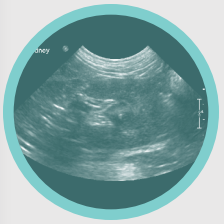

Small Animal Abdominal Ultrasonography

A TOUR OF THE ABDOMEN: PART 1

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Welcome to our series of articles on small animal abdominal ultrasonography. The first 3 articles provided an overview of basic ultrasonography principles, while this article and the next will review a systematic pattern for scanning the abdomen. Future articles will discuss scanning principles and normal sonographic appearance of abdominal organs and systems as well as identification of common abnormalities seen during ultrasound examination.

Abdominal ultrasonography is a noninvasive technique that provides cross-sectional anatomy of the organs of the abdomen based on differences in acoustic impedance. The first 3 articles in this series, available at **tvpjournal.com**, have discussed:

- Basics of Ultrasound Transducers & Image Formation (January/February 2015)
- Physical Principles of Artifacts & False Assumptions (May/June 2015)
- Basics of Imaging Optimization—How to Obtain High-Quality Scans (November/December 2015).

ABDOMINAL TOUR

A systematic pattern for scanning the abdomen is an important aspect of any abdominal ultrasound (US) examination. In approaching abdominal ultrasonography, the practitioner should identify the questions the scan needs to answer; however, a negative US scan does not rule out disease.

For abdominal US, the dog or cat can be in dorsal or lateral recumbency; both scanning techniques are equally effective. This article discusses a systematic approach to scanning the abdomen using a dorsally recumbent technique; however, the approach is just as applicable to scanning in lateral recumbency. The sonographer must learn to scan the patient in either position.

The systematic approach:

1. Starts in the cranial abdomen (at the liver)
2. Proceeds in a clockwise fashion that extends around the outside of the abdomen
3. Comes back in a counterclockwise fashion to incorporate the gastrointestinal tract and middle abdomen (see **Checklist for Systematic Approach to the Abdomen**, available at tvpjournal.com/clinical-resources).

Step 1 and part of step 2 are covered in this article; the remainder of step 2 and step 3 will be covered in the next article.

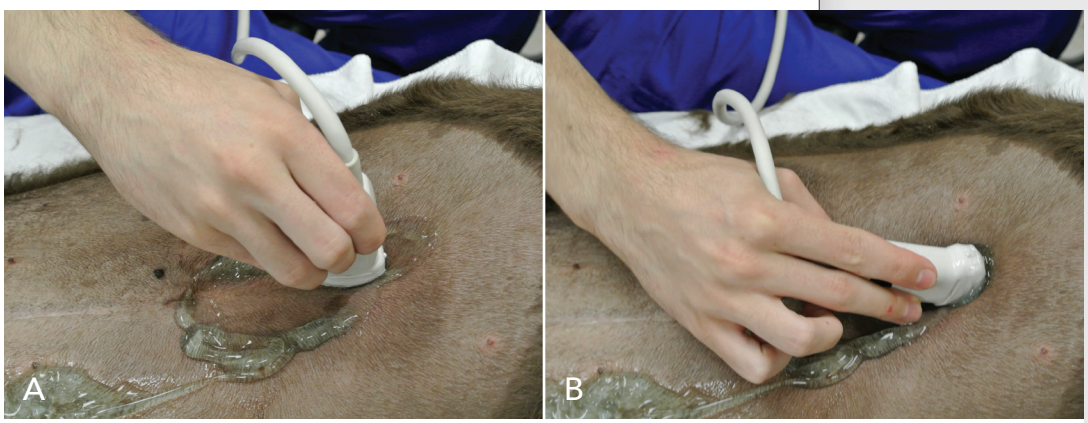

FIGURE 1. Transducer placement on the abdomen of a dog in dorsal recumbency: The transducer is placed perpendicular to the skin and is just caudal to the xiphoid process (**A**); the transducer notch is pointing cranially as the image is in long axis with the dog. The transducer angled cranially (**B**); all images would be considered long-axis views and in a sagittal plane.

BASICS OF DRIVING THE TRANSDUCER

Hold the transducer as you would a pen. You should be able to rotate the transducer 90 degrees by rolling the transducer between your fingers and thumb without applying undue pressure on your wrist. You do not need to grip the transducer tightly, and you do not need to push the transducer into the dog or cat's abdomen to produce good-quality images.

There are 3 different types of transducer motions:

1. With **distance motion**, the transducer moves across a physical distance on the patient. The transducer can move in cranial, caudal, right-sided, or left-sided directions.
2. With **nondistance angle motion**, the transducer is angled in different directions but stays in the same position (**Figure 1**, page 109). For example, the transducer is placed caudal to the xiphoid process and then angled cranially to visualize the liver.
3. By using **nondistance, rotational motion**, the transducer is fixed in its position and rotated in a clockwise or counterclockwise direction.

In finalizing an image of a specific organ, a combination of these motions is often used. US waves that reflect from organs that are perpendicular to the probe provide optimal images; therefore, always try to put the organ of interest in the near field and perpendicular to the probe.

PROBE ORIENTATION

Probe orientation and orientation of the image relative to the transducer can be confusing during abdominal ultrasonography. A notch on the probe has a "logo" that corresponds with the image display screen, identifying which way you are driving.

With regard to the patient, the notch should always be pointing in the cranial direction (**Figure 2**), to the patient's right when on midline, and toward the dorsal direction when the lateral aspect of the animal is being imaged. The "logo" orientation should always be on the left side of the screen as the sonographer is facing the display.

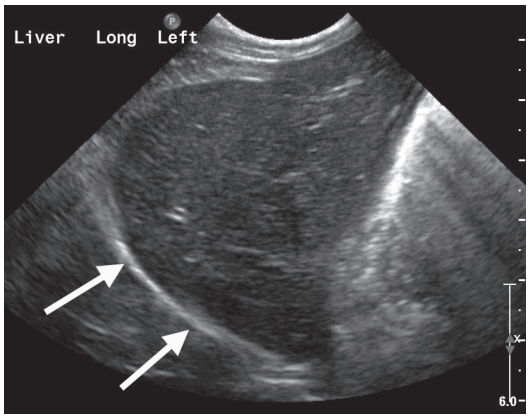

FIGURE 2. The transducer notch is placed in a cranial direction when in long axis on the abdomen of a dog (as in this case) or cat. As a result the cranial direction is toward the viewer's left (cranial) as seen in this corresponding image of the liver. The hyperechoic margin of the diaphragm–lung interface is noted along the viewer's left of the image (**arrows**).

TABLE.
Ultrasound Features of Each Organ/ Structure to Describe Normal Attributes

1.	Size
2.	Shape
3.	Margins/contour
4.	Location/position
5.	Number
6.	Echogenicity (gray-scale appearance) • Fluid • Medulla (renal) • Cortex (renal) • Liver • Spleen • Prostate (with benign prostatic hypertrophy) • Peritonitis
7.	Echotexture (internal echo appearance) • Uniform change • Mottled/mixed/multifocal • Heteroechoic • Target (alternating hyper- and hypoechoic concentric rings)

IDENTIFICATION OF ABNORMALITIES

Look for abnormalities in the described size, shape, margins/contours, location/position, number, and echogenicity (a feature that replaces opacity for radiographic changes).

Echogenicity & Echotexture

The hardest and most subjective aspect to evaluate is the relative echogenicity of a given organ or structure. It is easy to turn the gain too high or too low, resulting in images that are hyperechoic or hypoechoic overall, respectively (see **Basics of Imaging Optimization—How to Obtain High-Quality Scans** in the November/December 2015 issue).

In addition to the overall gray scale or echogenicity, the echotexture of the organ or structure of interest is also important (**Table**).

Memorizing Echogenicities

The relative echogenicities can be remembered using the mnemonic **For Most Cats Love Sunny Places,** which designates a progressive increase in echogenicity:

Fluid (anechoic or black)
Medulla (renal)
Cortex (renal)
Liver
Spleen
Prostate gland with benign prostatic hypertrophy
Peritonitis (the mesentery becomes hyperechoic or white and hyperattenuating)

Imaging Planes

For each organ, the evaluation must use 2 different imaging planes, which is particularly true for any suspected abnormalities. The imaging planes used in organ evaluation may not align with standard imaging planes, such as sagittal, transverse, or dorsal planes. An oblique imaging plane is often used to best visualize an organ.

Make sure that all images are labeled appropriately, with correct orientation. These images will become an official part of the patient's medical record.

TOUR OF THE ABDOMEN

With the dog in dorsal or lateral recumbency, begin with the probe just caudal to the xiphoid process.

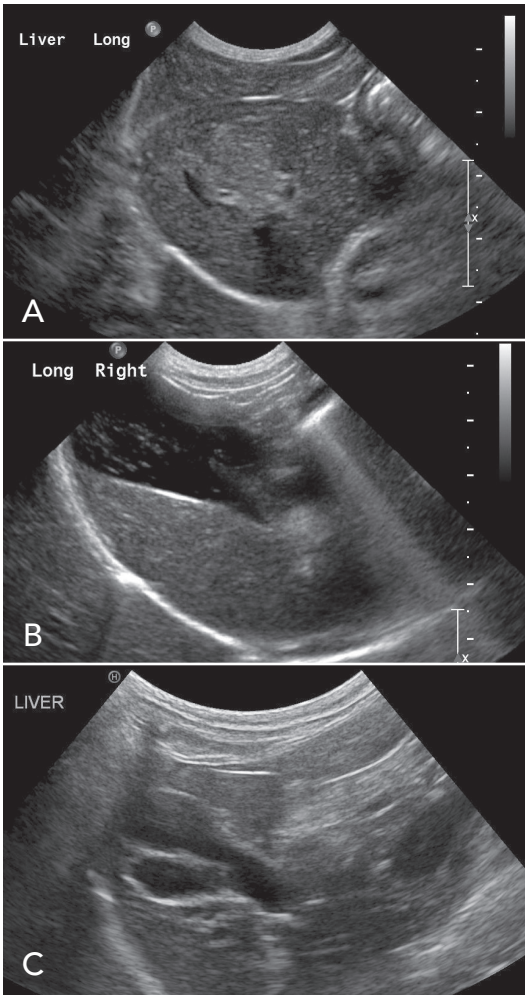

FIGURE 3. Long-axis image of the left side of the liver in a dog (**A**). Long-axis image of the right side of the liver and gallbladder in the same dog (**B**). Long-axis image of a bilobed gallbladder in a cat (normal anatomic variation of the gallbladder that can be seen in cats) (**C**).

Ultrasound of the Liver

With a nondistance motion, angle the probe cranially. The midsection of the liver should come into view. Depending on liver size, use a non-distance motion and angle the probe to the left to view the left side of the liver or the right to view the gallbladder and right side of the liver, including the porta hepatis (**Figure 3**).

The normal liver has a coarse echogenicity and contains vessels:

- The dominant vessels in the hepatic parenchyma are the *portal veins*, which have an outer hyperechoic wall due to the fibrofatty connective tissue surrounding the wall and within the wall itself. The intrahepatic *portal veins* are a continuation of the portal vein proper as it enters the porta hepatis.
- The *hepatic veins* can be seen as hypoechoic tubular structures that do not have hyperechoic walls (**Figure 4**); the vessels taper toward the periphery of the liver and enlarge centrally within the liver. The hepatic veins enter into the caudal vena cava in the dorsal right liver (**Figure 5**).

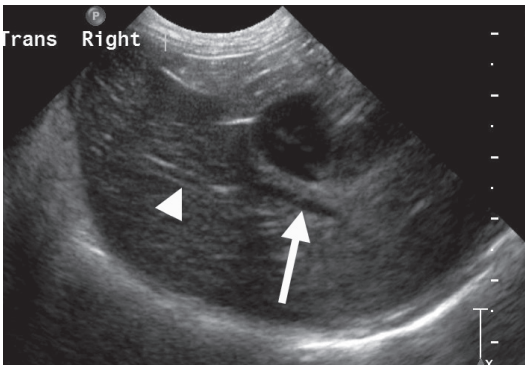

FIGURE 4. Short-axis (transverse imaging plane) view of the liver (right is to the viewer's left). The hepatic veins (**arrow**) are the hypoechoic vessels without a bright echogenic wall, whereas the portal veins (**arrow head**) are the hypoechoic vessels with a bright echogenic wall. In the normal liver, portal veins usually dominate the landscape.

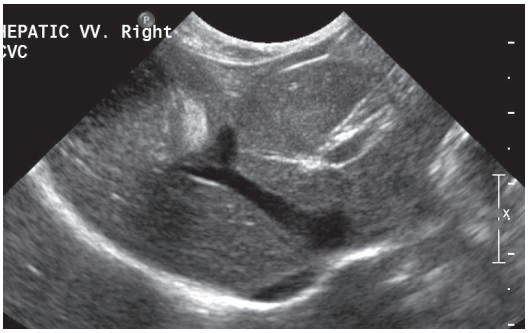

FIGURE 5. Hepatic vein entering the caudal vena cava as it courses through the liver (quadrate lobe).

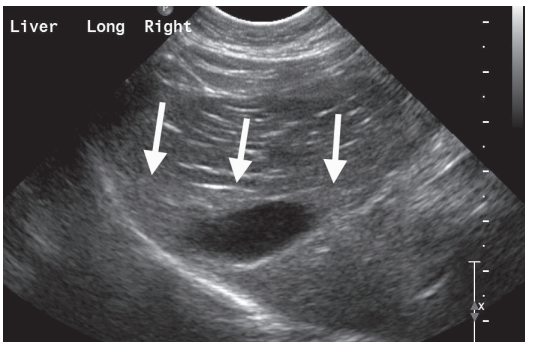

FIGURE 6. Long-axis view in a cat where the fat in the falciform ligament (near field) is slightly hypoechoic relative to the liver (far field). The arrows indicate the demarcation between the falciform fat (near field) and the liver parenchyma (far field).

The hepatic artery branches and intrahepatic bile ducts are not visualized normally. In dogs, the cystic duct and bile duct are normally not visualized; however, in cats the cystic duct and bile duct may be visualized and normally measure 2 to 3 mm in diameter.

Fat within the falciform ligament is seen in the near field, particularly in cats. This fat can be isoechoic to the liver (**Figure 6**). Distance motion may need to be used along the costal arch on both the right and left side to evaluate the entire liver. In some dogs, an intercostal approach is necessary to evaluate the liver and gallbladder. This is usually the case in deep-chested breeds or dogs with small livers and a barrel-chest conformation.

As with all US examinations, make sure to visualize each organ or structure in 2 imaging planes; rotate the probe 90 degrees to view the liver in transverse plane prior to moving on to the next organ.

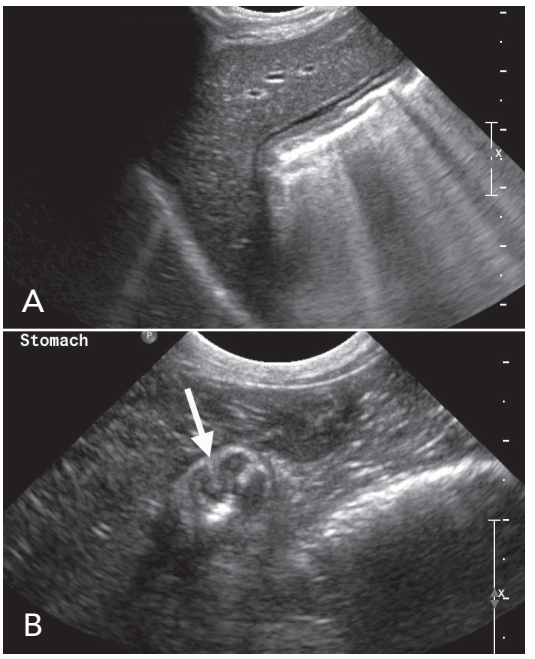

FIGURE 7. Long-axis image of a transverse section of the body of the stomach in a dog (**A**) and cat (**B**). In the cat, the bright submucosa is seen to be hyperechoic due to the fat deposition in this layer (**arrow**).

Ultrasound of the Stomach

From the xiphoid position, slide the transducer caudally so that the stomach is in short axis (in transverse section) even though the transducer is still aligned with the long axis of the patient (**Figure 7**); then evaluate the stomach in its entirety in both long- and short-axis images. When the transducer is swept toward the right side, the pyloroduodenal junction is visualized as the thickened area of the muscularis between the pylorus and proximal duodenum.

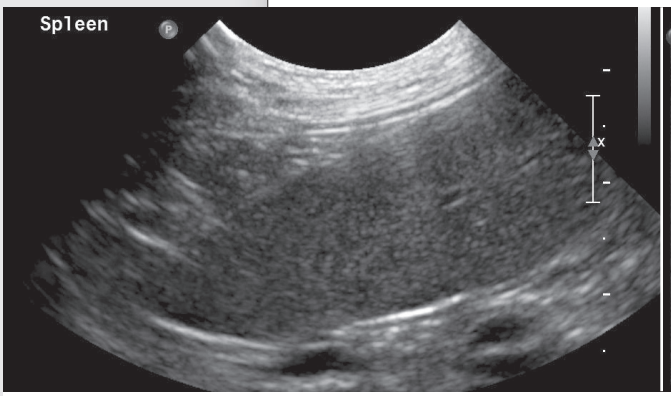

FIGURE 8. Long-axis image of the spleen in a dog. The spleen is seen in a triangular transverse plane due to its orientation as it courses from the left to the right side of the abdomen.

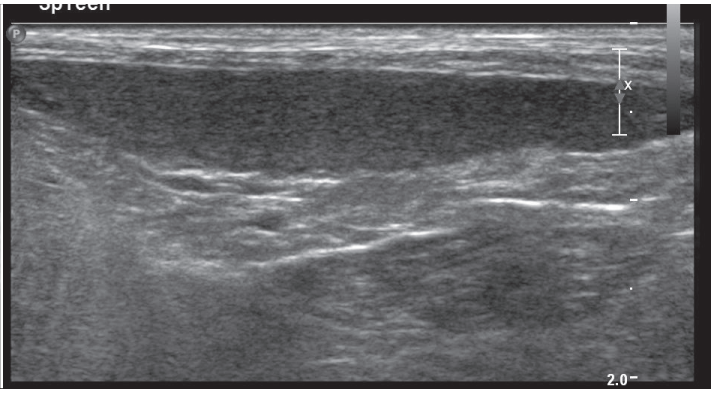

FIGURE 9. Long-axis image of the spleen in a cat. The spleen is also superficial but is smaller in the cat. This spleen is relatively hypoechoic to the surrounding fat but, in some cats, it can be isoechoic and, therefore, difficult to identify.

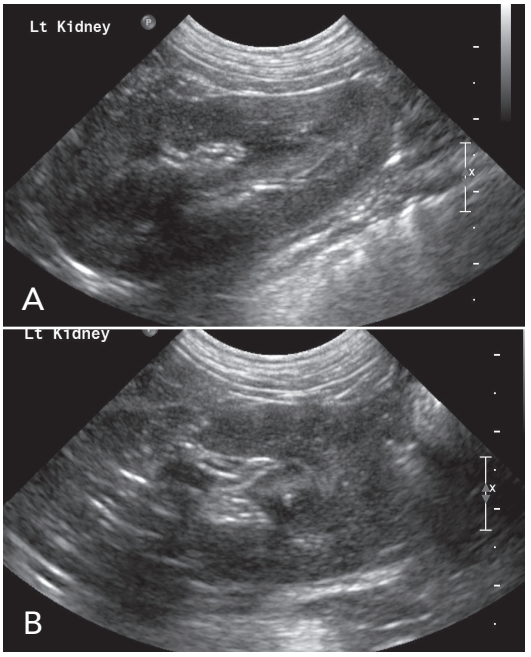

FIGURE 10. Long-axis sagittal (**A**) and short-axis transverse (**B**) imaging planes of the left kidney in a dog.

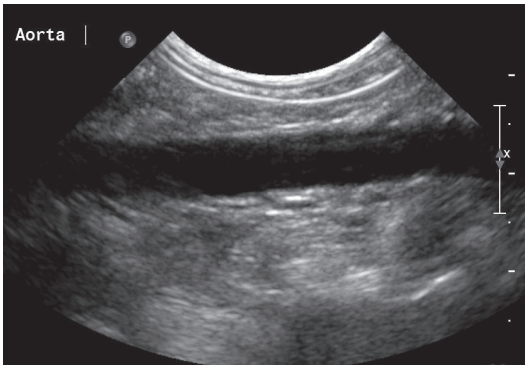

FIGURE 11. Long-axis image of the abdominal aorta in a dog; the cranial direction is still to the viewer's left.

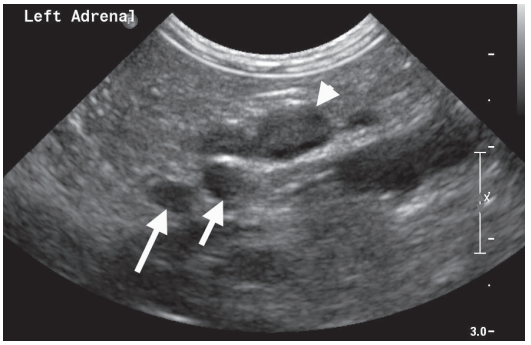

FIGURE 12. Long-axis image of the celiac (**long arrow**) and cranial mesenteric (**short arrow**) arteries and the left adrenal gland (**arrow head**) in a dog.

FIGURE 13. The left ovary is seen as a hypoechoic structure relative to the surrounding fat. This image was obtained from a dog. The transducer has been placed just caudal to the left kidney.

Ultrasound of the Spleen

Slide the transducer caudally and to the left to identify the spleen. Initially evaluate the spleen in transverse section, even though the probe is still oriented along the long axis of the patient. In the dog, the spleen is a large structure that extends across the abdomen from the left side (head of the spleen) to the right side (tail of the spleen, **Figure 8**, page 112). The feline spleen is a very small and thin structure (usually 5–7 mm thick) found in the left cranial and lateral abdomen in the near field (**Figure 9**, page 112).

Ultrasound of the Left Kidney & Left Adrenal Gland

From the level of the spleen, move the transducer with a medial and slightly caudal distance motion to identify the left kidney (**Figure 10**, page 113) and evaluate the kidney in long and short axes. From the left kidney, angle the probe medially; the abdominal aorta is seen in long axis (**Figure 11**, page 113). The celiac and cranial mesenteric arteries and the left renal artery form the cranial and caudal vascular delimiters, respectively, for the area where the left adrenal gland can be found (**Figure 12**, page 113).

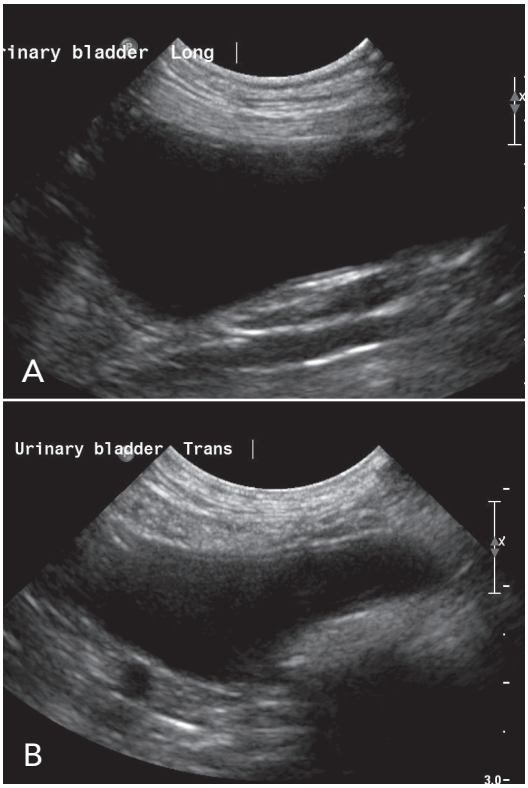

FIGURE 14. Long-axis view of the urinary bladder in a dog (**A**). Short-axis image of the urinary bladder cranial to the trigone (**B**).

Part 2 of this article will discuss identification of the right kidney and adrenal gland.

Ultrasound of the Left Ovary

The left ovary in an intact female is located caudal to the left kidney in the near field (**Figure 13**). Depending on stage of estrus, the ovary can be indistinguishable from the surrounding fat (anestrus) or can be seen as a hypoechoic structure with multiple anechoic cysts (estrus).

Ultrasound of the Urinary Bladder

Move the transducer caudally to a central and caudal abdominal position. Evaluate the urinary bladder

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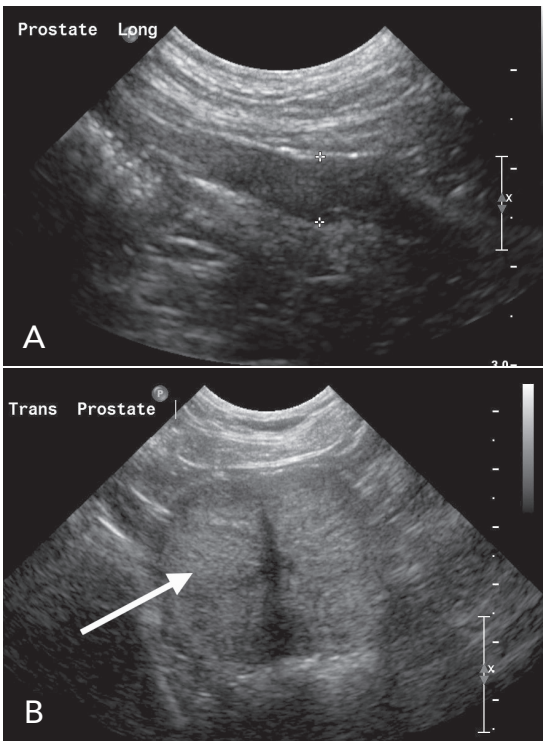

FIGURE 15. Long-axis image of the prostate gland in a neutered male (**A**). In the neutered male, the prostate gland is seen as a hypoechoic fusiform-shaped enlargement of the proximal urethra. In an intact male dog with benign prostatic hyperplasia, the prostate is enlarged and hyperechoic. A transverse view of an enlarged prostate (**arrow**) is shown in **B**.

in long and short axes (**Figure 14**). Always evaluate the trigone area carefully, particularly as it extends caudally into the urethra or prostate gland (if the dog is a male) (**Figure 15**).

IN SUMMARY

It is important to be systematic about your examinations and make sure that all images/video clips are correctly labeled and all normal/abnormal findings are well documented for future reference, particularly when follow-up evaluations are used, as in complex medicine cases or oncology cases. Part 2 of this article will review further exploration of the abdomen.

US = ultrasound

Suggested Reading

Kremkau F. *Sonography Principles and Instruments*, 8th ed. Philadelphia: Saunders-Elsevier, 2010.

Mattoon J, Nyland T. *Small Animal Abdominal Ultrasound*, 3rd ed. Philadelphia: Saunders-Elsevier, 2014.

Penninck D, d'Anjou M. *Atlas of Small Animal Abdominal Ultrasound*, 2nd ed. Ames, IA: Wiley Blackwell, 2015.