

Gastric Motility and Emptying Disorders

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“Dyspepsia is the remorse of a guilty stomach.”
A. Kerr

CLINICAL IMPORTANCE

Normally, the stomach should be emptied following an average meal in six to eight hours for dogs and four to six hours for cats (Twedt, 2005). The rate of gastric emptying is influenced by formulation and nutrient content of the food, size of the meal and body size (Nelson et al, 2001).

Gastric motility disorders arise from conditions that directly or indirectly disrupt three of the basic functions of the stomach: 1) storage of ingesta, 2) mixing and dispersion of food particles and 3) timely expulsion of gastric contents into the duodenum. Various processes can affect gastric emptying; however, some may not lead to clinical signs (Twedt, 2005). Delayed gastric emptying may be involved in the etiopathogenesis of gastric dilatation-volvulus (Wyse et al, 2001, 2003; Twedt, 2005; Burger et al, 2006).

Species differences in gastric emptying have been identified (Wyse et al, 2003). In addition, differences may be seen between breeds of dogs. A recent study of the long-term measurement of gastric motility using passive telemetry found significant differences in the postprandial motility patterns between

the Labrador retriever test group and the beagle test group. Further studies in breed-related gastric motility are needed (Burger et al, 2006).

Table 54-1 outlines a number of primary and secondary causes of gastroparesis reported to occur in dogs and cats. The importance of these disorders in the general pet population is unknown, but primary gastric motility disorders are probably rare.

PATIENT ASSESSMENT

History and Physical Examination

Delayed gastric emptying due to any cause results in vomiting. Owners may report vomiting of undigested or partially digested food more than 12 hours after the pet eats. The onset of clinical signs may be gradual in acquired cases of chronic hypertrophic pyloric gastropathy or acute in the case of foreign body ingestion. Clinical signs may have been present since weaning in dogs and cats with congenital pyloric stenosis.

Weight loss and poor body condition are often present in chronic cases. Other manifestations may include intermittent gastric bloating, nausea, partial or complete inappetence and

Figure 54-1. Lateral and ventrodorsal abdominal radiographs from an 11-year-old neutered female fox terrier with projectile vomiting demonstrating use of barium-impregnated polyethylene spheres (BIPS). A gastric emptying disorder was confirmed because the spheres were detected in the pyloric antrum 16 hours postadministration. (Courtesy Dr. Grant Guilford, Massey University, New Zealand.)

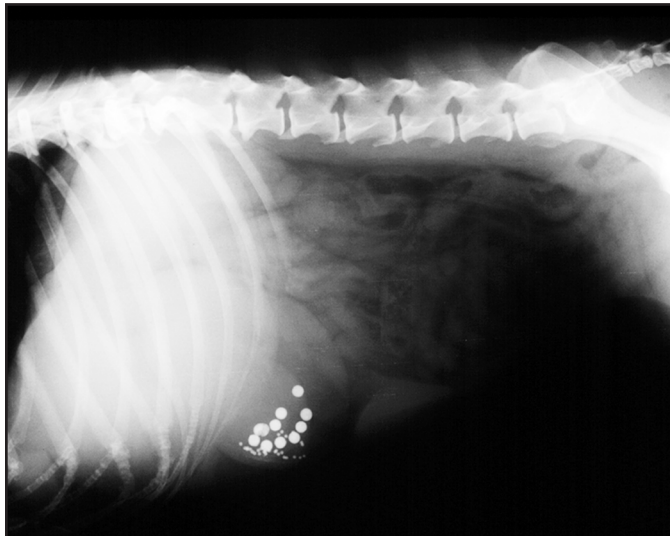


Figure 54-2. Endoscopic view of retained food in the stomach of a 12-year-old neutered female Scottish terrier presented for chronic intermittent vomiting. Food was found in the stomach 20 hours after consumption of a meal, which confirms delayed gastric emptying.

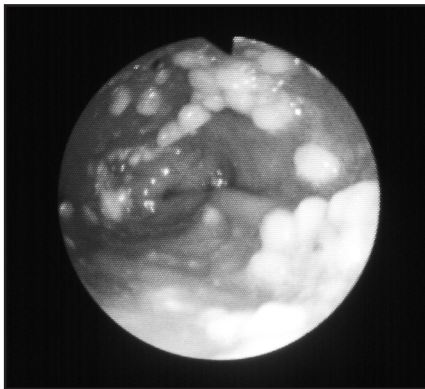
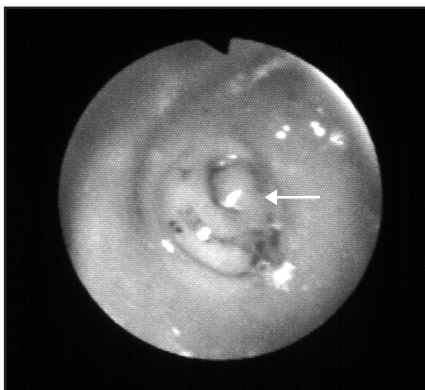


Figure 54-3. Gastroscopic photograph demonstrating hyperplastic mucosal folds (arrow) typical of chronic hypertrophic gastropathy in a 13-year-old neutered male Shih Tzu. (Courtesy Dr. Mike Matz, Southwest Veterinary Specialty Center, Tucson, AZ.)



belching. Occasionally, patients will present with unrelenting or projectile vomiting; complete gastric outflow obstruction should be suspected in such cases.

Physical examination findings are often unremarkable beyond evidence of weight loss. Body condition should be assessed and used as a reassessment tool. Gastric distention and tympany may be evident in some cases. Patients with unrelenting vomiting may present with dehydration, depression and malaise. In rare cases, severe electrolyte abnormalities resulting from persistent vomiting may manifest as weakness.

Laboratory and Other Clinical Information

Hematologic and serologic findings in patients with gastroparesis or gastric obstruction are nonspecific and may be more reflective of the underlying disorder. Chronic, persistent vomiting may precipitate dehydration and electrolyte (hypokalemia, hypochloremia) and acid-base abnormalities. Prerenal azotemia is common. Hypochloremic metabolic alkalosis with paradoxical aciduria may be present in dogs and cats with complete pyloric outflow obstruction.

Survey abdominal radiographs are often helpful for evaluating dogs and cats with gastric motility disorders. Typical findings include a stomach distended by fluid, air or food. The presence of food in the stomach 12 to 18 hours after the last meal is evidence of an emptying disorder. Occasionally, gastric wall thickening may be recognized on survey radiographs. Rarely, extraluminal masses causing pyloric obstruction may be identified.

Gastrointestinal (GI) contrast studies confirm delayed gastric emptying. If liquid contrast media (i.e., barium sulfate) remains in the stomach for more than four hours in dogs or 30 minutes in cats, gastroparesis or mechanical obstruction should be suspected (Moon and Myer, 1986). Liquid contrast media, however, is not representative of a typical meal. For that reason, feeding barium mixed with food or administering radiopaque particles (e.g., barium-impregnated polyethylene spheres, BIPS)^a mixed with food^b more completely assesses gastric function (Figure 54-1). Studies have demonstrated that radiopaque markers exit the stomach at a rate proportional to the disappearance of food (dry matter [DM]) in dogs (Sparkes et al, 1997; Wyse et al, 2001, 2003; Nelson et al, 2001; Twedt, 2005; Simpson, 2005). GI contrast studies also may identify thickened gastric walls, intraluminal foreign bodies and extraluminal masses.

Endoscopy frequently is preferred over radiographic studies in evaluating delayed gastric emptying and gastric outflow obstruction. Barium in the stomach can make endoscopy more difficult; therefore, endoscopy should be performed before administration of barium contrast media (Simpson, 2005).

Gastric emptying disorders may be suspected at the time of upper GI endoscopy. Food in the stomach after a 12- to 18-hour fast is good evidence of the condition (Figure 54-2). In some cases, endoscopic findings may be diagnostic. Chronic hypertrophic pyloric gastropathy, for example, has a typical endoscopic appearance, including hyperplastic mucosal folds surrounding the pylorus, protuberance of the pylorus and polyps (Figure 54-3) (Leib et al, 1993). In the case of antropyloric or proximal duodenal foreign bodies, endoscopy can be both diagnostic and curative.

Ultrasonography can be used to evaluate delayed gastric emptying. The rate of liquid- and solid-phase gastric emptying measured by ultrasonography is correlated closely with measurements by scintigraphy in people. Gastric contractions can be visualized in dogs using ultrasonography and prolonged retention of fluid in the stomach may indicate delayed gastric emptying. Studies suggest that ultrasonography may be a noninvasive method of evaluating liquid- and solid-phase gastric emptying in dogs (Wyse et al, 2003). Ultrasonography may be useful in the evaluation of pyloric masses and extraluminal sources of pyloric compression (Billir et al, 1994).

Fluoroscopy and nuclear scintigraphy can help assess gastric emptying rate. Radioscintigraphy is considered the gold standard method for evaluating gastric emptying. Correlation with results of radioscintigraphy is necessary to validate other methods of determining gastric motility (Wyse et al, 2003; Nelson et al, 2001). Other means of evaluating gastric motility include a variety of tracer studies and breath tests that have been developed for use in research settings (Wyse et al, 2001, 2003).

Risk Factors

Several breeds are associated with gastric motility disorders (Table 51-1). Congenital pyloric stenosis most often is encountered in brachycephalic dogs and Siamese cats. Chronic hypertrophic pyloric gastropathy usually affects small, purebred, middle-aged dogs, such as the Lhasa apso, Maltese, Shih Tzu and Pekingese (Matthieson and Walter, 1986; Simpson, 2005). Young animals are more at risk for gastric foreign bodies, whereas older pets are more likely to have neoplastic lesions that may obstruct gastric outflow. Young, large-breed dogs living in states bordering the Gulf of Mexico may be infected with *Pythium insidiosum*, resulting in gastric pythiosis and possible gastric outflow obstruction (Simpson, 2005, 2006; Grooters and Taboada, 2004).

Etiopathogenesis

Gastric motility disorders may arise from functional or mechanical obstruction of gastric outflow. Functional disorders of gastric emptying arise from abnormal or asynchronous gastric motility. Myenteric neuronal or gastric smooth muscle function or antropyloroduodenal coordination may be impaired.

A number of benign and malignant anatomic lesions of the stomach and proximal duodenum may result in mechanical gastric outflow obstruction (Table 54-1). The most common of these is chronic hypertrophic pyloric gastropathy, which refers

Table 54-1. Potential causes of gastric emptying disorders in dogs and cats.

Functional obstruction (primary motility defects)
Gastric ulcers
Idiopathic asynchronous motility
Idiopathic hypomotility
Infectious gastroenteritis
Postoperative ileus
Functional obstruction (secondary motility defects)
Drug therapy
Anticholinergics
Beta-adrenergic agonists
Narcotic analgesics
Electrolyte disturbances
Hypercalcemia
Hypocalcemia
Hypokalemia
Hypomagnesemia
Inflammation
Acute pancreatitis
Peritonitis
Metabolic disorders
Diabetes mellitus
Hepatic encephalopathy
Hypothyroidism
Mechanical obstruction
Congenital or acquired antral pyloric hypertrophy
Extraluminal compression
Gastric or duodenal foreign bodies
Gastric or duodenal granulomatous lesions
Gastric or duodenal neoplasia or polyps

to an acquired hypertrophic mucosal or muscular lesion of the pyloric antrum. In addition, congenital pyloric stenosis occurs in young dogs and cats as a consequence of benign muscular hypertrophy of the pylorus. Certain gastric and proximal duodenal neoplasms and granulomatous conditions (e.g., pythiosis, eosinophilic gastritis) can result in pyloric obstruction.

Key Nutritional Factors

Key nutritional factors for patients with gastric motility and emptying disorders are listed in Table 54-2 and discussed in detail below.

Water

Dehydration is a common problem in patients with persistent vomiting. Dehydration should be corrected with appropriate parenteral fluid therapy. Thereafter, water should be available free choice. Water should be offered between room and body temperature. Colder water delays gastric emptying.

Energy

Patients with chronic vomiting are often underweight due to longstanding inadequate caloric intake. The energy density of the food should be moderate to increased (4.0 to 4.5 kcal/g [16.7 to 18.8 kJ/g] [DM]) to ensure intake of sufficient energy with small amounts of food. Higher energy densities may help patients maintain or regain body weight and condition, but would require higher dietary fat levels. As discussed below, increased levels of dietary fat adversely affect gastric emptying and should be avoided.

Table 54-2. Key nutritional factors for foods for dogs and cats with gastric motility and emptying disorders.*

Factors	Recommended levels
Energy density	4.0 to 4.5 kcal/g (16.7 to 18.8 kJ/g)
Potassium	0.8 to 1.1%
Chloride	0.5 to 1.3%
Sodium	0.3 to 0.5%
Fat	≤15% for dogs ≤25% for cats
Crude fiber	≤5% crude fiber; avoid foods with gel-forming fiber sources such as pectins and gums (e.g., gum arabic, guar gum, carrageenan, psyllium gum, xanthan gum, carob gum, gum ghatti and gum tragacanth)
Food form consistency	Moist is best; initially liquid or semi-liquid
Food temperature	70 to 100°F (21 to 38°C)

*Nutrients expressed on a dry matter basis.

Electrolytes

Abnormalities in serum electrolyte concentrations, especially potassium, sodium and chloride, are common in patients with chronic vomiting and can adversely affect gastric motility and emptying. Initial abnormalities should be corrected with appropriate parenteral fluid therapy. Foods for patients with gastric motility should contain levels of potassium, chloride and sodium above the minimum allowances for normal dogs and cats. Recommended levels of these nutrients are 0.8 to 1.1% DM potassium, 0.5 to 1.3% DM chloride, and 0.3 to 0.5% DM sodium. Thereafter, the food should contain levels of minerals appropriate for the patient's lifestage.

Fat

Patients with chronic vomiting are often underweight due to longstanding inadequate caloric intake. The energy density of foods is related to dietary fat content and increasing dietary fat typically results in increased caloric intake. However, both solid and liquid foods containing increased fat levels generally are emptied more slowly from the stomach than similar foods with lower fat content. Fat in the duodenum stimulates release of cholecystokinin, which delays gastric emptying. Thus, foods for cats and dogs with gastric emptying or motility disorders should not provide excess fat. Foods with 15% or less (dogs) or 25% or less (cats) DM fat are probably appropriate for patients with gastric emptying or motility disorders.

Fiber

Many grocery brand moist foods contain gelling agents such as gums or hydrocolloids to enhance the aesthetic characteristics of the food. Foods containing gel-forming soluble fibers should be avoided in patients with gastric emptying and motility disorders because they increase the viscosity of ingesta and slow gastric emptying (Russell and Bass, 1985; Prove and Ehrlein, 1982; Sandhu et al, 1987; Burger et al, 2006). Such fibers include pectins and gums (e.g., gum arabic, guar gum, carrageenan, psyllium gum, xanthan gum, carob gum, gum ghatti

and gum tragacanth). However, increased levels (>8% DM) of insoluble fiber (powdered cellulose) in dry foods fed to cats had no effect on gastric emptying (Armbrust et al, 2003). Other reports show that the ratio of slowly to rapidly fermentable fibers is important (Kritchevsky, 2001). Therefore, the crude fiber content of foods for patients with gastric motility or emptying disorders should be limited to no more than 5% DM.

Meal Size, Food Form and Food Temperature

In cats and probably dogs, larger meals are emptied more slowly from the stomach than smaller meals (Goggin et al, 1998). Liquids are emptied from the stomach more quickly than solids due to lower digesta osmolality. Water is emptied most quickly, whereas liquids containing nutrients are emptied more slowly. High-osmolality fluids are emptied more slowly than dilute fluids. Solids are the slowest to be emptied from the stomach (Fleming, 1997). A study in cats noted that dry foods emptied more slowly than moist foods (Goggin et al, 1998).

The ideal food form for patients with gastric emptying disorders has a liquid or semi-liquid consistency. Cold meals slow gastric emptying. Therefore, food should be offered between room and body temperature (70 to 100°F [21 to 38°C]).

FEEDING PLAN

Dehydration, electrolyte and acid-base abnormalities and gastric outflow obstruction should be corrected with appropriate fluid therapy and surgical intervention, respectively, before the feeding plan is initiated. For dogs or cats with functional gastric motility disorders, several prokinetic agents are available (Table 51-1) and should be considered if dietary management is insufficient to control clinical signs.

Assess and Select the Food

The form and levels of key nutritional factors should be assessed in the current food and compared with the recommendations outlined in the key nutritional factors section (Table 54-2). Most importantly, the food should be complete and balanced for the current lifestage of the patient. The food may not need to be altered for patients with mild disease or few clinical signs.

Tables 54-3 for dogs and 54-4 for cats provide information about key nutritional factor content of selected commercial veterinary therapeutic foods marketed for GI diseases and compares them to the recommended levels. Moist foods are preferred and partially or fully liquefying the food may help promote gastric emptying. These techniques should be used initially in patients with gastric motility or emptying disorders. Add water to a moist veterinary therapeutic food and hand mix or blend to produce a liquid or semi-liquid consistency. Alternatively, liquid enteral products with appropriate key nutritional factor content may be used.

Feed or offer buffering foods rather than foods that contain acidifying salts to most patients with acute or chronic vomiting. Hypochloremic metabolic alkalosis may occur in patients with

Table 54-3. Key nutritional factors in selected moist commercial veterinary therapeutic foods compared to recommended levels for dogs with gastric motility and emptying disorders.*

Factors	Energy density (kcal/g)	Potassium (%)	Chloride (%)	Sodium (%)	Fat (%)	Crude fiber (%)
Recommended levels	4.0-4.5	0.8-1.1	0.5-1.3	0.3-0.5	≤15	≤5
Hill's Prescription Diet i/d Canine	4.4	0.95	1.22	0.44	14.9	1.0
Iams Veterinary Formula Intestinal Low-Residue	4.6	0.84	0.84	0.53	13.2	3.9
Medi-Cal Gastro Formula	na	0.6	na	0.6	11.7	1.0
Purina Veterinary Diets EN GastroENTERic	4.0	0.61	0.78	0.37	13.8	0.9
Royal Canin Veterinary Diet Digestive Low Fat LF	4.0	0.74	1.06	0.39	6.9	3.0
Royal Canin Veterinary Diet Intestinal HE	4.3	0.8	0.92	0.57	11.8	1.4

Key: na = information not available from manufacturer.

*From manufacturers' published information or calculated from manufacturers' published as fed values; all values are on a dry matter basis unless otherwise stated. Moist foods, foods with liquid or semi-liquid consistency are preferred. Foods should be offered at temperatures between 70 to 100°F (21 to 38°C).

Table 54-4. Key nutritional factors in selected moist commercial veterinary therapeutic foods compared to recommended levels for cats with gastric motility and emptying disorders.*

Factors	Energy density (kcal/g)	Potassium (%)	Chloride (%)	Sodium (%)	Fat (%)	Crude fiber (%)
Recommended levels	4.0-4.5	0.8-1.1	0.5-1.3	0.3-0.5	≤25	≤5
Hill's Prescription Diet i/d Feline	4.2	1.06	1.18	0.33	24.1	2.4
Iams Veterinary Formula Intestinal Low-Residue	4.0	0.93	0.69	0.40	11.7	3.7
Medi-Cal Hypoallergenic/Gastro	na	1.1	na	0.7	35.9	1.2
Medi-Cal Sensitivity CR	na	1.1	na	1.1	35.1	2.5

Key: na = information not available from manufacturer.

*From manufacturers' published information or calculated from manufacturers' published as fed values; all values are on a dry matter basis unless otherwise stated. Moist foods, foods with liquid or semi-liquid consistency are preferred. Foods should be offered at temperatures between 70 to 100°F (21 to 38°C).

unrelenting vomiting secondary to gastric outflow obstruction. In such patients, oral consumption of food is not possible and intravenous fluid administration with electrolyte therapy should be used to correct this profound acid-base disturbance. A highly digestible food formulated for GI disease should be fed after the gastric outflow obstruction has been resolved by surgical or endoscopic means.

Foods with lower energy density require larger or more frequent meals to meet the patient's daily energy requirement. Larger meals may promote more vomiting and can slow gastric emptying. Optimal energy and fat levels should be determined according to the patient's ability to tolerate meal size and maintain optimal body condition.

Assess and Determine the Feeding Method

Patients with gastric motility disorders often require specialized feeding methods; the current feeding protocol is rarely appropriate. A thorough assessment includes verification of the feeding method currently used. Items to consider include feeding frequency, amount fed, how the food is offered, access to other food, relationship of feeding to exercise and who feeds the pet. All of this information should have been gathered when the history of the patient was obtained. If the patient has a normal body condition score (BCS of 2.5/5 to 3.5/5), the amount of food fed previously was probably appropriate.

Offer foods between room and body temperature (70 to 100°F [21 to 38°C]). Frequent small meals (at least three per

day) are preferred. In some cases of complete pyloric outflow obstruction, parenteral nutritional support may be necessary to meet the patient's needs before surgical alleviation of the obstruction. This is indicated when the patient's body condition is poor (BCS of 1/5 or 2/5) and the patient is deemed at increased risk for postsurgical complications.

Late evening feedings are recommended for dogs with the so-called "bilious vomiting" syndrome. Gastroduodenal reflux in these patients probably arises secondarily to a gastric motility disorder. Late evening meals with or without prokinetic therapy may resolve clinical signs in affected dogs (Simpson, 2005).

Most patients can be fed using a feeding method similar to that used for normal pets, if normal gastric function is restored after surgery. The best feeding method will need to be individualized for each patient and determined by trial and error based on remaining gastric function.

REASSESSMENT

Body weight and condition should be assessed every two to four weeks. Document the presence or absence of vomiting. If vomiting continues, alter the food or feeding pattern. Dividing the daily food intake into additional meals also may increase GI tolerance. Use of prokinetic agents (e.g., metoclopramide, cisapride) should be considered if vomiting persists despite implementation of these therapeutic strategies.

Gradual attempts to normalize the feeding regimen can be made if the patient is doing well on the recommended therapy. Feeding more solid foods and larger, less frequent meals are more convenient for pet owners.

The prognosis for dogs and cats with gastric motility disorders varies with the underlying cause. Mechanical obstructions often can be managed effectively through surgical or endoscopic (e.g., foreign body retrieval) means, resulting in an excellent prognosis (Matthieson and Walter, 1986). Occasionally, dogs and cats with longstanding gastric outflow obstruction with gastric distention may have residual gastric motility abnormalities (Leib, 1997). These patients may benefit from the use of prokinetic agents.

ENDNOTES

- a. BIPS. Barium impregnated polyethylene spheres. Med-I.D., Medical I.D. Systems, Inc., Grand Rapids, MI, USA.
- b. Hill's Prescription Diet i/d, d/d or r/d are the foods recommended to be used with BIPS by the manufacturer.

REFERENCES

The references for **Chapter 54** can be found at www.markmorris.org.