What’s Your Abdominal Diagnosis?
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Interpretation of radiographs can be challenging. Many factors are involved, but these steps all relate to one central idea … be systematic. It begins with production of good quality radiographs, moves to detection of radiographic abnormalities, coalesces into creation of differential diagnoses and a radiographic diagnosis and concludes with a plan for achieving a definitive diagnosis.

Making quality radiographs involves correct radiographic technique. Using a technique chart that is tailored to your x-ray machine and film/screen combination or digital detector best facilitates this task. Proper patient positioning is important for consistent projection of anatomy. Even slight obliquity of structures may create a very different appearance of normal anatomy.

A significant part of image interpretation is pattern recognition. To facilitate pattern recognition, images should be displayed in the same manner every time. A complete radiographic study has a minimum of 2 radiographic projections allowing for more precise localization of lesions. Making only one radiographic projection often leads to more questions than it answers. Viewing images in a dark room without extraneous light is ideal.

A systematic approach starts with pattern recognition from which a list of differential diagnoses is derived. Next the list of differential diagnoses is prioritized based on signalment, physical examination findings, clinical data and other radiographic signs. Sometimes, the diagnosis is evident after this step, but often a plan must be formulated to arrive at a more definitive diagnosis. This plan may involve more imaging (contrast medium procedures, ultrasound, CT, MRI), additional lab tests or tissue aspirates/cytology. Without prioritization of the differential list, the correct plan for definitive diagnosis cannot be formulated.

The ability to describe lesions will lead the interpreter to the correct conclusion. The best method for describing lesions is using Roentgen signs. The Roentgen signs are number, size, opacity, position/location, margin/contour, and shape. These signs should be described for all anatomy on the radiograph. Thankfully, most of the structures on a radiograph are normal and are usually not described. Next, each type of radiographic series is reviewed in a systematic manner to ensure that all structures are evaluated. Many methods for evaluating each study are available and should be tailored to the individual. A method for evaluating the thorax, abdomen and musculoskeletal system are provided below.

Ideally, radiographs are interpreted without knowledge of clinical history. This helps avoid bias when interpreting radiographs. However, this is impractical for most veterinarians. One must be cautious and not try to make radiographs fit other clinical signs or laboratory data.

Each set of radiographs record a disease process at one specific, short instant in time. Comparing the current radiographic study to any and all radiographic studies of the same patient helps establish trends. One can evaluate if a disease is improving, worsening or staying the same.

Abdomen
A systematic approach for interpretation of abdominal abnormalities involves four stages. Stage 1 is extra-abdominal soft tissue structures, bones (spine, pelvis, ribs, hind legs) and thorax. Stage 2 involves an overview of the abdomen evaluating for changes in serosal margin detail and abdominal masses. Stage 3 involves evaluation of structures that are normally seen in the abdomen: liver, stomach, spleen, kidneys, urinary bladder, prostate gland (males) and intestinal tract. Stage 4 involves evaluation of structures that are normally not seen: pancreas, adrenal glands, ureters, urethra, lymph nodes, ovaries and uterus. Each region should be evaluated for changes in Roentgen signs. Once all the Roentgen signs are described, a prioritized differential list is created and then a radiographic diagnosis is formulated.

Approach to the abdomen.
The abdomen is a complicated area that contains numerous structures, many of which are able to change shape and position. No two abdominal images look alike even in the same patient. Understanding the range of normal is a skill that is developed over time.

Having a systematic approach to the abdomen is important so that nothing is missed. Whether your system is based on organ systems or physical location on the image, be sure to stick with it so that it becomes second nature.

As always, make sure to describe all abnormalities using the standard Roentgen signs:

- Size, shape, number, location, margination, opacity

In the abdomen it is useful to include an additional Roentgen sign:

Mass effect
This is because some of the abdominal organs can be displaced by masses and the direction of displacement can tell a lot about the origin of the mass.
Abdominal cavity – It’s all about location!
The abdominal cavity consists of both a peritoneal and a retroperitoneal space. The majority of the abdominal viscera is positioned within the peritoneal space and is surrounded by visceral serosa. By contrast, the kidneys and major abdominal vessels (abdominal aorta and abdominal vena cava) are positioned in a sublumbar location within the retroperitoneal space. Some of the abdominal organs, such as the liver, stomach, kidneys, urinary bladder, prostate, and descending colon, lie in a relatively predictable location within the abdomen. Other organs such as the small intestine, the proximal segments of the colon, and the spleen, can be variable in location, dependent on the position, size, and shape of the other internal organs.

Intra-abdominal detail
Intra-abdominal contrast in the normal abdomen is produced by inherent contrast differences of air, fat, soft tissue/fluids, and bone. In normal animals, abdominal organ margins are defined by surrounding intra-abdominal fat. As a result, the intra-abdominal detail is often better in obese animals. Conversely, very thin or emaciated animals that have very little intra-abdominal fat, and young animals that have intra-abdominal fat that is more dense than that of adults (higher water content, more like soft tissue), have poor intra-abdominal detail.

Gastrointestinal tract
Stomach
The appearance of the stomach is extremely variable and depends on the gastric contents that may be gas, fluid, solid material or an admixture. The size of the stomach and relative position within the abdominal cavity also changes with the degree of distension. In animals that are nervous, panting, or dyspneic, aerophagia can occur, resulting in a large volume of gas accumulating within the stomach and sometimes in the small intestine. Although not pathologic in and of itself, this can produce significant gastric distension.

1. Ventrodorsal (VD) Projection - The cardia, fundus, and body of the canine stomach are generally positioned to the left of midline on the ventrodorsal projection. The antral region of the stomach is positioned on midline and to the right of midline. The pyloric region is positioned to the right of midline in most instances. In the cat, the cardia, fundus, and body are positioned to the left of midline, while both the pyloric antrum and pyloric region of the stomach are positioned more on midline. When gas is present within the stomach, a gas cap is formed in the pyloric region (the most nondependent portion of the gastric lumen).

2. Lateral Projections - On a left lateral projection, if gas is within the stomach lumen, it accumulates within the pyloric region and produces a round gas lucency in the cranioventral abdomen. Usually the stomach is contained within the caudal most aspect of the rib cage and the long axis of the stomach roughly parallels the caudal most ribs. On a right lateral projection, because the pylorus is more dependent, the pyloric lumen fills with fluid. In some instances, this can produce a soft tissue or fluid-opaque circular opacity in the cranioventral abdomen. It is important to be able to differentiate a fluid-filled pylorus from an abdominal mass. The long axis of the stomach on a right lateral view, again is typically within the confines of the caudal portion of the rib cage. When markedly distended, the caudal margin of the stomach can extend past the rib cage margins.

Remember the LEFT ARM rule for the stomach. Place your left arm across your abdomen with your elbow bent at 90 degrees. Your shoulder and upper arm represent the fundus, your forearm is the body and your fist is the pyloric antrum. Now bend all around, replicating the position of the patient in different recumbencies and imagine where the fluid and gas will go based on the effect of gravity.

Small intestine
The radiographic appearance of the small intestine is extremely variable and depends on the luminal contents of the bowel, as well as the position and size of the other abdominal organs. The small intestine is highly mobile within the abdominal cavity, and can be easily displaced simply by position, alterations in the amount and composition of luminal contents, and the size and location of other internal organs. The definition of the serosal margins of the small intestine is improved in the presence of a large volume of intraabdominal fat. In addition, the ability to identify where the small intestine is located is improved when intraluminal gas is present.

In general, the small intestine should show some variation in diameter throughout its length, however a rule of thumb is that no segment should be more than approximately 50 percent larger than any other segment. Other guidelines for assessing small intestinal distension are that no small intestinal segment should exceed approximately 2-3 times the width of a rib or the height of the central part of a lumbar vertebral body (L2) on a lateral view. In the cat, another general rule is that no intestinal segment should exceed approximately 12 mm in diameter. The amount of gas present within the intestinal tract is extremely variable in the dog. In the cat, typically only a very small volume of gas is present in the normal animal.

Cecum and large intestine
In the dog, on the ventrodorsal projection, the cecum is often identified in the midabdomen to the right of midline. Often the cecum is gas-filled, and has a C-shaped appearance. The cecum on a lateral projection is often identified in the midabdomen positioned slightly dorsally. The cecum is usually not evident in the cat radiographically.
On the ventrodorsal projection, the large intestine is approximately "7" or "S" shaped. The large bowel is often times easily seen due to the presence of gas or granular appearing feces within the bowel lumen. Although the large intestine has a much more consistent position within the abdomen than the small intestine, there is some redundancy within the large bowel, which may cause a drift in the position of all but the most terminal segment. When the colon is empty, it may in many instances be difficult to distinguish from small intestine.

**Liver**
The liver has uniform soft tissue opacity, and in normal animals is positioned mostly within the confines of the rib cage. The cranial margin of the liver is adjacent to and conforms to the diaphragmatic margin, and the caudal margin of the liver is adjacent to the cranial margin of the stomach. On the lateral projection, the diaphragm and stomach often define the location and margins of the liver. Generally, the ventral margins of the liver are best seen on the lateral view due to the presence of surrounding fat within the falciform ligament. The caudoventral tip of the liver should not usually extend far beyond the costal arch. The margins of the liver should be sharply defined. On a ventrodorsal projection, the liver margins are typically not as well seen. The size of the liver is often assessed indirectly by position of the stomach. Except when surrounded by a large volume of fat, the lobes of the liver are often not defined, and the liver has uniform soft tissue opacity. In normal animals, the gallbladder is typically not seen due to its similar opacity to the liver parenchyma.

**Spleen**
The spleen is an elongate organ that is loosely associated with the greater curvature of the stomach. On the ventrodorsal projection, the head of the spleen is usually evident adjacent to the left lateral body wall, caudal or lateral to the stomach, as a triangular soft tissue structure. The body and tail may be difficult to see on the VD view as it extends across midline. In cats, the spleen is much smaller and may be positioned entirely along the left body wall. On a lateral projection, the body and tail of the canine spleen are seen end-on along the ventral aspect of the midabdomen as a flattened triangular structure. In cats, it is rarely seen on lateral radiographs. In both the dog and cat, the head of the spleen may be identified dorsally, adjacent to the vertebrae, cranial to the kidneys. Because the spleen is elongate, sometimes it folds slightly on itself. When this happens, a summation is seen at the fold, producing an increased opacity radiographically in the midsplenic parenchyma.

**Urogenital tract**

**Kidneys**
As stated before, the kidneys are located in the retroperitoneal space in the sublumbar region. The kidneys have a rounded bean-shaped appearance on both the lateral and ventrodorsal projections. The feline kidney may be more rounded than that of the canine. Demarcation of renal borders is improved in the presence of a large volume of retroperitoneal fat. The right kidney is more cranially positioned than the left kidney and its cranial margin is often obscured due to silhouetting with the renal fossa of the liver. The left kidney is more variable in position and is often displaced caudally by gastric distension.

**Kidney size**

**Canine**
The canine kidney is approximately 2.5 to 3.5 times the length of the 2nd lumbar vertebra, as measured from the ventrodorsal view.

**Feline**
The feline kidney is approximately 2.4 to 3 times the length of the 2nd lumbar vertebra.

Keep in mind that these are very crude estimates of kidney size, and that very often normal kidneys can measure outside this range (especially smaller). Conversely, kidneys that measure within these guidelines can, in fact, be abnormally large or small, depending on actual renal volume that is not assessed using this crude measurement.

**Ureters**
The ureters are typically not seen in normal animals. Keep in mind that the proximal ureters are located in the retroperitoneal space, while the more distal ureters, as they approach the urinary bladder are within the peritoneal space.

**Urinary bladder**
The urinary bladder is relatively fixed in position in the caudal abdomen, however its appearance can vary, depending on the degree of urinary bladder distension and the effects of displacement of the bladder by impingement from other organs such as the colon, prostate, and uterus. The urinary bladder generally has a uniform soft tissue or fluid opacity, and is pear-shaped when moderately distended.

**Urethra**
The urethra is not seen normally on survey radiographic examinations.

**Uterus**
The uterus is often not seen on survey radiographs.
Prostate gland
The canine prostate is positioned either in the pelvic cavity or in the caudal aspect of the peritoneal cavity. The prostate is uniformly soft tissue opaque and silhouettes in many instances with the urinary bladder. The prostate has a round to oval appearance and is best seen on the lateral view in most instances. It is never seen radiographically in cats.

References/suggested reading