olafsdottir E, et al. Intragastric maldistribution of a liquid meal in patients with reflux oesophagitis assessed by three dimensional ultrasonography. Gut 2002;50(2):153-8.

[39] Feinle C, Kunz P, Boesiger P, et al. Scintigraphic validation of a magnetic resonance imaging method to study gastric emptying of a solid meal in humans. Gut 1999;44(1):106

[40] Schwizer W, Maecke H, Fried M. Measurement of gastric emptying by magnetic resonance imaging in humans. Gastroenterology 1992;103(2):369-76.

[41] Jones K, Berry M, Kong MF. Hyperglycemia attenuates the gastrokinetic effect of erythromycin and affects the perception of postprandial hunger in normal subjects. Diabetes Care. 1999;22:339.

[42] Petrakis IE, Kogerakis N, Vrachassotakis N, Stiakakis I, Zacharioudakis G, Chalkiadakis G. Hyperglycemia attenuates erythromycin-induced acceleration of solid-phase gastric emptying in healthy subjects. Abdom Imaging. 2002;27:309–14.

[43] Horowitz M, Maddox AF, Wishart JM, Harding PE, Chatterton BE, Shearman DJ. Relationships between oesophageal transit and solid and liquid gastric emptying in diabetes mellitus. Eur J Nucl Med. 1991;18:229–34.

[44] Camilleri M. Appraisal of medium-and long-term treatment of gastro paresis and chronic intestinal dysmotility. Am J Gastroenterol. 1994;89:1769–1774.

[45] Abell TL, Bernstein VK, Cutts T, et al. Treatment of gastroparesis: a multidisciplinary clinical review. Neurogastroenterol Motil. 2006;18:263–283.

[46] Bouras EP, Scolapio JS. Gastric motility disorders:management that optimizes nutritional status. J Clin Gastroenterol. 2004;38:549–557.

[47] Fontana RJ, Barnett JL. Jejunostomy tube placement in refractory diabetic gastroparesis:a retrospective review. Am J Gastroenterol. 1996;91:2174–2178.

[48] Karamanolis G, Tack J. Nutrition and motility disorders. Best Pract Res Clin Gastroenterol. 2006;20:485–505.

[49] Camilleri M, Parkman HP, Shafi MA, Abell TL, Gerson L. Clinical Guideline: Management of Gastroparesis. The American journal of gastroenterology. 2013;108(1):18-38. doi:10.1038/ajg.2012.373.