Radiography of the Acute Abdomen

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Hello! I have focused on the most common abdominal disease that gets imaged in emergency practices. I have concentrated on radiology since this is the current standard of care in vetmed. There is ultrasound images included just to compare the correlative imaging and benefits of both.

The abdomen has poor inherent contrast and we exploit our radiographic parameters to contrast abdominal fat from the soft tissue dense parenchymal organs. When using analog filmscreen systems, this means we shoot a low Kvp setting to enhance radiographic contrast. Be sure to compensate with adequate mAs to achieve good penetration.

Abdominal radiographs are often the first diagnostic procedure performed, other than the physical exam, to try to determine if the cause of vomiting is best treated with surgery. This can be a challenging interpretation and increased confidence in your radiographic diagnosis can be obtained by utilizing contrast studies.
In the upper GI examination, barium contrast is utilized if GI perforation is unlikely. There is an appropriate dose of contrast which ranges from 7-13 mls/kg in the dog with larger dogs getting the lower dose. Cats are approximately 15-20 mls/kg with the average cat getting 100mls. Food should not be mixed with the barium contrast because this causes filling defects and slows gastric emptying. The stomach should be moderately distended with contrast on the immediate postcontrast radiographs with decreased gastric emptying seen in non-distended stomachs even in the normal patient. The gastroduodenal angle can be assessed immediately in an attempt to identify pancreatic enlargement.

When interpreting contrast studies we assess the degree of distention of the viscous containing the contrast, speed of contrast progression through the tract, filling defects in the contrast pool, mucosal irregularities at the contrast/mucosal interface and any mass effect on the organs which are made more visible with contrast. At 30 minutes after contrast administration, noticed a large amount of contrast has entered the nondistended small intestine.
Contrast progresses out of the stomach and through the small intestine over time and at one hour after original contrast administration it is noted that the small intestine contains most of the contrast. The rugal folds are evident in the stomach with a moderate amount of contrast persisting in the gastric lumen.

Only a small residue of contrast remains in the stomach at 1-1/2 hours after administration. The cecum, ascending colon and transverse colon are now contrast-filled. Most of the contrast resides in the distal portion of the jejunum and ileum.

3 hours after contrast administration

All of the contrast has left the stomach. Most of the contrast is present in the cecum and colon.
Notice that gastric emptying and intestinal transit is twice as fast in the cat as the dog.

<table>
<thead>
<tr>
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<th>Normal Gastric Emptying Time</th>
<th>Normal Intestinal Transit Time</th>
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<tbody>
<tr>
<td>Dog</td>
<td>3 hours</td>
<td>3 hours</td>
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<tr>
<td>Cat</td>
<td>1.5 hours</td>
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For liquid barium in the absence of food

Acute regurgitation is included in this presentation because a regurgitating patient often presents with the history of vomiting. It is up to our skillful history taking methods to discern regurgitation from vomiting.

Esophageal dilation is often an obvious radiographic finding if a gas filled megaesophagus is present. When there is fluid in the esophagus due to dysmotility, this becomes a more challenging interpretation. Notice the abrupt dorsal and ventral edges to the increased opacity overlying the caudodorsal lung and also noticed the ventral mass effect on the trachea in the cranial thorax. On the VD view there is widening of the caudal mediastinum.
Other causes of intermittent regurgitation include a hiatal hernia. This is most commonly seen in the Bulldog and can be intermittent. Therefore a patient can have signs of regurgitation caused by a hiatal hernia without a hiatal hernia being visible on survey radiographs due to its dynamic nature.

Esophageal foreign bodies can be challenging to interpret as well. It is nearly always a small breed dog and esophageal dilation should be evident. The oral dilation of the cranial thoracic esophagus abuts the hard soft tissue interface at the base of the heart which is a useful radiographic finding when interpreting foreign material in the GI tract. Fluid in the esophagus would not have such an abrupt interface.

Remember that esophageal dilation can be secondary to aerophagia as well. If aerophagia is the cause of esophageal dilation, the stomach and intestine will also be gas dilated typically. Also remember the esophageal dilation can be iatrogenic if the patient is anesthetized.
When interpreting findings associated with the stomach, it pays to know if the patient was in left or right recumbency when the images were obtained. In right lateral recumbency air should be filling the dorsally positioned fundus. When the patient is flipped into left lateral recumbency, air will move into the more ventrally positioned pylorus allowing assessment for pyloric foreign bodies or masses. When fluid interfaces with gas within the GI tract, there is typically a rounded meniscus.

Notice that the fluid-filled pylorus on the right lateral projection can mimic a mass caudal to the liver. Be certain to take a left lateral projection to help determine if this soft tissue mass seen in the right lateral view fills with air as the normal pylorus should.
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Geriatric canine with chronic weight loss and anorexia who developed hematemesis tonight.

Gastric adenocarcinoma with liver, lymph node and spleen metastasis.

Notice the beaked appearance to the stomach gas interface with the fluid within the pylorus on the lateral radiograph. This is an abnormal gas interface and makes an infiltrative process more likely although further imaging would be necessary for a more definitive assessment.

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Old Chow Chow
Acutely gagging and retching.

The classic radiographic appearance of GDV is represented here with gas dilation of the stomach, dorsal positioning of the pylorus evidenced by compartmentalization at the craniodorsal margin of the stomach. Notice the esophageal dilation which is often present with GDV.

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GDV 20 minutes later.

Unfortunately, this appearance can be misinterpreted occasionally with dire consequences for the patient.
Notice on the right side of the duodenum on the VD view there is extraluminal gas visualized.

Any delay in the surgical management of GDV can lead to rapid decompensation by the patient.

These last 3 cases all represent patient's that had a delay in surgical intervention for various reasons. Notice the lack of obvious evidence of compartmentalization on this initial image performed on a middle-aged female Mastiff.
This is the same patient imaged one hour and 40 minutes later. Despite the severe gastric distention which should stretch the stomach wall thin, notice the irregular interface of the fundic gas with a thickened, irregular gastric wall. This is a sign of devitalization of the gastric wall.

Not all gastric dilations are GDVs. Gluttony can present with abdominal distention and anxiety although the patient should have no evidence of cardiovascular shock. The patient should also be non-tympanic.

Proximal GI obstructions can be difficult to recognize because an obstruction can be present in the stomach or duodenum without intestinal dilation noted in the mid abdomen. Be sure to assess the patient for unusual gas opacities which can represent radiolucent foreign bodies.
Gastric outflow obstructions would most commonly have significant gastric dilation. Assessing the pylorus for a fixed outflow obstruction can be difficult. Gravelling is helpful in this case. Notice the perfectly round lucency with surrounding gravelling representing a ball in the pyloric outflow tract.

Uncommonly, GI foreign bodies can be radiopaque. This is like a gift. If there is GI dilation in combination with radiopaque foreign material, then obstruction is likely.

Notice the irregular contour of the fundic gas with a fluid within the pylorus on the right lateral projection included here. This is a subtle finding although interpreted in combination with the irregular soft tissue opacity in the region of the pyloric antrum on the VD view, this becomes suspicious for foreign material.
In the left lateral view of the same patient imaged above, the fundic gastric moves into an air-filled pylorus. If an irregular soft tissue opacity persists within the pylorus on the left lateral view, this is highly suggestive of a soft tissue dense pyloric foreign body. Also notice that by flipping the patient gas moved in the intestine to reveal intestinal plication as well representing a linear component to this GI foreign body.

This is an older cat with severe gastric dilation. It can be challenging to recognize gastric dilation when there is fluid and gas dilation. The slight gravelling noted ventrally on the lateral view is very helpful to confirm this as gastric dilation. This patient has a large infiltrative duodenal adenocarcinoma causing near complete obstruction of the proximal GI tract.

In this clinical scenario, gastritis and gastric ulceration is considered the most likely etiology. With these as the top differential diagnoses, assessing the patient for gastric perforation is indicated. Notice the small amount of air along the fundic wall in the left cranial quadrant of the abdomen on the VD view. This finding indicates aggressive therapy.
Large amounts of free peritoneal air can be challenging to interpret as well. Free peritoneal air, if not due to recent surgery, yields a guarded to grave prognosis with GI perforation the most likely cause of pneumoperitoneum.

Intestinal plication from a linear foreign body can often be seen on survey radiographs. In a cat, a dilated segment of bowel with a lobular, corrugated serosal margin in the mid ventral abdomen is the most common finding. Often the foreign body is lodged in the pylorus and extends down the duodenum in the right lateral abdomen which is seen to be plicated on the VD view.

Uncommonly, the linear foreign body is radiopaque. I find this study useful to understand that the foreign body is wadded and stuck in the pylorus with the intestine creeping up the string as the string extends into the jejunum.
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Criteria for assessing intestine for obstruction

- Is there intestinal dilation? compare to the mid-vertebral body diameter
- Is it small versus large bowel?
- Is there evidence of peristalsis (varying diameter)?
- Is there any normal diameter small bowel visible? two populations of bowel indicate a segmental bowel problem?
- Is there any graving evident?
- Are there any abnormal gas opacities due to plication, gas trapping in fibrous material or gas adjacent to foreign material?

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A radiopaque intestinal foreign body is noted just right of midline in the dorsal abdomen. This, in combination with segmental dilation of the small bowel and with mild gas and fluid distention of the stomach makes a mid GI obstruction likely. Notice there are some normal loops of small intestine which are fluid-filled and in the mid ventral abdomen documenting two populations of bowel and therefore segmental intestinal disease.

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Too much gas distended bowel is visible to represent large intestine alone. Gastric distention is also noted to a mild degree and therefore this likely represents a proximal GI obstruction. There are unusual opacities noted which are suspicious for foreign material although none are definitive. The obstructive pattern alone is reason for surgery.
There is intestinal dilation, small intestinal in origin based upon the colon containing feces and there being too much gas distended bowel to be large bowel alone. The dilated intestine varies in diameter typical of peristalsis and there are multiple segments of normal intestine visualized documenting 2 populations of bowel. This is a classic intestinal obstructive pattern.

There are gas dilated segments of bowel which are stacked in the cranial left abdomen. Another segment of dilated intestine is noted looping stiffly through the mid abdomen. There is an abnormal gas trapping pattern typical of fibrous foreign material in this looping bowel. Gravelling is noted at one end of this potential foreign material. There is an abrupt interface of this suspected soft tissue foreign body with gas dilated bowel.

Cats do not normally pant with stress and therefore should not have a gas distended stomach such as that seen here. That finding alone is a tip off to severe GI disease if the patient is not aerophagic from dyspnea. Notice the loss of serosal detail and the dorsal and leftward mass effect on the colon.
This upper GI examination is useful to localize the lesion in the proximal jejunum and to better discern the presence of both dilated and normal diameter intestine typical of segmental disease. This patient had an obstructing intestinal carcinoma.

Focal loss of serosal detail is challenging to interpret although can be seen with diseases such as pancreatitis. Pancreatitis can be present causing severe clinical signs with normal survey radiographs. If pancreatitis is severe, sometimes the focal peritonitis in the right cranial quadrant of the abdomen is visible radiographically by loss of serosal detail and a subtle mass effect displacing the bowel caudally out of the right cranial quadrant of the abdomen.

Most commonly, vomiting patient's presenting to emergency services have gastroenteritis. Radiographs of a patient with gastroenteritis can be normal or can be represented by mild uniform fluid distention of the small intestine such as seen in this patient. It is impossible to rule out a radiolucent foreign body, pancreatitis, intussusception or bowel infiltration on survey radiographs and therefore abdominal ultrasound or a contrast study is often implemented if the patient does not respond to medical management.
This patient was acutely in shock and severely lethargic which is atypical of a foreign body obstruction alone. There is the appearance of severe fluid and gas distention of the bowel although the loss of serosal detail is indicative of a more severe disease than acute intestinal obstruction. The patient should not have any degree of peritoneal inflammation/fluid within acute obstruction. Pancreatitis should not have bowel dilation of this degree. This patient unfortunately had a mesenteric torsion recognized at surgery.

Most commonly when the patient has an intussusception, the general practitioner has palpated the suspected intussusceptum prior to requesting radiographs or an ultrasound. In my opinion, intussusception is often not specifically seen on survey radiographs and therefore an abdominal ultrasound should be the first diagnostic study performed, if available.

A pyometra can cause fluid dilated tubular structures in the lateral recesses of the caudal abdomen and dorsal to the bladder. Uterine distension should not have gas within the lumen and this helps discriminate dilated bowel from uterine distention. Notice in this poor old girl she has concurrent severe discospondylitis at T12-13 through L1-2. At least these lesions are without our power to resolve once they are recognized.
Abdominal distension and serosal detail

The best of clinicians can have difficulty discriminating fluid distension of the abdomen from a fat abdomen during the physical exam. Notice the differences in serosal detail seen radiographically.

In the cat, fluid distention of the abdomen can mimic a mass effect because of the mesenteric and omental fat bunching in the mid abdomen.
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Notice the slight loss of serosal detail cranial to the bladder and in the left lateral aspects of the abdomen secondary to bladder rupture from urethral obstruction.

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A distended abdomen can be secondary to severe organomegaly as well as evidenced here. Noticed the dorsal and caudal displacement of the stomach indicative of hepatomegaly. The caudal contour of the liver is lobular which is atypical of a benign diffuse hepatopathy and more compatible with infiltrative neoplasia.

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Acute collapse
This is a classic presentation of a ruptured splenic mass in an older large breed dog. The mid abdominal mass can be difficult to discern when there is loss of serosal detail from hemorrhage. Often the amount of fluid in the abdomen is only moderate although, because it is frank blood, the patient can be severely affected. Notice the slight loss of resolution between the falciform fat and the liver and splenic margins.

Diaphragmatic hernias can occur with trauma as well as ruptured bladders or hemorrhage into the abdomen. Diaphragmatic hernias can often have only falciform fat or omentum herniated into the abdomen and this can be difficult to discern especially if concurrent pleural effusion is present. Paying close attention to the opacity of the herniated tissue can help determine it’s etiology. Assessing opacity of any mass in any organ system is imperative for accurate interpretation.

This is a classic situation of trauma with mild pleural effusion and tachypnea being present clinically. Is there a concurrent diaphragmatic hernia present the can be surgically repaired?
A peritoneogram is a safe and easy study to perform when trying to diagnose diaphragmatic hernias. Nonionic iodinated contrast (never barium) is injected free within the peritoneum and the patient is moved around to disperse the contrast. Repeat radiographs show no evidence of contrast leaking into the thorax which helps confirm the lack of a diaphragmatic hernia. False negative studies can occur if tissue is incarcerated through a small diaphragmatic rent.

It has become common for the emergency clinician to utilize ultrasound to assess the trauma patient for free fluid. Assessing the patient cranially, caudally and in both the right and left dorsal gutters of the abdomen for small amounts of fluid is a quick method to determine the severity of abdominal trauma. You do not need to be a full fledged sonographer to perform the study and in a short training session can gain the skills to recognize free abdominal fluid.