

## **Principles of Radiographic of the Abdomen**

### The abdominal cavity

The abdominal cavity is lined by the parietal peritoneum which is continuous with the visceral peritoneum, which covers the viscera. The peritoneum is covered by a thin layer of fluid. The space between the parietal and the visceral peritoneum is normally a potential space.

*Visualization of the abdominal organs depends on the following factors, taken singly or in combination:*

- 1- Differences in opacity between one organ and another.
- 2- .The amount of fat—retroperitoneal, mesenteric, and omental—present within the abdomen. Emaciated or very young animals with little abdominal fat show poor contrast.
- 3- .The contents of the abdominal organs vary in density and consequently in opacity. Such contents may help outline the organs, such as air or gas in the stomach, or feces may outline the colon. All the intraabdominal organs have a soft tissue or fluid opacity.

### Evaluation of the Abdominal Radiograph

- 1- .A good abdominal radiograph should show the structures in the cranial and caudal abdomen and the abdominal wall.
- .2There should be good range of contrast so that the various abdominal structures can be clearly distinguished from one another.
- 3- .Falciform and retroperitoneal fat should be identifiable.
- 4- .The bodies of the vertebrae should be clearly outlined and the bone density clearly identifiable.
- 5- . The film should be neither overexposed nor underexposed.

## Normal Appearance

On survey radiographs of the abdomen, the diaphragm, abdominal wall, stomach, small intestine, large intestine, liver, and bladder can usually be recognized. On the ventrodorsal and left-right lateral recumbent views, the spleen is also usually seen.

## Peritoneal Fluid

*Types of abdominal fluid include* (1) blood, (2) urine, (3) chyle, (4) transudate, and (5) exudate. The causes of peritoneal fluid are diverse, ranging from the commonplace (traumatic bladder rupture) to the obscure (peritoneal tapeworm infection).<sup>2</sup> Broadly speaking, escaped bile, stomach juices, and unformed bowel content also fall into the category of peritoneal fluids.

## Abnormalities

### Peritoneal Air (pneumoperitoneum)

Most dogs with readily appreciable free air in the peritoneal cavity that have not had recent abdominal surgery are likely to have a serious disease. Peritoneal air, like fluid, is most detectable when present in large quantities but, unlike peritoneal fluid, which obscures the abdominal viscera, peritoneal air enhances it. Medium volumes of peritoneal air may outline otherwise invisible organs, such as the diaphragm or uterus.

### Intravisceral Gas

#### 1- Liver gas

Filamentous gas accumulations are usually indicative of air in conduits such as blood vessels or bile ducts, whereas gas bubbles are more likely to represent a cavitated abscess. Lord and colleagues, reporting an emphysematous hepatic abscess in a dog, described the liver as containing “a bubbly accumulation of gas.

#### 2- Gas in the Gallbladder

Gas in the wall or lumen of the gallbladder (emphysematous cholecystitis) is most likely to be the result of infection, which may be associated with necrosis and localized peritonitis.

### 3- Splenic Gas

Splenic gas usually is located in the vasculature, often as a result of torsion. Splenic gas also was reported in a dog with splenic hemangiosarcoma, ruptured gallbladder, and peritonitis.

### 4- Intestinal Gas

Gas in the wall of the small intestine (pneumatosis intestinalis) is rare. In most instances, the cause of intramural gas is unknown, with ischemia, bacteria, and antigens the most commonly proposed causes.

### 5- Gas in the Urinary Bladder

Gas in the wall or lumen of the urinary bladder is usually the result of infection, often, but not always, occurring in diabetic dogs.

### 6- Uterine Gas

Uterine gas (physometra) most often is identified in dogs with open pyometra, the result of retrograde atmospheric contamination owing to an incompetent cervix. Uterine gas also may be seen in conjunction with a dead fetus but only rarely with infection.

### Peritonitis.

Peritonitis is inflammation of the peritoneum. It may result from infection, rupture of an abdominal organ, trauma, or a penetrating wound of the abdominal wall. It may be secondary to pancreatitis or pancreatic neoplasia. Peritonitis causes loss of the sharp outline of the abdominal organs so that the abdomen in the affected area appears hazy or blurred. Serosal surfaces are not clearly seen. An associated outpouring of fluid enhances the effect. Large amounts of fluid produce a homogeneous opacity. Small irregular areas of increased opacity (mottling) are often evident as a result of an irregular distribution of small amounts of fluid. There may be associated adhesions.

### Abdominal Masses.

Masses within the abdominal cavity are from enlargements of one or more of the intraabdominal structures. Enlargement of an organ may be attributable to physiologic or pathologic processes. Distention of the stomach after eating, enlargement of the uterus during pregnancy, and enlargement of the spleen during barbiturate anesthesia are examples of physiologic enlargements. Pathologic enlargement may be the result of inflammatory processes; abscess or cyst formation; hematoma, torsion, obstruction; or neoplasia. Hypertrophy may cause enlargement of an organ. A mass can usually be identified on a plain radiograph. Abdominal masses are sometimes masked by intraabdominal fluid.

### The Abdominal Wall

Cranially the abdomen is bounded by the diaphragm. Laterally and ventrally it is bounded by the ribs and the abdominal musculature. Its dorsal boundary is formed by the sublumbar muscles. It is lined by the peritoneum, which forms the caudal limit of the abdomen.

### Abnormalities

*Hernias.* A distinction may be made between protrusions that have a peritoneal lining and those that have an associated abdominal wall rupture. A hernia is a protrusion of abdominal organs through a natural or physiologic opening so that they come to lie beneath the skin.

- 1- *Inguinal Hernia.* Radiography can be helpful in determining the contents of an inguinal hernia. Gas shadows within the hernial outline indicate the presence of a portion of intestine. The uterus casts a homogeneous, fluid type of opacity, as does the bladder. Fetal skeletons may be seen if the animal is in late pregnancy. A barium study can be used to determine the position of the intestine.
- 2- *Ventral Hernia.* There may occasionally be doubt as to the nature of a swelling on the abdominal wall. In the case of a ventral hernia, radiographs may show loops of intestine containing gas outside the

abdomen and under the skin. The point of herniation may be seen as a discontinuity in the shadow of the abdominal wall.

- 3- Perineal Hernia. Radiographs can be helpful in determining the contents of a perineal hernia. Contrast cystography will show whether the bladder is in the hernia. If there is retroflexion of the bladder, introducing contrast medium may be difficult. Fat, a displaced rectum, or the anechoic urine-filled bladder may be identified in the perineal swelling on ultrasound examination.
- 4- Hiatal Hernia. In this hernia there is a protrusion of the stomach, or part of it, through the esophageal hiatus of the diaphragm, displacing the terminal esophagus cranially. The cardiac area of the stomach is most likely to be involved. The term hiatal hernia implies a herniation of part of the stomach through the esophageal hiatus into the thorax. With the sliding type of hernia,

Diaphragmatic Hernia. Rupture of diaphragm. Celiography or peritoneography, that is, introduction of contrast medium into the peritoneal cavity, has been described as an aid in the diagnosis of these hernias.

## The Liver

The liver lies within the intrathoracic portion of the abdomen. It is made up of six lobes, the left medial, left lateral, right medial, right lateral, quadrate, and caudate lobes. Cranially the liver is convex in outline and lies, for the most part, in contact with the diaphragm. Caudally it is in contact with the right kidney at the renal fossa, the cranial flexure of the duodenum, and the stomach.

### *Normal Appearance*

Because the liver lies in the deepest part of the abdomen at expiration, sufficient kilo voltage should be used to ensure adequate penetration. An impression of liver size can usually be gained from a study of plain radiographs of the abdomen.

The exact outline of the liver is not discernible on plain radiographs of the abdomen. On a lateral radiograph, the liver occupies a triangular area between the diaphragm and the ventral body wall, the falciform ligament, and the stomach. Its caudal border, represented by the left lateral lobe, is sharp in outline and may project a short distance caudal to the ventral portion of the costal arch. Sometimes the liver shadow that contacts the stomach merges with that of the spleen, particularly on radiographs made in right lateral recumbency. This merging of shadows obscures the caudal limit of the liver. The liver lies somewhat more caudally in older dogs and may project beyond the costal arch.

### *Abnormalities*

Enlargement (Hepatomegaly)

#### Radiologic Signs

1-Generalized enlargement is associated with rounding of the caudoventral edge, particularly that of the left lateral lobe on the lateral view.

2- There is a visible increase in size. The caudal liver edge projects farther beyond the costal arch than usual.

3 .Displacement of structures related to the liver is seen.

4-The stomach is displaced caudally and dorsally on the lateral view and caudally and more often to the left on the ventrodorsal view. The cranial duodenal flexure, right kidney, stomach, and transverse colon are displaced caudally.

### The Spleen

The spleen is situated in the left cranial abdomen, approximately parallel to the greater curvature of the stomach. Its head is attached to the stomach by the gastrosplenic ligament and lies adjacent to the gastric fundus, the cranial pole of the left kidney, and the left body wall.

### *Normal Appearance*

The spleen is usually seen on plain radiographs of the abdomen made in right lateral recumbency. It is well visualized after intravascular injection of contrast medium.

On a ventrodorsal view of the abdomen, the spleen appears as a triangular soft tissue opacity on the left side, caudal and lateral to the stomach and cranial to the left kidney. In right lateral recumbency, it is seen as a rounded, oval, or triangular structure in the ventral abdomen, just caudal to the liver, from which it occasionally cannot be clearly distinguished.

### *Abnormalities*

#### Enlargement (Splénomegaly)

Neoplasia. Several forms of neoplasia may affect the spleen, including leukemia, lymphosarcoma, hemangioma, hemangiosarcoma, fibrosarcoma, and leiomyosarcoma. Feline mastocytosis results in gross enlargement of the spleen. radiographically visible nodules and masses.

### The Pancreases

The pancreas is a gland shaped somewhat like an inverted V. It lies adjacent to the greater curvature of the stomach, duodenum, and ascending and transverse colon. It consists of a body and two lobes.

## Radiography

The normal pancreas is not visible radiographically in the dog. In the cat the pancreas is sometimes seen in obese animals on the ventrodorsal projection medial to the spleen.

## Abnormalities

### Inflammation (Pancreatitis)

#### Radiologic Signs

- 1- Pancreatitis causes an area of increased soft tissue opacity in the right cranial abdomen resulting from associated peritonitis. Normally, the right cranial abdomen is relatively more radiopaque than the left, and care is necessary in evaluating this area.
- 2- .Swelling of the pancreas causes the duodenum to be displaced toward the right and sometimes dorsally or ventrally, with the pylorus being displaced to the left. This may give the duodenum a C-shaped
- 3- The duodenum shows reduced peristalsis with slow passage of ingesta or barium through it. It may be dilated.
- 4- The duodenal wall may be thickened, with a static gas pattern.
- 5- The pyloric antrum may be displaced toward the left.

## **THE ALIMENTARY TRACT**

### THE Esophagus

The esophagus begins at approximately the level of the middle of the first cervical vertebra and ends at the entrance to the stomach. During its course in the neck, it inclines toward the left side, and at the entrance to the thorax it lies to the left of the trachea. Within the thorax, the esophagus initially lies to the left of the trachea, but it then crosses the trachea to reach its dorsal aspect at the carina



## Radiography

### Plain radiography

Air, fluid, food material, or a combination of these within the esophagus may outline it, at least partially. Although some esophageal abnormalities can often be detected on plain radiographs, the administration of contrast material is necessary for detailed study. Survey radiographs in the lateral and ventrodorsal positions should first be made. Because the esophagus at least partially overlies the spine in the ventrodorsal position, it is also advisable to make a ventral right-left dorsal lateral oblique radiograph

### Contrast media

A barium paste is useful if a special study of the mucosa is required because it adheres to the esophageal mucosa. The paste may be useful if esophagitis or neoplasia is suspected. If the esophageal study is part of a gastrointestinal series, however, the paste should not be used because it is not suitable for outlining the stomach or intestines and does not readily mix with liquid barium.

### *Normal Appearance*

The esophagus is not usually seen on plain films of the neck or thorax; in its normal collapsed state its opacity is the same as that of the neck muscles and mediastinum.

### Abnormalities

#### Dilation (Megaesophagus, Esophageal Hypomotility).

Localized dilation may be caused by vascular ring anomalies, foreign body, stenosis, or pressure on the esophagus from an external mass. Neoplasia may result in stenosis and consequent dilation. A correlation between pylorospasm and esophageal dilation has been reported in cats. Megaesophagus is frequently associated with some degree of aspiration pneumonia.

### Radiologic Signs

- 1- Plain radiographs of the thorax show the esophagus to be dilated with air, fluid, food material, or a mixture of these. When the esophagus is dilated with air, it drapes itself over the dorsal trachea, giving a tracheal stripe sign. The edge of the longus colli muscle is seen dorsally. The walls of the esophagus in the caudal thorax are seen to converge at the esophageal hiatus.
- 2- If the dilation is severe, the trachea and the heart are displaced ventrally.
- 3- The dilated esophagus widens the mediastinum.
- 4- A barium study reveals the full extent of the dilation. A large quantity of barium may be required to outline the esophagus fully. Food mixed with barium may be more useful. Barium
- 5- Standing lateral studies taken with a horizontal beam often show a fluid level within the esophagus caused by an accumulation of fluid material ventrally and air dorsally.

### Neoplasia.

Primary neoplasia of the esophagus is rare in the dog and cat. Osteosarcoma or fibrosarcoma may occur secondary to *Spirocerca lupi* granuloma., Squamous cell carcinoma is occasionally seen in the cat.

### Radiology

A barium study should be undertaken to show irregularity of the outline of the esophageal mucosa or a stricture at the site of the tumor.

### Vascular Ring Anomalies

Congenital anomalies of the vascular system within the thorax may result in vessels or vessel remnants forming bands that constrict the esophagus near the base of the heart.

### Radiologic Signs

- 1- On a lateral view, the dilated portion of the esophagus, cranial to the point of constriction is often outlined on plain radiographs by food material, fluid, air, or a mixture of these.
- 2- The trachea and the heart may be displaced ventrally, and the esophagus may be draped over the trachea.
- 3- The dilation ends over the base of the heart, and the esophageal outline appears normal caudal to the point of constriction.
- 4- The dilation may extend up into the neck.
- 5- On a ventrodorsal radiograph the normal shadow of the aortic arch on the left side may be absent.
- 6- barium study will show the area of the esophageal dilation cranial to the base of the heart.

### Foreign Body.

Foreign bodies may be radiolucent or radiopaque. They are most commonly seen within the thoracic esophagus between the base of the heart and the diaphragm.

### Radiologic Signs

- 1- A radiopaque foreign body is readily recognizable on a plain radiograph.
- 2- Intraluminal air, distending the esophagus, is usually visible cranial to a complete obstruction.
- 3- Varying amounts of fluid are seen cranial to the obstruction.
- 4- A radiolucent foreign body can be outlined by contrast medium, preferably a barium sulfate paste. Nonionic water-soluble contrast media are preferred if perforation is suspected.

### Diverticulum.

Diverticula are not common. A traction diverticulum results from adhesions and contraction associated with a periesophageal lesion.

### Radiology

Barium is used to demonstrate a diverticulum.

### Spirocerca Sanguinolenta (Spirocerca Lupi) Infestation

New bone formation spondylitis is frequently seen on the ventral aspects of the thoracic vertebrae from approximately the seventh to the tenth.

### Radiology

A barium study will help determine the degree of occlusion of the esophagus.

### Esophagitis.

Inflammation of the esophagus may result from a foreign body, trauma, gastroesophageal reflux, or chemical irritants.

### Radiologically

Irregularity of mucosal folds and segmental narrowing of the esophagus are sometimes noted after a barium swallow. Air is often present within the esophageal lumen.

### Extrinsic Compression

Masses within the neck and thorax not associated with the esophagus (e.g. enlarged thyroid, thymus, lymph nodes) may cause pressure on it.

### Radiology

Such masses are commonly seen on plain radiographs. A barium swallow will show the site and degree of compression. The esophageal lumen, though compressed, remains regular and smooth in outline, with no filling defect.

### Gastroesophageal

Intussusception. Gastroesophageal invagination or intussusception is passage of a portion or all of the stomach into the esophageal lumen. It may be associated with megaesophagus.

### Radiologic Signs

- 1- Plain radiographs show an area of increased opacity in the caudal thorax.
- 2- The esophagus may be dilated with gas cranial to the mass.
- 3- Often the bubble of gas normally seen in the stomach is small or absent.
- 4- .If barium is introduced, gastric rugal folds are seen within the esophagus.
- 5- .The stomach may cause a complete obstruction of the esophagus, in which case barium will not enter the stomach.

### Esophageal Fistula and Esophagobronchial Fistula

Fistulas are rarely seen and may communicate with the skin, trachea, or a major bronchus.

### Radiology

a water- soluble nonionic iodinated contrast medium can be given by mouth to outline the defect. If this is negative, a barium study may be given.

### THE STOMACH

1. Cardia: the portion that blends with the esophagus.
2. Fundus: the large blind pouch that lies dorsal and to the left of the cardia.
3. Body: the principal portion, extending from the fundus to the pylorus.
4. Pylorus: the distal third, approximately. Its proximal portion, the pyloric antrum, is a thin-walled sacculle that is continuous distally with the pyloric canal.

### *Normal Appearance*

Radiograph is made with the animal in right lateral recumbency, the gas will be seen in the fundus and body. Conversely, in left lateral recumbency gas will be seen, for the most part, in the pyloric antrum.

### *Abnormalities*

#### Foreign Body.

Many foreign bodies are radiopaque and therefore readily seen on plain radiographs of the abdomen. Radiolucent objects are occasionally encountered.

#### Radiology

Foreign bodies are best demonstrated by positive contrast, although they are sometimes outlined by gas within the stomach. Double contrast may be used. Small amounts of barium should be used because too much may obscure the outline of the foreign body.

#### Gastritis.

Gastritis is not easy to diagnose radiographically with certainty. The gastric wall may be thickened. Increased production of mucus may cause flocculation of barium. Rugal folds become thicker with gastritis.

#### Gastric Dilation and Volvulus (Torsion).

Dilation of the stomach may result from an obstruction of the outflow tract or from atony of the stomach wall. Acute gastric dilation may occur with or without torsion.

#### Radiologic Signs

- 1- A large, gas-filled, distended stomach is seen on plain radiographs. The stomach may be so dilated that it appears to fill almost the entire abdomen.
- 2- The intestines are displaced caudally
- 3- stomach wall can be seen on the lateral view crossing the distended stomach.( “compartmentalization”)

- 4- The pylorus is displaced dorsally, cranially, and to the left. Its recognition in this abnormal position helps distinguish torsion from simple dilation.
- 5- The duodenum and small intestine may contain large amounts of gas.

### Displacement.

The stomach can be displaced in a number of ways by masses within the abdomen. Enlargement of the liver, pancreas, or spleen can cause displacement. Less common causes are masses in the transverse colon or mesentery. Enlargement of the liver causes the stomach to be displaced caudally and usually dorsally. Localized masses within the liver have a variety of effects on the stomach depending on their location. Masses in the right liver lobes tend to displace the pylorus caudally and to the left; masses in the left liver lobes displace the fundus and body of the stomach caudally and to the right.

### Neoplasia.

Neoplasia of the stomach is relatively rare in dogs. Adenocarcinoma is the most common malignant tumor in dogs and lymphosarcoma the most common in cats. Leiomyomas and leiomyosarcomas have been reported. Neoplasms of the pancreas may invade the stomach.

### Radiologic Signs

- 1- Absence of or gross distortion of the normal pattern of rugal folds.
- 2- Thickening of the gastric wall.
- 3- The presence of an intraluminal mass, sometimes outlined by gas within the stomach.
- 4- Failure to outline the stomach fully on barium examination—a so-called filling defect.
- 5- Ulceration of the gastric mucosa. Barium may fill the ulcer crater and persist there, unchanged in outline, over a series of radiographs.

### Gastric Ulceration.

Contrast studies are required to demonstrate gastric ulceration. Seen in profile, gastric ulcers appear as outpouchings from the wall of the stomach.

### Radiology

A radiolucent halo representing edema of the stomach wall may be seen around the ulcer.

### Pyloric Obstruction

Pyloric obstruction may be attributable to a number of causes. Acute obstruction may show no radiologic changes. Acute obstruction is often caused by a foreign body or inflammation.

### Radiologic Signs

- 1- The stomach is enlarged and often dilated in longstanding cases.
- 2- There may be food material in the stomach even after prolonged fasting.
- 3- A large amount of fluid is often present in the stomach.
- 4- Mineralized opacities are sometimes seen in the stomach proximal to an obstruction.
- 5- There is delayed initial emptying of contrast from the stomach.