

Abdominal radiology review: seeing the hidden stuff

Amy Newfield
Veterinary Team Training

Introduction

As a technician you will likely be the first person to view a patient's radiograph. A radiograph should be reviewed twice: first for technique and second for the medical condition of the patient. Taking a good quality film is a requirement in order for the radiograph to be diagnostic. Being able to understand normal and abnormal abdominal anatomy on a radiograph will help provide faster and complete medical care to the patient.

Brief overview

A film should be reviewed in its entirety and should be looked at the same way each time to ensure nothing is missed. Abdominal radiographs are mainly used to compliment other diagnostic findings and are rarely the only diagnostic tool. There are five main areas of the abdomen: gastrointestinal system, urogenital system, reproductive system, peritoneal space and the extra-abdominal area. Each one of them is very complex, but there are a few basic points that you can learn to help make looking at an abdominal radiograph less confusing. Due to the numerous structures located in the abdomen, the extra-abdominal area will not be discussed in detail.

Gastrointestinal system

Contains the stomach, small and large intestines, liver, spleen and pancreas.

There is no discussion on the pancreas because a normal pancreas cannot be visualized on radiographs.

Stomach

There are four regions of the stomach: cardia, fundus, body, and pylorus. When viewing a right lateral radiograph, the stomach's cranial surface lies closely to the caudal surface of the liver. In a right lateral, the pylorus will be 'down' (ventral) and may resemble a round ball (easily mistaken for a mass). In a left lateral the pylorus will be 'up', and likely air will be pushed into it causing the pylorus to appear air filled. In a V/D view the stomach will lie perpendicular to the spine and the pylorus will be near the right body wall. In cats the stomach appears J-shaped. The position of the stomach is important to help rule out a variety of diseases. Certain diseases (such as hepatomegaly) may cause the stomach to become displaced. There are very few objective studies for determining liver size on radiographs, so being able to identify whether the stomach is in a correct position is important.

Radiopaque gastric foreign bodies are generally easy to visualize on radiograph. If a foreign body is suspected, but cannot be identified, then taking multiple views to look for a shift in gas or fluid may help. Contrast studies, ultrasound or gastric endoscopy can also be useful in diagnosing a foreign body.

Gastric dilation and volvulus occur mainly in deep chested dog breeds. Gaseous distention of the stomach can occur due to aerophagia as a result of pain or dyspnoea. With gaseous distention and/or dilation the stomach is enlarged with air but retains normal position. With gastric volvulus the stomach becomes twisted and malpositioned. This can be best seen on a

right lateral radiograph. The fundus will generally shift to lie against the ventral abdominal wall while the pylorus will shift dorsally, cranially and to the left. This will cause the body of the stomach to shift right. Because the spleen is attached to the stomach by the gastrosplenic ligaments and vessels, the spleen will also follow the stomach and will become displaced, if not twisted as well.

The pylorus itself can become obstructed both acutely or chronically. Acute causes of pyloric obstruction include gastric volvulus or foreign bodies. Chronic obstructions are usually caused by diseases that affect the wall, causing the pylorus to narrow (such as pyloric stenosis, neoplasia, or inflammation). Because the pylorus is unable to empty the contents fully into the small intestines, the stomach may become distended with material.

Gastric ulcers are difficult to identify on plain radiographs. Most frequently in animals, ulceration has been associated with neoplasia. There are however, both benign and malignant ulcers. Most commonly nonsteroidal anti-inflammatory drugs have been known to cause benign ulcers. Dachshunds are predisposed to getting gastroduodenal ulcers. Endoscopy or ultrasound would be needed to confirm the suspicion of a gastric ulcer.

Small and large intestines

When viewing a radiograph, you should always evaluate the intestines from left to right. The position of the small and large intestines can vary greatly depending on the weight of the animal, whether the stomach is full and the size of the bladder. The cecum is located at L2-L4 on a V/D radiograph and has a characteristic C-shape. It is located dorsal to the mid-abdomen on a lateral radiograph. On a cat, it is not gas filled, while in dogs it is commonly gas filled. Contrast media may be helpful to increase the opacity of the bowel. However, it statistically does not produce diagnostic results and therefore should be reserved for those patients when a diagnosis is difficult to obtain. Due to the expense of the procedure and the time it takes for the staff and animal (enemas, 24-hour fasting, multiple films, sedation to the patient) contrast media has been replaced by ultrasound. This is because ultrasound generally offers more diagnostic answers. If ultrasound is unavailable, then contrast study should be considered in patients who are acutely persistently vomiting, chronically vomiting without improvement or where GI disorders are suspected.

The small intestines are made up of the duodenum, jejunum, and ileum. The duodenum filters the contents of the stomach from the pylorus into the jejunum and is the shortest part of the small intestines. The jejunum is longer and empties its contents in the longest part, the ileum. Together the jejunum and ileum are suspended by the mesentery, which gives the small intestines its great mobility. The duodenum can be seen by tracing it cranially into the stomach, while the jejunum and ileum are generally nondescript loops.

Ileus is the decrease or complete cessation of motility of the intestines. On radiograph the intestines appear gas or fluid filled, and the loops exceed the diameter of the ribs by 3-4 times. There are two types of ileus: mechanical or functional. Mechanical ileus is caused by a physical obstruction of the bowel, while a functional ileus occurs because the bowel has as vascular or neuromuscular abnormality. Functional ileuses can occur from diseases (parvovirus, peritonitis) or from less common diseases such as mesenteric volvulus or spinal trauma. Animals with a mechanical ileus generally have abdominal pain on palpation. A linear foreign body occurs when part of a long foreign material (string, nylon hosiery) becomes lodged in the stomach or proximal small intestine and the rest of the material continues to travel through the intestines causing the GI tract to bunch up. On radiograph GI bunching is a common finding. As the intestines try to pass the material, it becomes stretched and may perforate the intestines. Linear foreign bodies can also become stuck in the mouth by catching under the tongue, passing through the stomach and into the intestines.

Neoplasia of the small and large intestines can occur. Common neoplasms of the small intestine include: adenocarcinoma, lymphosarcoma, mastocytoma and leiomyosarcoma. Ultrasound or barium studies can both be used to help diagnose masses in the intestines.

Intussusception may occur in both the large and small intestines. In the small intestines it is generally due to an obstruction from a mass or foreign body. On palpation a sausage like mass may be able to be felt. One of the hallmark signs of an intussusception is a telescoped appearance of the bowels on ultrasound. If the intussusception occurs in the large intestines, the small intestines may become dilated or gas filled.

The most common ailment of the large intestines seen on radiograph is colonic impaction. The accumulation of faeces in the large colon makes the impaction easy to detect on radiograph. General causes of impaction include dietary indiscretion, changes in diet or masses. When there is a generalized enlargement of the colon, it is referred to as megacolon (a condition caused by ineffective motility). Megacolon occurs mainly in older cats and can be idiopathic or associated with numerous diseases including spinal diseases and metabolic disorders.

Liver

The liver appears cranial to the stomach and is the largest solid organ in the abdomen. In a V/D view the liver is fairly symmetrical on both the right and left sides of a dog but sits more to the right in a cat. The gallbladder is located in the cranioventral portion of the liver and is not normally visible. In obese animals you may see the liver displaced dorsally. In younger animals, the liver size may appear larger than what it should be for the body size. The liver lobes should appear crisp on film. The more radiographs viewed, the better you will become at detecting normal size. Mild changes cannot be detected radiographically, but generalized hepatomegaly can be easily detected. In generalized hepatomegaly the liver margins will be rounded or blunted. The stomach, spleen and kidneys may also be displaced. Hepatic lipidosis and steroid hepatopathy are common causes of hepatomegaly. Chronic hepatitis can cause both a small or large liver size. Neoplastic and benign masses of the liver can be common, but it is often difficult to distinguish between a mass of the stomach or the liver. The most common causes of microhepatica are cirrhosis and portosystemic shunts. When changes to the liver are seen on radiograph, it is best to follow up with further diagnostics such as an ultrasound, bloodwork, or liver aspirate.

Spleen

The spleen's appearance and location can vary greatly. It is best seen on a right lateral radiograph where appears on the abdominal floor between L2-L4. On a V/D view it appears as a triangle between the fundus and left kidney next to the body wall. In the cat the spleen is more difficult to view radiographically. The size of the spleen is subjective, but generalized splenomegaly results in round blunted margins and can result in displacement of the small intestines. There are four main reasons that splenomegaly occurs: inflammatory (toxoplasmosis, ehrlichiosis), hyperplasia (haemolytic disorders), congestion (splenic torsion, barbiturates) and infiltrative disease (neoplasia). Like the liver, when changes to the spleen are seen on radiograph, it is best to follow up with further diagnostics such as an ultrasound, bloodwork, or splenic aspirate.

Urogenital system

Contains the adrenal glands, kidneys, ureters, urinary bladder, urethra and prostate gland

Please note there is no discussion on the ureters because they cannot be visualized on radiographs. Adrenal glands are not usually seen on a dog, but in cats can sometimes be seen due to mineralization.

Kidneys

If the intestines are filled with material, visualizing both kidneys can be difficult. The right kidney is generally poorly viewed, but on a V/D view lies around the 13th rib near the pylorus and duodenum. The left kidney on a V/D view is located caudally to the spleen and mid-abdomen and is generally easier to visualize than the right. On a lateral view, both kidneys may appear dorsal and almost against the spine, with the right kidney being more cranial than the left. The left kidney is more pendulous and can sometimes be seen in the mid-abdomen on a lateral radiograph. Sometimes they can be completely superimposed over each other on a lateral radiograph, making it impossible to distinguish between the two. In general, a dog's kidney is about three times the length of the L2 vertebral body on the V/D view, while a cat's range is between 2-3 times the length of the L2 vertebra.

Chronic or acute kidney disease is one of the most common diseases that affects cats, but it can also affect dogs. On radiograph, the kidneys may appear small and irregular in shape. Renal calculi can frequently be seen on radiographs, however not all calcified renal opacities are calculi. Neoplasia can also affect the kidneys, causing the kidneys to become irregular in shape, and their size can vary between too small or too large. Hydronephrosis (distention of the renal pelvis) generally causes the kidneys to appear enlarged on radiograph. This usually occurs because of neoplasia, ectopic ureter, or urethral calculi. Since it is impossible to make a diagnosis based on kidney size and shape on radiograph, it is important that the animal is given a full work up to determine the cause. Below is a general chart for some common kidney diseases based on various sizes and shape:

Normal size and shape	Normal size, irregular shape	Small size, regular shape	Small size, irregular shape	Large size, regular shape	Large size, irregular shape
Glomerulonephritis	Infarct	Hypoplasia	Dysplasia	Neoplasia	Neoplasia
Acute Pyelonephritis	Chronic Pyelonephritis	Glomerulonephritis	End State	Glomerulonephritis	Primary Tumour
	Abscess		Renal	Peri-renal Cyst	Hematoma
	Polycystic			Hydronephrosis	

Urinary bladder

Located in the ventral caudal abdomen, it is often difficult to view on a V/D or D/V view because of the overlying spine. On a lateral radiograph it is usually easily visible but can be obscured if there is fat or it is not distended enough. Signs of bladder disease are limited on radiographs, but include abnormal bladder position, size, shape, and opacity. Contrast cystography and ultrasound are quick and relatively inexpensive techniques that helps to identify bladder diseases such as masses or ruptures.

One of the most common disorders of the bladder is the presence of urinary calculi. Not all calculi are radiopaque, but those comprised of phosphate, oxalate and silica are. It is important in male dogs or cats with a history of urogenital problems, to obtain a lateral radiograph that includes the entire penile urethra.

Ruptured bladders can also occur from trauma or disease. Unfortunately, acute ruptures may not show any radiographic changes and a cystography may be needed to rule out rupture.

Urethra

The urethra is shorter and wider in females, while the male's urethra is narrow and long. Because of this reason, radiographic evaluation of the urethra is rarely performed in females. Survey radiographs of a male's urethra are rarely useful, but it still should be examined for evidence of radiopaque urethral calculi. Pelvic fractures may cause urethral injury, such as tears. Contrast urethrography is indicated whenever urethral disease is suspected.

The prostate gland

The prostate gland is located at the neck of the bladder. Many times, it is obscured by the pelvic canal, but in male dogs it is usually seen as a soft round tissue opacity. In a male cat, a normal prostate is not visible radiographically. All common prostatic diseases cause prostate enlargement. The larger the prostate the more cranial displaced the bladder becomes. Certainly, any suspicions about prostatic disease can be confirmed with ultrasound. It is important when taking a radiograph in a male dog that you include the prostate (caudal abdomen) to ensure there is no obvious signs of disease.

The most common disease of the prostate is benign prostate hypertrophy, in which the prostate increases in size causing it to become more visible on radiographs. If an enlarged prostate is seen in a neutered dog, ideally chest films should be taken to look for metastasis.

Bacterial infections can occur causing the prostate to increase in size from inflammation. Occasionally cysts can occur (both benign and neoplastic) sometimes causing an increase in size of the prostate gland.

Reproductive system

Normal ovaries and uterus are not normally identifiable on radiograph. The majority of the uterus is cranial to the bladder in the mid-abdomen, but the body of the uterus is sometimes between the bladder and colon on a lateral radiograph. The uterus can expand to encompass most of the abdomen and, in the case of a pyometra, can easily be mistaken for an abdominal mass. Usually, the uterus is not visible until it becomes larger than the intestinal loops. Foetal mineralisation is not visible until about day 42 of pregnancy. While ultrasound is better for early detection of pregnancy, radiographs are better for counting the number of foetuses.

The male reproductive tract lies outside the abdomen. Sometimes males will have a retained testicle which can be found anywhere from the caudal aspect of the kidneys to the inguinal ring. Unfortunately, non-diseased retained testicles are not likely visible on radiograph.

Peritoneal space

The peritoneum is a thin membrane which is divided into two continuous layers: parietal and visceral. The parietal peritoneum covers the surface of the abdominal cavity and is adhered to the abdominal muscles. The visceral peritoneum covers the organs of the abdomen, and the connecting peritoneum includes the omenta, intraabdominal ligaments, and mesenteries. The retroperitoneal space is the space between the dorsal margin of the parietal peritoneum and the abdominal wall and contains the kidneys, ureters, and adrenal glands. There is normally a small amount of fluid present within the peritoneal space which is not visible on radiograph. When there is a loss of detail within the abdomen when a good radiograph technique was performed, then a build-up of fluid should be suspected. Animals under the age of three months or emaciated animals frequently have a loss of abdominal detail. Fat and masses can also cause a decrease in abdominal detail. Peritonitis, the general inflammation of the serosal surfaces, can

result in a decrease in detail as well because of inflammation and oedema. There are many reasons to have abdominal effusion, and the classification of fluid is broad including blood, urine, bile and chyle.

Gas may also form in the intraperitoneal space. Normal gas accumulation occurs in the fundus, duodenum, cecum, and colon. Ileus, though not normal, will also cause gas accumulation in the intestines. The two most common causes of free gas in the intraperitoneal are the penetration of the abdominal wall and the perforation of the bowel. Perforation of the abdominal wall includes surgery, which automatically causes some air to invade the peritoneal space. Other causes of gas include ruptured masses.

The peritoneum should be continuous on radiograph. Disruption of the borders may indicate a hernia. There are four main types of hernias that involve the abdomen: hiatal, peritoneopericardial, inguinal or perineal. Hiatal and peritoneopericardial hernias were discussed in the Thoracic Radiographic Review. Inguinal hernias occur when muscle stretches and tears in the inguinal area causing the abdominal contents to exit out of the peritoneal cavity. A perineal hernia occurs when there is a tear in the perineal area (region surrounding the anal and urogenital openings). Intestines and the bladder are most prone to exiting the peritoneal cavity.

Conclusion

The ability to diagnose diseases from radiographs relies heavily on the quality of the radiograph being taken. Taking radiographs can cause a lot of stress to already stressed animals and sedation should be used when appropriate. The technician's ability to identify diseases on radiograph and alerting a veterinarian to life threatening ailments will expedite appropriate patient care. The more radiographs that you take and review, the better you will become at both technique and recognition of normals versus abnormals.

References available upon request.