

# **Basics of abdominal radiographic interpretation**

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Abdominal radiographs can be challenging to interpret and overwhelming due to the variation that exists between species, breeds and definitions of “normal”. By understanding how different nonpathological conditions can affect the appearance of abdominal radiographs and by using a systematic approach to reviewing radiographs and recognizing key features, your interpretation of even the most challenging radiographs will improve substantially.

## **Abdominal radiographs**

Proper interpretation begins with a proper study. Without a proper radiographic study there is a higher risk of missing important radiographic findings or misinterpretation. Radiographic assessment of the abdomen should include at least two orthogonal radiographs (e.g. lateral and ventrodorsal view). These radiographs should include the entire diaphragm and extend just caudal to the hips. The ideal radiograph is performed during expiration as this will prevent the abdomen from being crowded during inspiration. Although two radiographic views are often sufficient, both right and left lateral radiographs are often helpful because of the differences in the distribution of the gas in the stomach on each view. On a left lateral radiograph, the gas will rise into the pyloric antrum potentially highlighting any foreign material stuck in the pylorus. Dorsoventral radiographs are of limited use as they will have a “crowded” appearance and reduce organ conspicuity. Occasionally a dorsoventral radiograph can be useful to highlight a dorsal gastric mass as the gas will rise and highlight the lesion. A horizontal beam radiograph with the dog in lateral or dorsal recumbency can also be useful when evaluating for free air in the abdominal cavity.

## **Radiographic interpretation**

When evaluating abdominal radiographs begin by approaching the images in a systematic manner. You may evaluate by order of organ system, in a clockwise direction or perform a four-quadrant evaluation. Once the radiographs are evaluated it is important to interpret or attempt to explain the radiographic findings which requires consideration of signalment of the patient, history, physical examination findings and results of other diagnostic tests. Following initial radiographic evaluation and review of pertinent clinical information it can also be helpful to assess the radiographs looking for specific radiographic findings such as

gastric dilatation and volvulus (GDV), cystic calculi, small intestinal obstruction, or pneumoperitoneum.

In order to perform an accurate and useful interpretation of radiographs it is important to recognize normal findings as to not confuse them with pathology. Below is a guideline for the normal radiographic anatomy of major abdominal organs<sup>1,2</sup>.

#### *Liver*

- Almost completely within the costal arch
  - The caudoventral border of the left lateral liver lobe may extend slightly beyond costal arch in dogs
  - Deep chested dogs have livers that lie more completely within costal arch
- The liver should have sharp margins
- The gastric axis should be at 90° angle with spine
- The gallbladder may be seen in cats protruding ventrally on the lateral radiographs

#### *Spleen*

- Smooth margins
- Size is very subjective in dogs
- Shouldn't see tail of spleen on lateral radiographs in cats

#### *Kidneys*

- Measured best on VD radiographs because of less magnification artifact
  - Dogs: 2.5 - 3.5x length of L2
  - Cats: 2.4 – 3.0x length of L2
- Right kidney harder to see because it abuts the caudate lobe of the liver and is often obscured by gas/fecal material in cecum/ascending colon
- Smooth margins
- Ureters not normally seen

#### *Urinary bladder*

- Size is variable
- Smooth margins
- Uniform opacity

#### *Prostate*

- Not seen in neutered dogs
- Smooth margins
- Size in intact males is variable
  - Enlarged if prostatic length >70% of distance from sacral promontory to pubic brim<sup>3</sup>.

### *Uterus*

- Not normally seen in the bitch or queen
- Radiographs limited to pregnancy or pathological conditions
- Visualization limited by image contrast and uterine size

### *GI tract*

- *Stomach*
  - Size is variable
  - Pyloric antrum is in the right cranial abdomen, fundus on left
    - Pylorus located along mid line in cats
  - Wall thickness cannot be accurately assessed on radiographs because any fluid or food adhered to the wall is the same opacity as the wall
  - Gastric emptying times can range from 4 to 16 hours depending on type of food
- *Small intestine*
  - Dog: Maximal normal diameter less than 2x width of rib or <1.6x height of L5 vertebral body at narrowest point
  - Cat: 12mm, 2x height of central portion of L4, or ratio max SI diameter to L2 vertebral endplate of <2.0
  - Intestinal wall thickness cannot be judged on survey radiographs because any fluid or food adhered to the wall is the same opacity as the wall
  - Gas within bowel segments is variable
    - Fasted cats should have few gas containing segments of small intestine
    - Cats that are not fasted may have gas throughout the bowel
  - Shape of intestine should be smooth and continuously curving tubes with cylindrical or rounded gas opacities
- *Large intestine*
  - Size is variable
  - Cecum often gas filled in dogs and not usually seen in cats
  - Ascending, transverse and descending colon should be recognized

Some abdominal organs are not routinely seen on normal abdominal radiographs with a few exceptions. The pancreas is not usually seen with the exception of obese cats where the intraperitoneal fat may create enough contrast resolution to allow the left limb to be seen. The adrenal glands cannot be seen normally, although in some cats incidental mineralization of the adrenal gland may occur allowing them to be seen. Normal lymph nodes cannot usually be seen. Although these organs are not usually identified it is still important to evaluate the region where these organs reside as there may be local findings that may reflect changes in these tissues.

There are also many normal or incidental findings that may be seen and mistaken for pathology<sup>4</sup>. Some of the most common of these include:

- The pylorus on right lateral radiograph often has a soft tissue opacity with round margins and may be mistaken as a mass
- There are many nonpathological conditions that can result in extension of the hepatic margins beyond costal arch
  - Overexpansion of thorax
  - Older dogs and cats with stretching of triangular liver
  - Obese dogs
  - Brachycephalic and chondrodystrophic dogs
  - Neonatal and young cats and dogs
- The cecum may contain gas
  - Forms a C shaped segment of intestine in the right mid to cranial abdomen
- The spleen is often enlarged secondary to sedation
- Intraperitoneal fat in cats causes small bowel to be located centrally and/or to the right side
- The ventral aspect of L3 and L4 may be slightly where the diaphragm inserts
- The deep circumflex iliac artery and vein may be seen as two small soft tissue opaque nodules in retroperitoneal space ventral to L6
- Bates bodies
  - Incidental mineral opaque nodules in peritoneal space caused by dystrophic mineralization within nodular fat necrosis

### **Interpretation of specific radiographic abnormalities**

Interpretation of abnormalities should consist of assessing the size, shape, number, margins, location, and opacity of the abnormal structures. The guidelines of normal abdominal radiographic anatomy provided above can help with this interpretation but are not definitive as there are many normal animals which may be outside of these references ranges. It is important to recognize the limitations of radiographs and realize there is variation between different breeds and species in regard to what is “normal”.

When interpreting abdominal radiographs one of the first things that should be assessed is the serosal detail. If the radiographs are performed with proper exposures and positioning the margins of the majority of the abdominal organs are easily seen and discernible from each other. Many conditions can result in decreased serosal detail and using the distribution of the decreased serosal detail it can aid in prioritizing differential diagnosis (Table 1).

**Table 1: Causes of decreased serosal detail and there most common distributions**

<b>Cause</b>	<b>Distribution</b>
Abdominal effusion (e.g. hemorrhage, urine, bile, transudative effusion, chyle, neoplastic effusion)	Diffuse (will depend on amount)
Peritonitis	Focal or Diffuse
Pancreatitis	Focal (mid cranial abdomen)
Carcinomatosis	Diffuse
Emaciation/lack of fat	Diffuse throughout peritoneum and retroperitoneum
Juvenile animals with increased brown fat	Diffuse throughout peritoneum and retroperitoneum
Mass effect	Focal

One of the most difficult organs to evaluate is the gastrointestinal tract because of the dynamic nature of this organ and the large amount of variation present. Evaluation of the gastrointestinal tract is often focused on determining if there is an obstruction or not. Signs of ileus and gastric distension may be noted and are important to recognize. Ileus refers to failure of intestinal contents to pass through the intestinal tract and can be categorized as either mechanical (secondary to physical obstruction) or functional/paralytic. Mechanical obstruction typically results in bowel of larger diameter with both fluid and gas while functional ileus typically results in more uniform gas filled segments. Other radiographic findings seen with mechanical ileus are listed below (Table 2). Causes of functional ileus are numerous and include recent abdominal surgery, severe dehydration, electrolyte imbalances, drugs (e.g. analgesics, general anesthesia, sedatives, parasympatholytics), GDV, severe gastroenteritis, intestinal volvulus and neurologic dysfunction. Mild gastrointestinal dilation can also occur independent of ileus which can create a diagnostic challenge. Diseases causing mild distension while preserving motility include bowel wall neoplasia, enteritis, or granulomatous wall infiltrate. Patients with mechanical ileus often have some segments of the intestine that are normal in size whereas functional ileus is typically more generalized.

**Table 2: Radiographic signs associated with mechanical ileus**

Mixed population of distended small intestinal segments
Stacking of intestinal segments
Segments of intestine creating hair pin turns
Plication
Abnormal/sharply demarcated luminal gas

## **Conclusions**

It would be ideal if a definitive diagnosis could be reached on all radiographic so that appropriate treatment could be initiated immediately. Unfortunately, this is not always possible

and making appropriate clinical decisions in these cases can be challenging. For this reason it is important to correlate the imaging findings with signalment, history, physical examination and other available clinical information so that the radiographic findings can be prioritized appropriately. In this way, radiographs will compliment your clinical practice and become an important tool to guide you.

## References

1. Thrall DE. *Textbook of Veterinary Diagnostic Radiology*. 6<sup>th</sup> edition. St Louis, 2013, Elsevier.
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