LIGHTS, CAMERA, ABDOMEN! GETTING THE MOST OUT OF BASIC GI IMAGING

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INTRODUCTION

Gastrointestinal clinical signs are a relatively common cause of patient presentation. Workups for these patients can vary depending on the nature of the clinical signs, though abdominal imaging is often a mainstay of the workup process. While a proportion of these patients may require more advanced abdominal imaging, such as advanced abdominal sonography or abdominal CT, a large proportion of these patients can be diagnosed and appropriately managed using basic gastrointestinal imaging. Specifically, abdominal radiography and limited abdominal sonography can yield a definitive diagnosis and lead to an appropriate treatment plan in the vast majority of these cases. To this end, it is important to be comfortable with basic imaging of the gastrointestinal tract to allow for accurate and timely evaluation of these patients.

Goals

This talk will focus on common gastrointestinal diseases in dogs and cats and using basic gastrointestinal imaging to accurately diagnose these conditions. By the end of this talk, you will feel more confident in assessing some of the most common causes of canine and feline gastrointestinal clinical signs. To accomplish this, we will first review pertinent and clinically relevant points of anatomy in the dog and cat, focusing on radiographic anatomy with a brief foray into sonographic anatomy. From there, we will review five common diseases that cause gastrointestinal clinical signs. During this portion of the talk, we will rely heavily on real-world case examples to guide the discussion and highlight the imaging appearances of these diseases. Through this process, you will increase your confidence in recognizing these common diseases and feel more assured the next time you have a vomiting cat or a puking dog.

ANATOMY

Canine Radiographic Anatomy

Let us begin our anatomic journey in the stomach! In the canine patient, the stomach is positioned caudal to the liver and is centered on midline or just to the left of midline in a ventrodorsal or dorsoventral projection. In the vast majority of patients, there will be both gas and fluid within the gastric lumen as a normal finding. This can be incredibly helpful, as the gas and fluid will redistribute and change position depending on the recumbency of the patient. Of particular note is that in a right lateral projection, the pylorus is in the gravity-dependent portion of the abdomen and will fill with fluid. This is important as it is not uncommon to see a homogeneously soft tissue opaque rounded structure in the cranioventral aspect of the abdomen in a right lateral projection – do not mistake this fluid-filled pylorus for a gastric or hepatic mass! Conversely, in the left lateral projection, the pylorus should fill with gas, which will often lead to visualization of rugal folds. The left lateral projection is an essential projection when assessing for pyloric antral abnormalities, such as pyloric foreign bodies, as these will often be well outlined by gas and much more apparent in this projection than in a right lateral or ventrodorsal projection.

On our journey through the GI tract, we will next encounter the duodenum. The duodenum in a dog is relatively consistent in its position and can be best appreciated in a ventrodorsal projection, coursing to the right from the pylorus and then extending caudally into the mid abdomen along the right lateral aspect of the abdominal cavity. In the region of L3-L5, the duodenum will encounter the caudal flexure and continue its course cranially and medially. In the left lateral projection, it is relatively common for the duodenum to fill with a mild amount of gas. When this occurs, small regions of duodenal luminal outpouchings can be seen - the so-called pseudo-ulcers - which are actually regions of mucosal depressions overlying lymphoid follicles within the duodenal wall.

Aborad from here, the small intestine will be distributed throughout the abdomen; however, the small intestine is often contained caudal to the stomach and cranial to the urinary bladder. In a ventrodorsal or dorsoventral projection, the intestine are often centered to the right of midline. It is common for the intestine in a normal patient to have a mild amount of gas and fluid within the lumen, giving a somewhat variable appearance of the luminal contents.

Distally from here, we encounter the ileocolic junction. The ileocolic junction, similar to the duodenum, is relatively reliably located to the right of midline in a ventrodorsal projection in the region of the cranial abdomen (L1 to L3). Often the junction itself is not evident, though the cecum will often be apparent caudal to this and is commonly mildly to moderately gas-filled, frequently taking a tortuous course resembling a “reverse C” in a ventrodorsal projection. From here, the ascending colon continues cranially in the right lateral aspect of the abdomen. As it approaches the stomach, it will course laterally to the left as the transverse colon. The transverse colon is often located in the cranial abdomen in the region of L1 to L2. From there, the transverse colon transitions to the descending colon, which has a relatively linear course caudally toward the pelvic canal.

The descending colon is almost always located in the left lateral aspect of the abdomen, though occasionally a right-sided colonic location can occur as a transient change or normal variant.

Feline Radiographic Anatomy

In general, the feline gastrointestinal anatomy is relatively similar to the canine gastrointestinal anatomy and follows a similar overall appearance and course. A few clinically relevant points to know about the feline gastrointestinal tract are as follows:

- For the stomach, the feline stomach is often centered more to the left of midline in the ventrodorsal projection, and the gastric wall in a cat contains submucosal fat, which can occasionally be evident radiographically and give a striated appearance to the gastric wall.
- For the small intestine, it is relatively common to have empty or nearly empty intestinal segments, though occasionally gas-filled intestinal segments are present. These gas-filled intestinal segments can occasionally have a so-called string-of-pearls appearance that is the result of normal peristaltic motion and should not be confused with plication that would indicate a linear foreign body. Additionally, the feline small intestine is often relatively closely positioned in the mid-abdomen and is very commonly centered to the right of midline, particularly in obese patients.
- The cecum of a cat, when compared to the dog, is much smaller and is rarely gas-filled, thus it is often not evident radiographically. The feline colon follows a similar course to the canine colon, though in a small portion of feline patients, the ascending +/- portions of the transverse colon may not appropriately develop, and the ileocolic junction can join the ileum to the transverse or occasionally descending colon.

Basic Sonographic Anatomy

Let's lightly touch on some basic sonographic anatomy. The entirety of the gastrointestinal tract, from the upper esophageal sphincter to the anus, has repeatable wall layering with hypoechoic and hyperechoic (dark and bright) striping of the wall that corresponds to histologic portions of the gastrointestinal tract. The presence of wall layering is an expected and normal part of the anatomy, and alterations in the wall layering or a loss of wall layering indicates various gastrointestinal pathologies.

Working outward from the lumen, the first layer encountered is a thick hypoechoic mucosal layer, followed by a thin hyperechoic submucosal layer. Peripheral to that is a thin hypoechoic muscularis layer, and finally, there is a very thin and often inapparent hyperechoic serosal layer.

The overall thickness of portions of the gastrointestinal tract in dogs and cats can vary by patient size and by the portion of the tract being imaged. As a general rule, the gastric wall thickness in dogs and cats should be approximately 2–4 mm. The intestinal wall thickness should be 3–4.4 mm in dogs and 2–3.5 mm in cats, with the duodenum and ileum often mildly thicker than the jejunum. The colonic wall thickness is similar in both dogs and cats, at approximately 1.5 mm, making it the thinnest part of the gastrointestinal tract.

Lymph nodes draining the gastrointestinal tract are often small (2–7 mm in cats and 4–7.5 mm in dogs), elongated and fusiform in shape, and typically of similar echogenicity to the adjacent mesenteric fat.

Finally, let's briefly touch on the appearance of the pancreas. The pancreas, which is a notoriously difficult organ to evaluate for individuals beginning their journey into abdominal sonography, is located adjacent to the stomach, duodenum, and transverse and descending colon. The pancreas is often 1 cm or thinner in thickness and is generally similar in echogenicity to the liver (though in some dogs the pancreas can be hyperechoic, and in older cats it can be hypoechoic). A mildly dilated pancreatic duct can be seen in older cats as a normal finding.

CASE BASED DISCUSSION

Mechanical Obstruction vs Functional Ileus

One of the most common questions that leads to GI imaging is a concern for a mechanical obstruction versus a functional ileus. A mechanical obstruction, most often caused by obstructive gastrointestinal foreign material, can have a variable appearance depending on whether the obstruction is complete or partial and the location of the obstruction. Contrary to this, a functional ileus, which can occur for a variety of gastrointestinal and systemic diseases, will commonly present with gastric distension accompanied by uniform small intestinal distension.

For a mechanical obstruction at the gastric outflow tract, the stomach will often be moderately to severely distended with gas and fluid, though the stomach can be normal in size if the patient vomits prior to imaging. For a small intestinal mechanical obstruction, most often the patient will have two different populations of small intestine: the intestine orad to the obstruction will be moderately to severely gas- and fluid-dilated, and the intestine aborad to the obstruction will be empty. Contrast this with a functional ileus, where the intestine can vary from mild to severe distension, though the distension is often relatively uniform in nature and the intestine will often present as a single population rather than two discrete intestinal populations.

Often, the degree of distension for the distended intestinal population in a mechanical obstruction can increase confidence in diagnosing a mechanical obstruction. Various ratios have been evaluated to improve diagnostic

confidence, often comparing the intestinal diameter with the height of a vertebral body, most commonly the height of L5. For example, a ratio of 1.95 and above has a relatively high probability of obstruction, whereas a ratio less than 1.4 often excludes obstruction.

Linear Foreign Body

Linear gastrointestinal foreign bodies consist of string-like material that is anchored in a portion of the gastrointestinal tract. Once anchored, the gastrointestinal tract will often try to propel the linear foreign body in an aborad direction, and in doing so can cause various pathologies, including wall abrasions, the foreign body sawing into the wall and causing intestinal perforation, various degrees of mechanical obstruction, and occasionally the development of intussusceptions.

The majority of linear foreign bodies are anchored in the pylorus of the stomach and will extend distally to involve the duodenum, jejunum, and occasionally more distal portions of the intestine. Due to the common involvement of the pylorus as a site of anchoring, a left lateral radiographic projection can be critical in detecting pyloric foreign material, which can increase confidence in diagnosing a linear foreign body.

Additional changes that can occur and increase diagnostic confidence include the presence of plication and medial duodenal deviation in a ventrodorsal projection. Intestinal plication occurs when the intestine is folded into hairpin turns around the intraluminal linear foreign body. Radiographically, this will appear differently in dogs versus cats; dogs often have larger and more irregular regions of plication that can be best appreciated with irregular regions of intraluminal gas, appearing as comma and paisley-shaped gas foci. Conversely, cats will often have more tight and uniform plication with undulation of the serosal wall and minimal to mild gas within the intestinal segments.

Pancreatitis

Pancreatitis, which can be an important and relatively common cause of gastrointestinal clinical signs, can be somewhat tricky to definitively diagnose. From an imaging perspective, the majority of mild to moderate cases of pancreatitis may not be apparent radiographically. In more severe cases, the inflamed portion of the pancreas will cause inflammation of the adjacent fat. This inflamed fat, when combined with enlargement of the affected region of the pancreas, will lead to a mass effect that can be seen radiographically, deviating the adjacent portions of the gastrointestinal tract. Most often, pancreatitis will cause widening of the angle between the stomach and duodenum and caudal displacement of the colon. In addition, this change will often be accompanied by a loss of serosal detail and mild to moderate peritoneal effusion. Lastly, pancreatitis can induce secondary gastrointestinal changes, including gastric distension/gastroparesis, a functional intestinal ileus, and diarrhea.

Sonographically, pancreatitis appears as a hypoechoic region of the pancreas that is often enlarged. This will be surrounded by moderately to severely hyperechoic fat, consistent with fatty inflammation, and these patients often have abdominal effusion that is readily apparent sonographically.

Gastric Malpositioning

Gastric malpositioning, most commonly gastric dilatation and volvulus, is a relatively common cause of acute abdominal signs in dogs and is very rarely diagnosed in cats. Most often, gastric malpositioning will manifest as a gastric volvulus that is a 180-degree rotation with very typical radiographic changes. In these patients, the radiographic changes are most apparent in the right lateral projection and include moderate to severe gastric gas and fluid distention, craniodorsal displacement of the pylorus, and gastric compartmentalization.

When we learn about gastric dilatation and volvulus, it is often taught as a relatively routine diagnosis that will appear similar in every case. While that is relatively true, there are additional forms of gastric malpositioning that have been more recently described and are worth being aware of. A 360-degree gastric volvulus, which is much less common than the typical 180-degree volvulus, will cause a similar degree of gastric distention. However, in contrast to the 180-degree volvulus, the 360-degree volvulus will often lack the typical compartmentalization and classic craniodorsal displacement of the pylorus in the right lateral projection. Conversely, the 360-degree volvulus can be accompanied by esophageal distention with tapering of the esophagus at the level of the lower esophageal sphincter, and these cases often lack pronounced intestinal distention.

Another form of gastric malpositioning that has been relatively recently described – gastric instability/incomplete volvulus – occurs in patients in which the stomach is similarly malpositioned to a 180-degree volvulus; however, there is often no gastric outflow tract obstruction, and the degree of gastric distention can be minimal to mild. Additionally, these cases can be chronic in nature (weeks to years), with variable clinical signs that can range from asymptomatic to mild GI clinical signs.

Masses

Gastrointestinal masses, while less common causes of gastrointestinal clinical signs than some of the previously described diseases, are important to diagnose as they can have a distinct treatment course and prognosis. Detection of abdominal masses can be challenging radiographically, particularly for small lesions, though there are a few features that can aid in the detection and diagnosis of GI masses. First and foremost, if

an abdominal mass is apparent, closely evaluate for any evidence of gas in the central portion of the mass. If present, this is often an indicator that the mass is gastrointestinal in origin, with the gas representing gas within the intestinal lumen. In addition, in cases such as this, carefully evaluate for any evidence of free gas within the abdominal cavity, as this would indicate perforation of the mass and represent a surgical emergency for septic peritonitis. Small intestinal masses can sometimes cause a chronic partial small intestinal mechanical obstruction. In these cases, small bits of food and other material will accumulate immediately upstream of the mass and appear radiographically as granular mineral material, creating a “gravel sign”. Finally, intestinal masses can be accompanied by adjacent peritoneal changes radiographically, including a regional loss of serosal detail and regional lymphadenopathy (which may appear as a separate mass/masses). Sonographically, the vast majority of gastrointestinal masses appear as hypoechoic lesions of the gastrointestinal wall, most often with a complete loss of normal wall layering.

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