# Radiography of the Feline Abdomen: A Focus on the Gastrointestinal Tract

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Radiography is the initial diagnostic imaging test of choice when one encounters a vomiting patient. Routine abdominal radiography, including right lateral and ventrodorsal projections at minimum, may reveal a significant amount of information regarding patients with gastrointestinal signs. A left lateral projection is often indicated, resulting in movement of gas within the stomach, and allowing outline of gastric foreign bodies.

The utility radiography is dependent upon image quality, which is dictated by technique and positioning. Therefore, it is important that one understands the proper positioning and technical factors, whether using digital radiography or film/screen imaging techniques, when obtaining abdominal radiographs.

**Objectives**

1. Briefly review positioning and technical factors affecting quality-control in abdominal radiography
2. Develop a systematic review process for the evaluation of abdominal radiographs.
3. Understand the differences in radiographic anatomy between dogs and cats, recognizing normal anatomic variants that may be confused with pathology
4. Review the appearance of focal and generalized intestinal dilation, and parameters for identifying intestinal dilation in cats
5. Recognize findings associated with linear foreign bodies in cats

**Key points**

1. Cats are not small dogs, and their abdominal anatomy, while predominantly similar to that of dogs, has some variations that must be recognized
2. Radiographic interpretation must be done in a systematic manner to minimize oversights and maximize identification of abnormalities
3. Focal intestinal distention most commonly correlates with mechanical obstruction; generalized intestinal distention most commonly correlates with functional gastrointestinal disease processes
4. The distinction between focal and generalized intestinal dilation aids in the generation of a succinct and prioritized list of differential diagnoses which is important for appropriate therapeutic intervention
5. Linear foreign bodies often do not cause radiographic evidence of mechanical obstruction

**Positioning**

For a lateral projection the pelvic limbs should be caudally extended, and the x-ray beam should extend from the cranial aspect of the xyphoid to the coxofemoral joints. Liberal use of the collimator should be employed to reduce the field of view to only that needed for thoracic radiography. Typically right lateral and ventrodorsal projections are obtained.

Abdominal radiography is a technical challenge as there is little contrast between the soft tissue structures of the peritoneal and retroperitoneal spaces. Contrast is maximized with low kVp and high mAs techniques.

**Basic Abdominal Radiographic Anatomy**

**Body condition and serosal detail**

The first step in interpretation is assessment of extraabdominal structures, the patient's body habitus, and the presence of intraabdominal fat. Intraabdominal fat is the primary source of contrast in the abdomen as differences in atomic number allow differential absorption of x-rays, generating contrast (photoelectric effect). Age is an important consideration in this assessment, as young patients may have little intraabdominal fat normally. The retroperitineal space contains the kidneys, the ureters, the adrenal glands, and several lymph nodes. The peritoneal space is separate, and contains the remainder of the abdominal organs.

**The abdominal wall**

Assessment of the osseous structures is an important starting point, checking for appropriate density, alignment, and the presence of new bone formation, including disc mineralization. The body wall should be continuous, without masses or swellings. Identification of a pendulous abdomen should also be noted. The diaphragm should be intact, and visible, without defects or changes in shape.

**Liver**

The liver lies against the diaphragm and silhouettes with it. The stomach lies immediately caudal to the liver, and is attached to it via the lesser omentum. The margins of the liver should be sharp, and typically the ventral margin should not extend beyond the costochondral arch. Assessment of the gastric axis is also helpful in assessing liver size; the gastric axis should be parallel to the ribs. However, some variability is seen in these features depending on patient conformation. In cats, the liver often has a "triangular-shape", and a large volume of the falciform fat is often present immediately ventral to the liver on lateral projections.

The gall bladder is not typically visible as it is located between the quadrate and right medial liver lobes, silhouetting positively with these soft tissue structures. However, mineralized cholelithsmay make the relative location of the gall bladder identifiable.

**Spleen**

The spleen is a dynamic organ with a somewhat triangular shape that typically has sharp borders. The head of the spleen is relatively constant in position, lateral to the gastric fundus on the ventrodorsal projection and dorsocaudal to the stomach on the lateral projection, owing to the relatively firm attachment of the gastrosplenic ligament. In dogs, splenic size is variable; it is influenced by breed, age and sedation.

In the cat, the spleen is much more consistent in size and location. If the tail of the spleen is visualized on a lateral radiograph, it typically indicates generalized enlargement, which should be investigated.

**Gastrointestinal tract**

The canine stomach lies transversely across the abdomen. The fundus is located to the left of midline and dorsal, the body is located on midline and ventral, and the pylorus is located to the right of midline, midway between the dorsal and ventral border of the abdomen. On a right lateral projection the fundus contains gas, and the pylorus contains fluid. The pylorus can be mistaken for a round, soft tissue mass. On left lateral projections, however, the pylorus often contains gas, confirming that this is not a mass but normal viscera. Because of the mobility of gas within the gastric lumen, positional radiography is also often important in highlighting gastric wall masses. In the feline patient, the entirety of the stomach is located to the left of midline on the ventrodorsal projection, with the pyloroduodenal junction located on midline, or occasionally slightly to the right of midline on the ventrodorsal projection. In addition, the feline stomach has "J" shaped appearance on the ventrodorsal projection.

The descending duodenum runs caudally along the right side of the abdomen on a ventrodorsal projection and is located about midway between dorsal and ventral abdominal borders on the lateral projection. The duodenum is typically fluid filled.

The small intestinal tract fills the mid abdomen and seen as multiple, curvilinear soft tissue loops that contain variable amounts of gas in the canine patient. The intestines often have a variable diameter, usually indicating a degree of peristalsis and segmentation. The most common cause for gas in the intestinal tract of the canine patient is aerophagia. In the feline patient, very little gas should be present in the intestinal lumen, and in more obese feline patients, the jejunal segments are often found in the right mid-abdomen. This should not be confused with the bunching often seen with plication associated with a linear foreign body.

Intestinal diameter should not exceed 12 mm from serosal margin to serosal margin in the feline patient; in the canine patient, intestinal diameter as a rule of thumb should not exceed 1.6 times the height of the body of L5 centrally.

Intestinal distention, once identified, can be further characterized by its distribution. Focal distention involving a segment or segments of bowel typically indicates mechanical obstruction, while diffuse distention typically indicates a functional abnormality.

The large intestine and cecum are relatively fixed in position. The canine cecum is typically gas filled and located to the right of midline on a ventrodorsal radiograph, midway between dorsal and ventral on a lateral radiograph. It is usually “C” shaped, and is in close proximity to the descending duodenum and right limb of the pancreas. A gas filled cecum is not typically seen in the feline patient.

The ascending colon is short, extending cranially to the right colic flexure where it becomes the transverse colon. The transverse colon is located immediately caudal to the stomach, and is in close proximity to the left limb of the pancreas. It continues across midline to the left colic flexure, where it turns caudally and becomes the descending colon. The descending colon continues caudally along the left abdomen, relatively dorsal in position, becoming the rectum at the level of the pelvis.

**Pancreas**

The canine pancreas is normally not visible. Abnormalities in pancreatic size may cause displacement of surrounding organs. In obese cats, the left limb of the pancreas may be visible in the triangle of fat surrounded by the gastric fundus, the spleen and the left kidney.

**Kidneys**

Both kidneys are smoothly marginated, with a kidney bean shape and a prominent hilus. In the canine patient, the right kidney is in contact with the caudate lobe of the liver, making identification of the cranial pole difficult in some cases. This is not typical in feline patients. In both species, left kidney is commonly located more caudally than the right, and is well visualized in a patient with adequate retroperitoneal fat. Feline kidneys attend to appear more round, and in some cases, hilar fat is evident.

Renal size can be assessed by comparing renal length to the length of L2 vertebrae. In the dog, 2.5-3.5 x L2 is the normal range, whereas in the cat, 2-3 x L2 is the accepted normal range.

The ureters are not typically seen; however, if radiopaque ureteroliths are present, they will be visualized just lateral to the caudal lumbar vertebrae as they descend the ureter.

**Urinary bladder**

The urinary bladder is located in the caudoventral abdomen and has a variable size with smooth margins and an oval to round shape. Tumors or the presence of non-radiopaque urinary calculi may be further investigated with contrast studies or ultrasonography.

**Prostate**

The normal prostate is contained within the pelvis, but may lie in the abdominal cavity in older dogs, or in patients with a full urinary bladder. In a male that has been neutered at a young age, the prostate is not typically visible as a discreet structure. In intact males, the prostate should not exceed 70% of the distance between the sacral promontory and the cranial rim of the pubis. In most cases, benign

prostatic hyperplasia results in a symmetric enlargement with smooth margins and without mineralization. The presence of mineralization may indicate the presence of neoplasia or a chronic inflammatory process.

In cats, the prostate is not identified. Although, when performing positive contrast urethrography, urethral spasms located at the level of the prostatic urethra may be seen in should not be mistaken for areas of stricture.

**Uterus and ovaries**

The normal uterus and ovaries are not typically visible. The uterine body is located between the colon and the urinary bladder, and the uterine horns extend craniolaterally to the ovaries. The ovaries are located caudal and lateral to the kidneys.

Enlargement of the uterine horns produces a characteristic craniodorsal and central displacement of the intestines. In this instance, the uterus can be identified as a large, tortuous tubular soft tissue structure with its caudal extent located between the colon and the urinary bladder.

Ovarian masses tend to be located in the mid abdomen, somewhat laterally. While located near the kidneys, ovarian enlargement does not cause radiographic findings typical of retroperitoneal masses.

## Interpretive principles

**Roentgen signs**

Fundamentally, image interpretation is based on thorough evaluation of location, size, shape, number and opacity. Evaluation of location refers not only to changes in organ location but also lesion location and distribution (focal, multifocal, diffuse). Determination of size is, in some cases, subjective, but objective measurements for some organs have been published. Shape, contour and margination of an organ or structure is also important in evaluation of pathology (rounded, irregular, smooth). While number of organs is relatively constant, the number of lesions (one, two, multiple) along with their distribution can be used in concert to arrive at a more narrow list of differentials. Most tissues in the abdomen will have soft tissue opacity. Relative differences in the soft tissue opacity of organs are often related to physical density, or thickness. Fat opacity is responsible for the contrast available in the abdominal cavity.

The basis for interpretation is recognizing when an organ deviates from its expected normal appearance. Roentgen signs provide an organized, systematic method to evaluate an organ for normalcy, and to decide exactly how it has become abnormal.

**Mass effect**

The term “mass effect” relates to those cases where displacement of organs is noted, but a discreet mass is not identified. Therefore, radiographic effects of a mass are noted, but the mass itself cannot be located.

The location of a mass is paramount in interpretation of abdominal radiography. Once the location (Roentgen Sign!) can be ascertained, a limited number of organs can be implicated as the source of the mass.

**Border effacement**

When two structures of the same opacity are in contact with one another, their margins cannot be ascertained. This is a cardinal principle of radiology, and is a concept that is often used in interpretation.

**Intestinal dilation**

Intestinal dilation is identified using the measurements described above (12 mm diameter). While recognition of pathologic dilation of an intestinal segment is of utmost importance, the distribution of this distention has greater value in determining the underlying etiology of the disease process. Focal dilation is recognized 12 distinct populations of bowel are present: A distended population and a normal population. Typically, this results from the presence of a mechanical obstruction.

This is in contrast to generalized or diffuse dilation which affects the entirety of the intestinal population and suggests a functional cause.

The purpose of distinguishing between focal and generalized dilation is to aid in the generation of an appropriate differential list. Obstruction, for example, may result from luminal disease (foreign body, intussusception), mural disease (intestinal neoplasia, infection, inflammation), or extramural disease (vascular infarction or intestinal volvulus). Contrast at this list with that generated by a radiographic diagnosis of generalized dilation. This differential list would include peritonitis of any cause, neurologic disease, toxin, drug-induced, or possibly distal mechanical destruction (ileocolic junction).

As you can see, making the correct radiographic diagnosis with regard to focal or generalized dilation can lead to a specific set of differential diagnoses, and will more accurately guide your next diagnostic and/or therapeutic step.

## Conclusion

The material included in these proceedings is meant as a guide to the radiographic anatomy of the abdomen, highlighting differences between canine and feline patients. Specifically the focus is on identifying focal and diffuse/generalized intestinal dilation and subsequently generating a prioritized and succinct list of differential diagnoses.

These notes are in no way a complete discussion of abnormalities that may be encountered. The reader is referred to the Textbook of Veterinary Diagnostic Radiology or other diagnostic imaging literature for a more detailed explanation of radiographic abnormalities.