IMAGING ESSENTIALS

Ultrasonographic Differences Between Dogs and Cats

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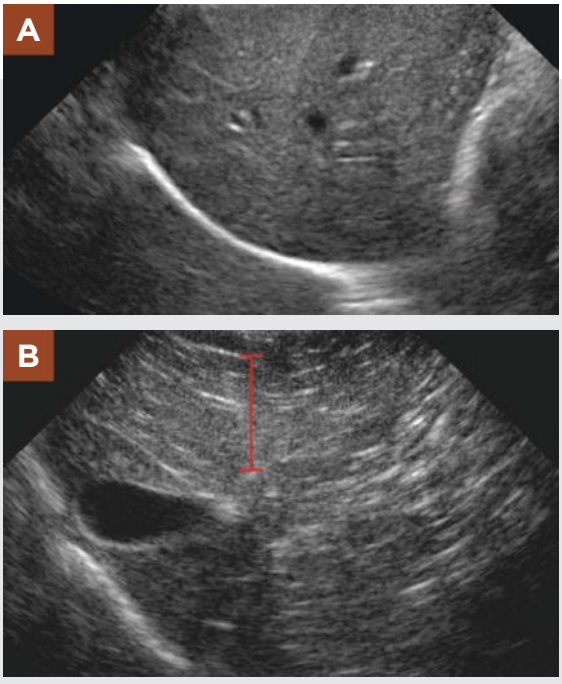

Figure 1. (**A**) Long-axis view of the canine liver. The echotexture and echogenicity of the liver are normal with distinct portal vein walls (hyperechoic walls) and hepatic veins (isoechoic walls). The curvilinear hyperechoic line demarcating the cranial periphery of the liver, in the far field, is the reflective lung/diaphragm—liver interface. (**B**) Long-axis view of the feline liver. Note the large isoechoic falciform ligament fat in the near field (red bar) with an echogenic line delineating the start of the hepatic parenchyma.

Welcome to our series of articles on small animal abdominal ultrasonography. The initial articles provided an overview of basic ultrasonography principles and a discussion about how to perform a systematic scan of the abdomen. The rest of the series discusses ultrasound evaluation of specific abdominal organs/systems. Read the other small animal abdominal ultrasonography articles published in *Today's Veterinary Practice* at todaysveterinarypractice.com.

Most abdominal organs have distinctive ultrasonographic characteristics in dogs and cats, including size, shape, echogenicity, echotexture, and localization specific to the normal anatomy in the given species. **TABLE 1** describes the expected normal measurements of canine and feline abdominal organs.[1–10] For greater detail on each organ, please refer to the relevant previous Imaging Essentials articles on todaysveterinarypractice.com.

LIVER

The liver is composed of the right lateral, right medial, left lateral, left medial, quadrate, and caudate lobes; the caudate lobe is made of the caudate and papillary processes. Ultrasonographically, the lobes cannot be differentiated. Instead, the liver appears as one contiguous structure containing normally branching hepatic portal veins. A normal-appearing liver does not exclude infiltrative disease in dogs or cats.[11]

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TABLE 1 Normal Abdominal Organ Measurements in Dogs and Cats

ORGAN	DOG	CAT
Gallbladder wall thickness	1 mm[1]	1 mm[1]
Common bile duct diameter	Not visualized[1]	<4 mm[1]
Spleen thickness	Not reported	Up to 10 mm[1]
Kidney length	Reduced if LK:Ao <5.5[2] Increased if LK:Ao >9.1[2]	3.66 ± 0.46 cm[1]
	Renal length to vertebral length (measured as a straight line from ventral or lateral aspect of L5 or L6) ratios 1.3–2.73	3.5–4.4 cm[1]
Renal pelvis width	Normally not dilated; if 1–3 mm, diuresis is likely[1]; other causes of pyelectasia are possible; if ≥13 mm, obstruction is possible[4]	Normally not dilated, but can be 1–3 mm
Urinary bladder wall thickness	Minimally distended: mean 2.3 mm[5] Mildly distended: mean 1.6 mm[5] Moderately distended: mean 1.4 mm[5] Fully distended: 1–2 mm[1]	Minimally distended: mean 2.3 mm[5] Mildly distended: mean 1.6 mm[5] Moderately distended: mean 1.4 mm[5] Fully distended: 1–2 mm[1]
Adrenal gland caudal pole height	Mean: <0.74 cm[1] <10 kg: ≤0.54 cm 10–30 kg: ≤0.68 cm >30 kg: ≤0.80 cm[6]	0.4–0.46 cm[1]; 0.8 cm in length
Pancreas thickness (mean)*	Left: 4.8–8.2 mm[7] Body: 4.7–7.9 mm[7] Right: 6.3–9.9 mm[7]	Left: 3.4–9.0 mm[1,8] Body: 2.5–9.5 mm[1,8,9] Right: 2.8–6.0 mm[1,8]
Pancreatic duct diameter*	Mean: <1 mm	Mean: <2.5 mm[9] Age ≤10 years: 0.5–1.3 mm[8] Age ≥10 years: 0.6–2.4 mm[10]
Ovary size (in estrus)[1]	Length: 1.5 cm Thickness: 0.5 cm Width: 0.7 cm	0.5 × 0.5 × 0.5 cm

LK:Ao, ratio of left kidney length to aortic luminal diameter.
Superscript numbers are reference citations.
**In dogs, pancreatic thickness and pancreatic duct diameter significantly increase with body weight.*

Dog

The canine liver (**FIGURE 1A**) is hypoechoic relative to the adjacent spleen. The falciform fat in dogs is not necessarily a good indicator of overall liver echogenicity, as it may appear hypo-, iso-, or hyperechoic relative to the liver in a normal dog. Canine portal veins have distinct hyperechoic walls.[12]

Cat

Unlike in dogs, the feline liver (**FIGURE 1B**) is typically isoechoic to the falciform fat, which is thicker than in dogs. However, the liver becomes hyperechoic in clinically obese cats secondary to lipid-rich liver or feline hepatic lipidosis or hypoechoic as with active hepatitis or lymphoma (**FIGURE 2**). The hepatic portal veins in cats are less distinct than in dogs.

GALLBLADDER

The gallbladder is a thin-walled (<1 mm), fluid-filled, anechoic structure (**FIGURE 3**). Its degree of distention in both species varies, depending on when the last meal was eaten and the fat content of that meal.[13]

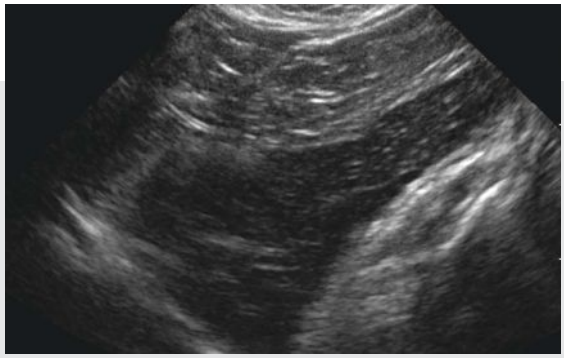

Figure 2. Long-axis view of the feline liver. The liver is hypoechoic relative to the falciform fat. Distinct hepatic vascular walls are not as readily seen as in the dog.

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Dog

The neck of the gallbladder should taper normally; consequently, the cystic and bile ducts are not visualized to the level of the major duodenal papilla in dogs (**FIGURE 4**). Echogenic material within the canine gallbladder is considered normal but has been seen in a higher incidence in dogs with Cushing's disease.[14,15] Typically, echogenic material in the gallbladder is more gravity dependent (in the far field).

Cat

The gallbladder can be bilobed in the cat as a normal anatomic variant (**FIGURE 3B**).[16] In normal cats, the cystic and bile ducts can be followed to the level of the major duodenal papilla and can measure up to 2 to 3 mm in diameter (**FIGURE 5**).[17] If echogenic material is seen in the feline gallbladder in conjunction with wall thickening, consider cholecystitis or cholangiohepatitis as a diagnostic differential; the normal feline gallbladder usually does not contain echogenic material.[18,19]

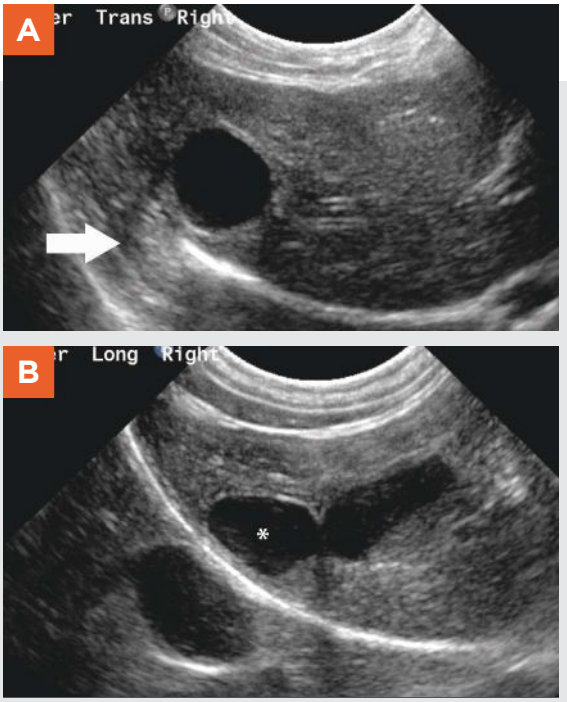

Figure 3. (**A**) Short-axis view of the canine liver. Note the round, thin-walled, anechoic gallbladder located within the right side of the liver. The bile within the gallbladder is anechoic. Its fluid nature causes distal acoustic enhancement, noted in the far field of the image (white arrow). (**B**) Long-axis view of the feline liver. Note the thin-walled, bilobed gallbladder (*) with mirror-image artifact on the opposing side of the diaphragm.

SPLEEN

In both species, the spleen can have a fine, heterogeneous echotexture when using a high-resolution linear transducer when compared with the microconvex transducer. The splenic arteries are not apparent without color Doppler evaluation.

Dog

In the dog, the craniodorsal extremity (sometimes called the *head*) of the spleen is located immediately to the left of the gastric fundus and may change its location based on the degree of gastric distention (**FIGURE 6A**). The splenic size in dogs is also variable, and in some breeds it can be quite large (e.g.,

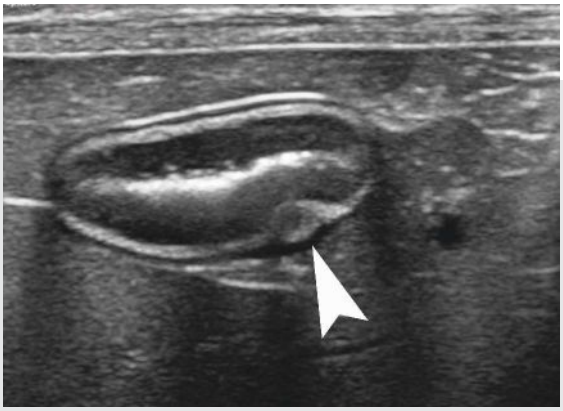

Figure 4. Short-axis view of the canine major duodenal papilla (white arrowhead) at the level of the orad descending duodenum. Note the normal focal thickening of the hyperechoic submucosal layer of the duodenum at the level of the insertion of the major duodenal papilla.

Figure 5. Short-axis view of the feline cystic duct at the level of the gallbladder. Note the gradual tapering and relative distention of the feline cystic duct; this is considered normal in a cat with a measurement of <3 mm. A small amount of echogenic sludge is in the lumen of the gallbladder.

greyhound, German shepherd). The canine spleen is easy to find but difficult to trace in its entirety due to its size. A left-sided intercostal approach may be necessary to visualize the entire dorsal aspect (head) of the spleen. The splenic portal veins are seen along the visceral (mesenteric) surface of the spleen.

Cat

The feline spleen is positioned along the left body wall, lateral to the stomach, and is more consistent in size and location than in dogs; it should not be >1 cm in thickness, which is measured on the left lateral aspect of the abdomen in the near field of the image.[1] The feline spleen is usually no longer than 3 to 5 cm.[1] The feline spleen has a coarser echotexture than the canine spleen (**FIGURE 6B**). In cats, the spleen can be difficult to visualize as it is often isoechoic to slightly hypoechoic relative to the surrounding mesenteric fat and is located in the near field (within the first centimeter). The splenic portal veins are less apparent in cats but can still be found, particularly with color Doppler.

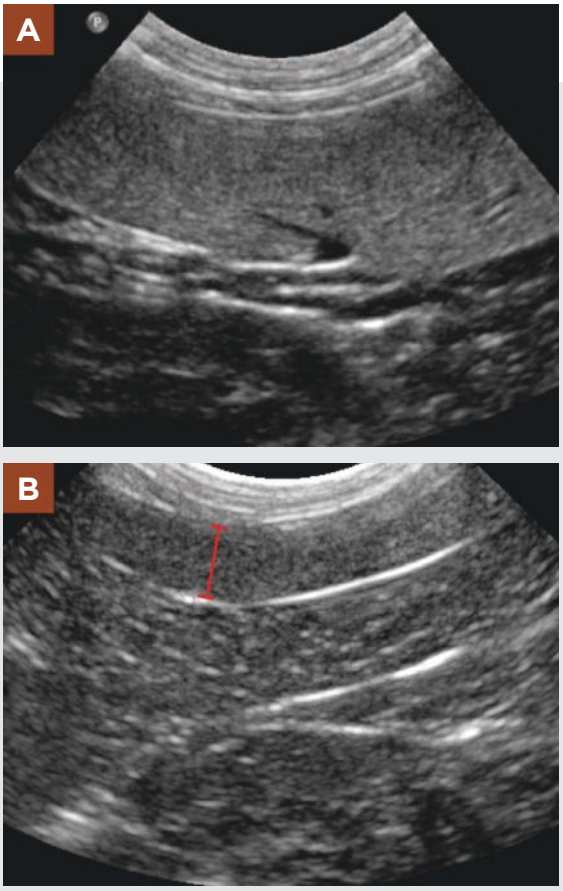

Figure 6. Long-axis views (relative to the body of the patient, resulting in a short-axis view of the organ itself) of the (**A**) canine and (**B**) feline spleen. Note that in both species, the spleen is superficial, being located close to the abdominal body wall, in the near field. The canine spleen is smoother and more "tightly packed" in echotexture than the canine liver. The feline spleen (red bracket) is more difficult to distinguish from the adjacent mesenteric fat; however, the hyperechoic surrounding splenic capsule can be used to differentiate the spleen from the surrounding mesentery.

KIDNEYS

The normal right and left kidneys of both dogs and cats should be symmetric, with a sharp zone of transition between the cortex and medulla; they are usually bean shaped at the hilum when imaged in dorsal plane (**FIGURE 7**). The cortex is relatively hyperechoic. In the renal diverticular regions, hyperechoic thin-walled vessels, called *arcuate vessels*, can be mistaken for renal diverticular mineralization; however, these vessels are normal in dogs and cats.

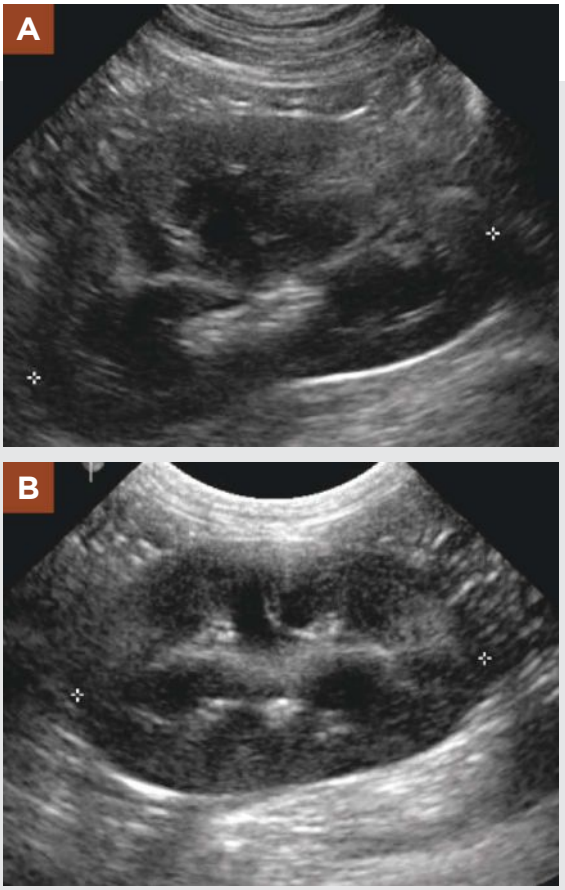

Figure 7. Long-axis views of the left kidney in the (**A**) dog and (**B**) cat. Note the visible corticomedullary distinction of both normal kidneys. The canine kidney (seen in the sagittal plane due to the presence of the renal pelvis) is bean shaped and oblong, whereas the feline kidney (dorsal plane) is more rounded.

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TABLE 2 Localization of Canine and Feline Adrenal Glands

	DOG	CAT
Left adrenal gland	Left renal artery is the caudal delimiter; "cat eyes" (celiac and cranial mesenteric arteries) are the cranial delimiters	Adjacent or caudal to celiac and cranial mesenteric artery; the left renal artery is often difficult to find
Right adrenal gland	Adjacent and medial to right kidney and immediately dorsolateral or lateral to the caudal vena cava	Cranial to right kidney and caudal to the caudate lobe of the liver; lateral to caudal vena cava

Dog

Renal size in dogs varies based on body conformation. Therefore, a normal ratio of left kidney length to aortic luminal diameter (LK:Ao) has been established (**TABLE 1**). Kidney size is a nonspecific indicator of renal disease, as histopathologically abnormal kidneys may still be normal in size. In normal dogs, there can be an inner hyperechoic band associated with the renal cortex that has been shown to represent the outer renal medulla (not seen in cats).[20]

Cat

In cats, the kidneys are more consistent in size, with a normal length of 3.5 to 4.5 cm. Fat deposition in the renal sinus is greater in cats than in dogs. Castrated male cats tend to have more hyperechoic kidneys from increased fat deposition (**FIGURE 8**).[21]

URINARY BLADDER, URETHRA, AND CANINE PROSTATE

In dogs and cats, the layers of the urinary bladder are difficult to distinguish (**FIGURE 9A AND 9B**). In addition, the urinary bladder wall thickness and size can be variable, depending on the volume and size of the patient (**TABLE 1**).

Dog

The canine prostate is visualized caudal to the trigone (urinary bladder neck) and located surrounding the proximal aspect of the urethra. It is uniformly hypoechoic and fusiform in a neutered male dog but appears large, homogeneously hyperechoic, and rounded in an intact dog. Enlargement and heterogeneity (small anechoic cysts) are common in adult/older male intact dogs, likely representing benign prostatic cystic hyperplasia (**FIGURE 10**). In dogs, the trigone and proximal urethra can be in a pelvic position and thereby not evaluable from a transabdominal approach.

Cat

In cats, the urinary bladder can be smaller in volume, be more consistent in size, and contain suspended echogenic contents representing normal mucus or fat droplets. The feline prostate is not a discrete macroscopic structure, so it will not be ultrasonographically visualized, although it is present histologically. Although rare, prostatic carcinoma can occur in cats, so the proximal urethra should be evaluated in male cats. The proximal urethra is typically in an abdominal location and can be evaluated (**FIGURE 9C**).

ADRENAL GLANDS

TABLE 2 describes the ultrasonographic localization of the left and right adrenal glands in the dog and cat.

Dog

Canine adrenal glands appear as long, thin structures.

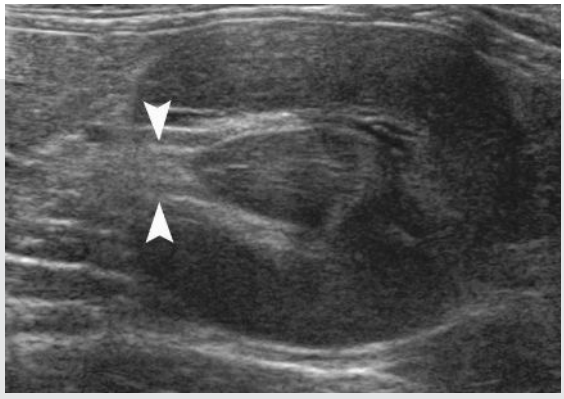

Figure 8. Short-axis view of the left feline kidney. Note the subjective hyperechoic renal pelvis (white arrowheads) relative to the adjacent medulla.

Figure 9. Long-axis views of the (**A**) canine urinary bladder, (**B**) feline urinary bladder, and (**C**) proximal feline urethra. Both urinary bladders are moderately distended, making the wall layers difficult to distinguish. In **C**, note the gradual transition of the feline urinary bladder to the urethra (white arrows).

The left adrenal gland is often peanut-shaped in small-breed dogs (**FIGURE 11A**); it can appear pancake- or "lawn chair"-shaped in medium-sized and large dogs. The right adrenal gland is usually oval in small-breed dogs and pancake- or V-shaped in medium- and large-breed dogs. Normal adrenal gland sizes for dogs and cats have been reported. The commonly accepted normal height for the caudal pole of the canine adrenal glands is 0.5 to 0.7[41]; however, recent studies have suggested taking the body weight of the patient into account for a more accurate size measurement.[6] Clinical findings and results of additional diagnostic tests should be taken into account when adrenal gland measurements are obtained and interpreted.

Mineralization in canine adrenal glands is seen in adrenal neoplastic masses.

Cat

Feline adrenal glands are usually oval or bean-shaped, bilaterally symmetrical in size, and hypoechoic relative to the surrounding retroperitoneal fat. Two adrenal gland measurements have been proposed for cats: 4.0 to 4.6 mm in height[22] and 5.3 mm in width.[23] It is more difficult to see the distinction between the adrenal cortex and medulla in cats. Mineralization of the feline adrenal gland is considered an incidental finding (**FIGURE 11B**).

PANCREAS[1,8,9]

The pancreas in the dog and cat can be isoechoic to the surrounding mesenteric fat and therefore not readily visualized. Decreasing the dynamic range of the image to create more contrast in the image can help in identifying the pancreas as it becomes more hypoechoic relative to the surrounding mesenteric fat.

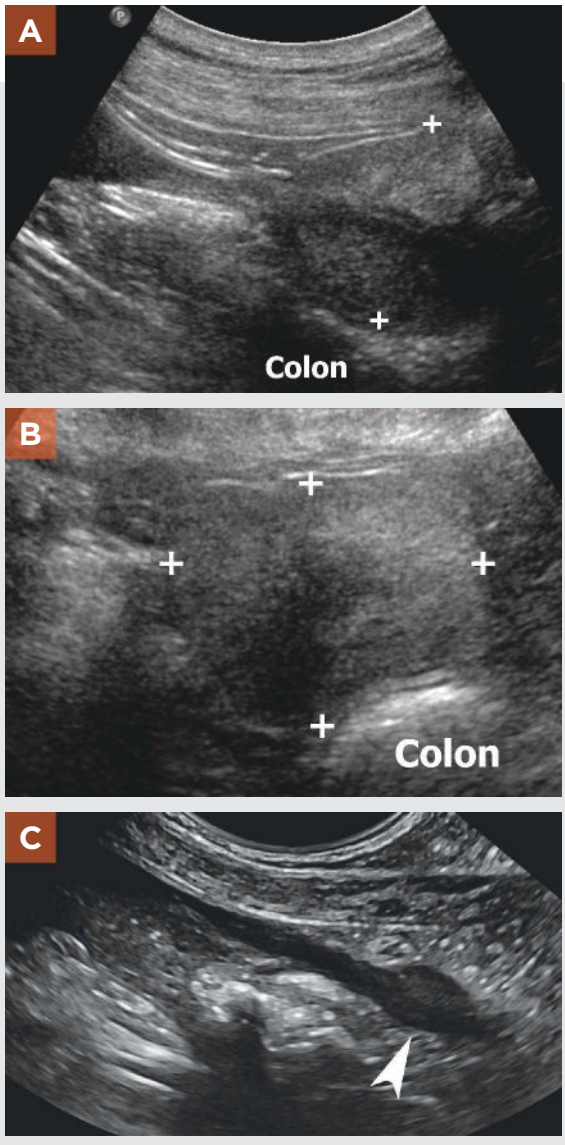

Figure 10. (A) Long- and (**B**) short-axis views of the prostate gland from an intact male dog. Note the smoothly marginated, symmetric, moderately enlarged, hyperechoic prostate consistent with benign prostatic hyperplasia. (**C**) Long-axis view of the prostate gland from a 10-month-old Boston terrier that was neutered at 4 months of age. The prostate is fusiform and hypoechoic (white arrowhead).

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Dog

In dogs, the right lobe of the pancreas (**FIGURE 12A**) is easier to identify based on its larger size relative to the left lobe and proximity to the descending duodenum. The canine pancreas generally varies in size depending on the size of the dog.[7] The normal canine pancreatic duct is inconsistent in being identified. When present, the canine pancreatic duct appears as 2 hyperechoic parallel lines in the center of the pancreas.[7]

Cat

In cats, the left lobe of the pancreas (**FIGURE 12B**) is easier to identify because it is larger than the right lobe (the descending duodenum in cats is more difficult to identify because of its midline and dorsal position compared with the canine descending colon). The centrally located feline pancreatic duct can be routinely identified and is commonly used as a landmark to identify the pancreas. The feline pancreas duct diameter increases with age in normal cats (**TABLE 1**).[8-10]

GASTROINTESTINAL TRACT

The gastrointestinal tract of dogs (**FIGURE 13**) and cats (**FIGURE 14**) has 5 layers:

- Outer serosa (hyperechoic)
- Muscularis (hypoechoic)
- Submucosa (hyperechoic)
- Mucosa (hypoechoic)
- Inner mucosal-luminal interface (hyperechoic)

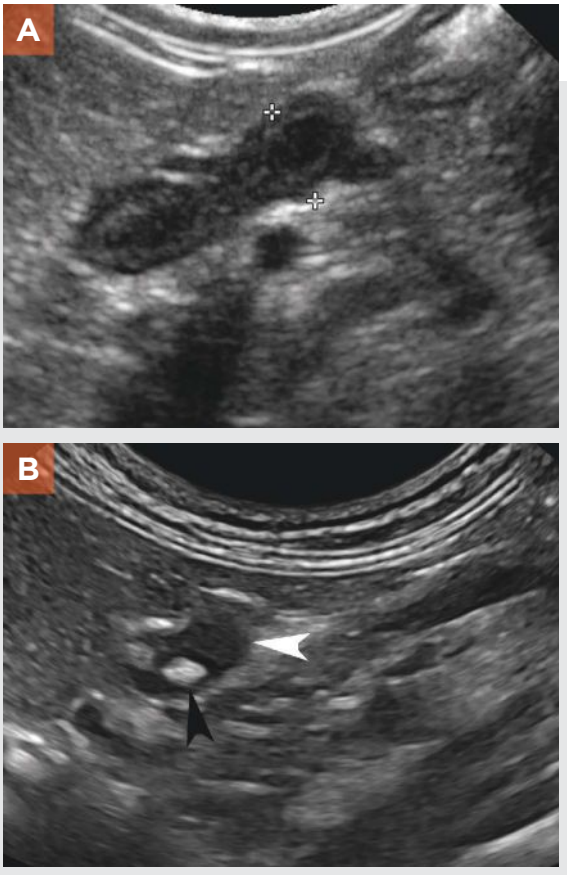

Figure 11. (**A**) Long-axis view of the left canine adrenal gland. Note the peanut shape with a well-delineated adrenal cortex and medulla. The hypoechoic phrenicoabdominal vein between the cranial and caudal poles is seen in the near field. The anechoic structure in the far field is the adjacent cranial mesenteric artery. (**B**) Long-axis view of the feline adrenal gland (white arrowhead). Note the oval shape and central hyperechoic focus (black arrowhead), representing incidental mineralization.

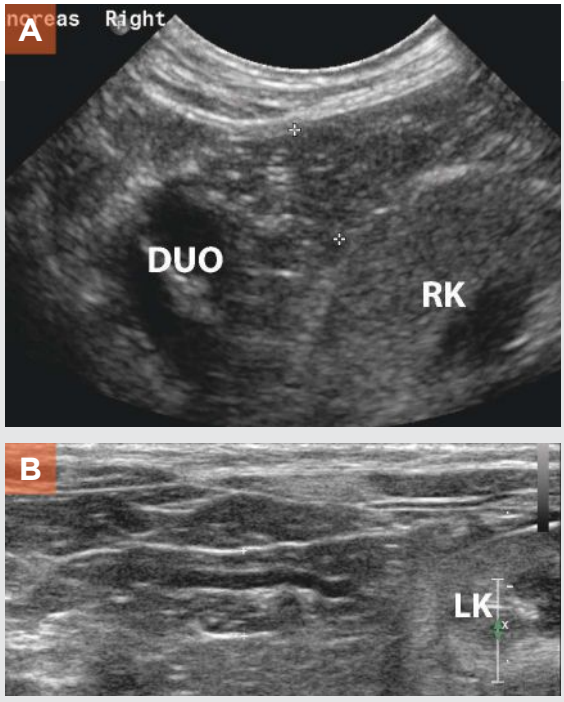

Figure 12. (**A**) Short-axis view of the right lobe of the pancreas in a normal dog. Note the location in relation to the right kidney (RK) and descending duodenum (DUO). The duodenum is typically located lateral to the right lobe of the pancreas, and the right kidney is typically located medial to the right lobe of the pancreas. (**B**) Long-axis view of the left lobe (short-axis position of the transducer relative to the abdomen) of the pancreas in a normal cat. Note the location (between the calipers) in relation to the left kidney (LK) and the presence of the pancreatic duct (anechoic tubular structure located central to the pancreas). The left lobe of the pancreas is typically found craniolateral to the cranial pole of the left kidney and medial to the body of the spleen, between the caudal border of the stomach and the cranial border of the transverse colon.

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TABLE 3 Normal Wall Thicknesses of the Gastrointestinal Tract of Dogs and Cats

	DOG	CAT
Stomach	3–5 mm[25]	2 mm (inter-rugal)[26,27] and 4 mm (rugal fold thickness)[26]
Duodenum	<5 mm[28]	2.0–2.5 mm[27]
Jejunum	2–5 mm[29]	2.5–3.2 mm[27]; thickest segment in the cat
Ileum	2–4 mm[1]	
Colon	2–3 mm[29]	1.4–2.5 mm[27,30]

Superscript numbers are reference citations.

Each segment of the gastrointestinal tract (stomach, duodenum, jejunum, ileum, and colon) can be ultrasonographically distinguished based on wall layering and thickness. Ultrasonographic measurements of the individual wall layer thicknesses of the canine duodenum, jejunum, and colon have been proposed to assess gastrointestinal diseases that target specific wall layers or the entire intestinal wall segment.[24] **TABLE 3** lists differences in overall wall thicknesses of the different intestinal segments as well as the appearance of the wall layering in dogs and cats.[1,25-30]

Dog

The canine gastric submucosal layer is thin like that of the small intestine (**FIGURE 13A AND 13C**). Complete evaluation of the stomach can be limited by the presence of food material and/or gas, which is a common feature of the canine gastrointestinal tract.

The transition between the **pyloroduodenal angle** and proximal duodenum can be identified; the pyloroduodenal junction and cranial duodenal flexure are in a more lateral position in dogs than in cats. An intercostal right-sided approach may be necessary to identify the cranial duodenal flexure in a dog.

The canine **duodenum** is the thickest portion of the small intestine in the dog and normally has a thicker mucosal layer than the jejunum. The duodenal thickness in normal dogs varies according to weight.[31]

The major duodenal papilla is located near the cranial duodenal flexure and appears as a hyperechoic, spindle-shaped structure located in the submucosa, with an area of eccentric thickening where the papilla is located (**FIGURE 4**).

In the **jejunum**, the mucosal layer is the thickest layer, whereas the submucosa and the muscularis are thinner.

In the **ileum**, the wall layers of the muscularis, submucosa, and mucosa are more equal in width than in the duodenum and jejunum.

The large canine **cecum** is usually gas-filled, making it difficult to identify as a separate structure from the ascending colon.

The **colon** is the thinnest gastrointestinal segment. It can be traced from the pelvic inlet to the ileum in both dogs and cats, and its anatomic positioning is similar in both species.

Cat

In cats, the rugal folds of the fundic portion of the stomach have a hyperechoic, prominent submucosal layer (**FIGURE 14A**) secondary to fat deposition. As in dogs, evaluation of the stomach can be limited by the presence of food material and/or gas; however, gas is less common in the feline gastrointestinal tract. The rugal folds in the region of the fundus become smaller at the transition to the gastric body and pyloric antrum (**FIGURE 13B**).

As in dogs, the transition between the **pyloroduodenal angle** and proximal duodenum can be identified; however, the pyloroduodenal angle is narrower and in a more midline and dorsal position in cats than in dogs.

The mucosal layer of the feline **duodenum** is thinner when compared with the duodenum in the dog. This is similar to that of the feline **jejunum**. The location and appearance of the major duodenal papilla are similar to those in the dog.

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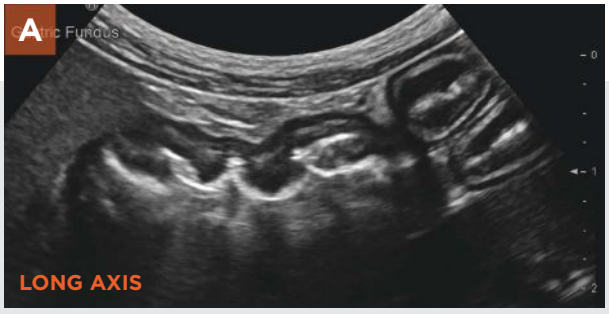

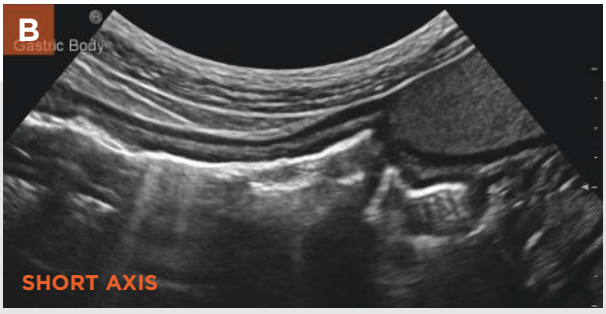

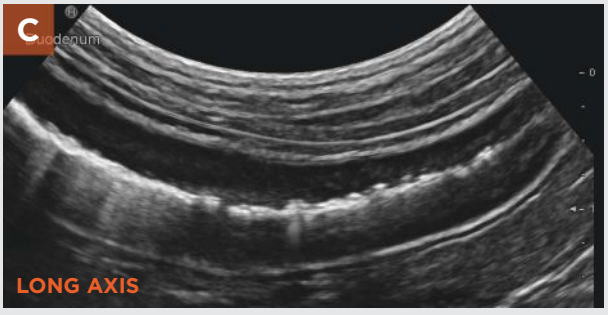

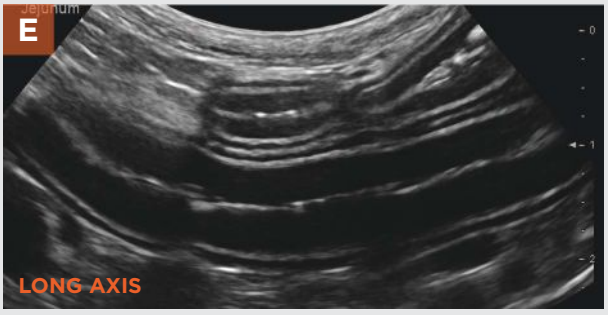

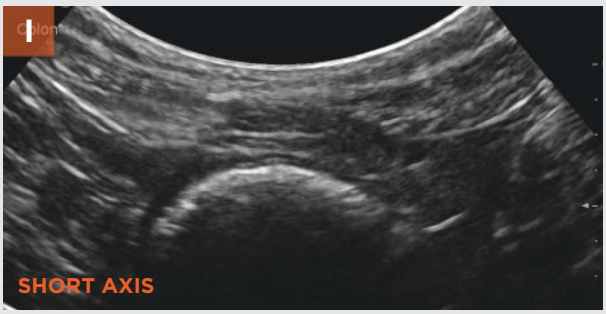

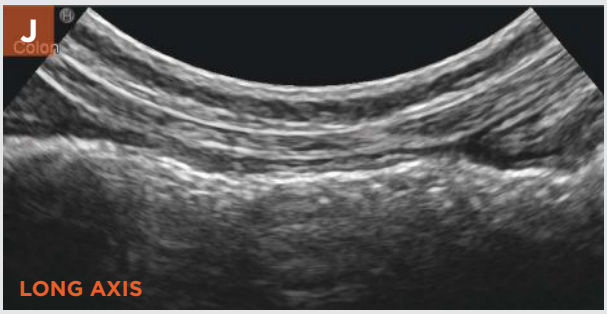

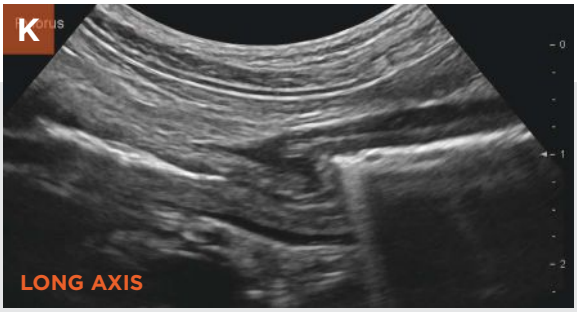

Figure 13. Gastrointestinal tract of a normal dog. Note the different wall layering of each segment and the overall differences between them. (**A**) Note the normal rugal folds within the fundic lumen. The hyperechogenicity with reverberation artifact represents gas within the lumen of the stomach. (**B**) The body of the stomach typically contains fewer rugal folds than the fundus. (**C**) The pyloroduodenal angle is depicted an abrupt transition, clearly delineating the gas-filled pylorus and empty duodenum in this patient. (**D and E**) The duodenum in a normal dog has a prominent mucosal layer (hypoechoic) compared to the jejunum. The normal anatomic location of the duodenum (along the right lateral body wall) and its ultrasonographic appearance aid in differentiation from the jejunum. (**F and G**) The jejunum is typically located throughout the midabdominal cavity and normally has a thinner mucosal layer (hypoechoic) than the duodenum. (**H**) The ileocolic junction (ICJ) is an abrupt transition from the ileum to the colon. The ileum is usually empty, and the colon is usually gas filled. (**I**) The lumen of the empty ileum can be likened to spokes on a wagon wheel. (**J and K**) The colon has a thin wall and usually contains gas that appears hyperechoic with dirty shadowing and fecal matter that results in attenuation of the ultrasound beam.

The **ileum** is the thickest portion of the small intestine in the cat. The feline ileum has thicker muscularis and submucosal layers compared to the mucosal layer.

The cat has a common opening to the ileum, cecum, and colon called the **ileocecocolic junction**, whereas the dog has separate ileocolic and cecocolic junctions. The feline **cecum** is usually not gas filled and is therefore small and identifiable as the ascending colon is traced in the sagittal or transverse imaging plane caudal to the ileocecocolic junction in the right cranial to mid abdomen.

As in dogs, the **colon** is the thinnest gastrointestinal segment and can be traced from the pelvic inlet to the ileum.

ABDOMINAL LYMPH NODES

Dog

The jejunal and medial iliac lymph nodes can be routinely seen in dogs. The **medial iliac lymph nodes** are fusiform and are found lateral to the caudal abdominal trifurcation into the external iliac arteries and continuation of the caudal abdominal aorta (FIGURE 15A). The **jejunal lymph nodes** are elongated, oval structures surrounding the caudal mesenteric artery and vein and are seen to the right of midline at the level of the umbilicus. These lymph nodes are much larger in puppies and can be lobulated and have hypoechoic peripheral areas (FIGURE 15C). The jejunal lymph nodes are hypoechoic relative to the surrounding mesenteric fat.

Cat

In cats, normal **medial iliac lymph nodes** (FIGURE 15B) are often not seen. The **jejunal lymph nodes** are found to the right of the umbilicus, medial to the ileocecocolic junction and adjacent to the cranial mesenteric portal veins. These lymph nodes are oval or bean shaped and hypoechoic to the surrounding mesentery. The **ileocolic lymph nodes** in the cat are seen adjacent to the ileocecocolic junction and typically measure <3 mm in width. These lymph nodes are often enlarged and infiltrated when round cell neoplasia is present.

SUMMARY

Ultrasound differences between the dog and cat are important to recognize. When performing a thorough abdominal exam in either the dog or cat, one must keep these normal anatomic variations in mind to ensure accurate descriptions of ultrasound abnormalities that might be seen. TVP

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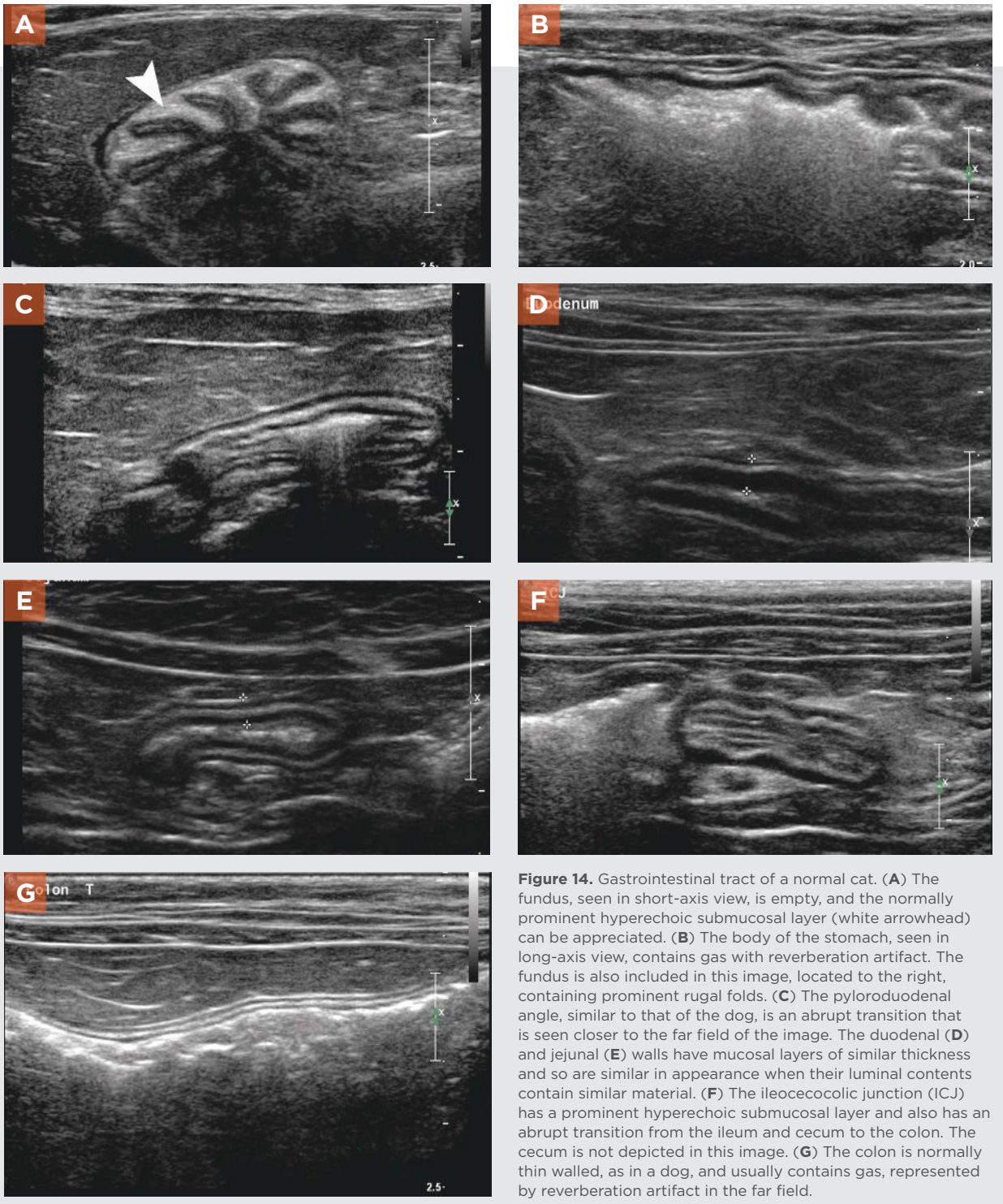

Figure 14. Gastrointestinal tract of a normal cat. (**A**) The fundus, seen in short-axis view, is empty, and the normally prominent hyperechoic submucosal layer (white arrowhead) can be appreciated. (**B**) The body of the stomach, seen in long-axis view, contains gas with reverberation artifact. The fundus is also included in this image, located to the right, containing prominent rugal folds. (**C**) The pyloroduodenal angle, similar to that of the dog, is an abrupt transition that is seen closer to the far field of the image. The duodenal (**D**) and jejunal (**E**) walls have mucosal layers of similar thickness and so are similar in appearance when their luminal contents contain similar material. (**F**) The ileocecocolic junction (ICJ) has a prominent hyperechoic submucosal layer and also has an abrupt transition from the ileum and cecum to the colon. The cecum is not depicted in this image. (**G**) The colon is normally thin walled, as in a dog, and usually contains gas, represented by reverberation artifact in the far field.

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Figure 15. Long-axis views of the right medial iliac lymph node in a normal (**A**) dog and (**B**) cat. Note the normal fusiform shape and relative isoechogenicity of the lymph nodes relative to the adjacent mesenteric fat. These lymph nodes are considered normal. Ao = abdominal aorta. (**C**) Jejunal lymph node from a 10-month-old male neutered Boston terrier. Note the increased size, lobulated appearance, and peripheral oval to fusiform hypoechoic areas (white arrowhead).

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