

Ultrasound Tips

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Abdominal Cavity:

Bladder:

Have a well-distended bladder to evaluate for masses. When not fully distended, the bladder apex is thicker, and the wall thins caudally towards the neck. The wall can look undulating and slightly irregular when it is not well distended.

If there are multiple, fairly evenly spaced small rounded masses, it may be polypoid cystitis rather than cancer.

If you find a hyperechoic focus, it is a “stone” if it is: mobile, lies on the gravity-dependent side, and shadows (although very small stones sometimes do not shadow if the ultrasound transducer frequency is too low, or the shadow may be lost in the curved edge shadow artifact). Change patient position to make sure the stone/s are mobile and move (roll or fall) to the gravity-dependent side.

Some tumors (especially transitional cell carcinomas) have mineralizations which may appear like a stone, but will not move with patient position change (unless they are pedunculated).

Some stones are “stuck” to the wall by blood clots, and will not move (but sometimes may be balloted to loosen them to move).

The colon can appear like a big, round bladder stone in the transverse view, but if you turn the transducer 90 degrees, you will see it is a tube shape/elongate.

Sometimes a “pile of sand” can look like a stone. Changing patient position should help things slide/roll to better evaluate them.

Proximal Urethra: Look caudally from the bladder neck into the proximal urethra if possible to look for urethral tumors or stones.

Prostate: In all canine males, look caudally from the bladder neck to find the prostate. The rate for cancer in neutered male canines is about 3 times higher than in intact males. If the prostate is enlarged or has mineralization in a neutered male, it is almost pathognomonic for prostate cancer.

Normal size for a neutered male canine prostate is about 2-3 cm by 1.0-1.5 cm by 1.0-1.5 cm. If a dog was neutered as an adult less than a year ago, it may still be larger than this, but should eventually shrink down.

Prostate in an intact male should be symmetrical, bilobed, fairly homogeneous in echogenicity, and have smooth echotexture. If cysts or mineralizations are present, there may be benign hyperplasia, or abscesses, or inflammation, or neoplasia, or chronic disease. Size depends on size of dog, but an average measurement is about 3.3 x 3.5 x 3.0 cm (L x W x H).

Prostates are nearly impossible to see in cats in my experience.

Kidneys:

Cortex is hyperechoic and Medulla is hypoechoic normally. Check for corticomedullary definition, if decreased (similar echogenicities and unclear borders) it indicates non-specific renal disease.

If multiple cysts bilaterally, it almost definitely means polycystic disease, in especially long-haired cats. In dogs it could be polycystic disease or just old age or chronic renal disease.

Renal sinus/hilum is normally bright (hyperechoic) because blood vessel walls, renal pelvis and proximal ureter walls, and local fat are hyperechoic.

In dogs, the left kidney should be compared to the spleen, and should be darker than the spleen's echogenicity. The right kidney should be compared to the liver, and should be equal to or slightly darker than the liver's echogenicity.

In cats, fat can normally be stored in the renal parenchyma, so kidneys may be echogenic (fat is usually echogenic on ultrasound), but still normal.

In cats with bilateral renal lymphoma, kidneys almost always exceed 5 cm in length, are quite hyperechoic, and may have a little fluid (or more) surrounding them. Large cats, such as Maine Coons, may normally have 5 cm kidneys. Greater than 5.5-6.0 cm may be a better cut off for them.

There may "normally" be a tiny amount of fluid in the renal pelvis if the patient is on IV fluids, or a diuretic, or is producing excessive urine—polyuria.

If hydronephrosis / hydroureter is seen, see if you can follow it to an obstruction.

Hydronephrosis may be so severe that only a large cystic structure remains of the kidney.

Perinephric (subcapsular) pseudocysts can be so large that the kidney looks tiny inside of it. They may be full of urine, lymph, blood, or serous fluid. Bilateral or unilateral. More common in cats than dogs.

For accurate difference in renal sizes: Take measurements in 3 dimensions if one kidney is smaller/bigger than the other to calculate the volume of each with the prolate ellipse volume formula: $L \times W \times H \times 0.523$ which come from $\frac{4}{3}\pi \times L \times W \times H$. (basically $L \times W \times H$ divided by 2).

Adrenal Glands:

Dogs: Most often found medial to the kidney. Peanut shaped, hypoechoic. Crossed by the phrenicoabdominal vein. Occasionally cranial (like in textbooks), and rarely at the caudal end of the kidney. Normal is 5-7 mm thickness. Adjust down a little for very small dogs. Get “plump” appearance of normal shape if hyperplastic, get more “round” if tumorous. If tumor present, try to see if it invades the vena cava (harder to surgically remove and more likely cancerous). If FNA is done, it may release epinephrine if it is a pheochromocytoma.

Cats: Usually found cranial to the kidney. Oval shape. Often quite hypoechoic. Normal is 3-6 mm thickness.

Liver:

If very hypoechoic and enlarged: consider diffuse lymphoma, hepatitis.

If very bright: consider fatty liver or cellular vacuolization (steroid hepatopathy)

If bright or slightly heterogeneous and small and slightly lumpy: consider cirrhosis—especially if ascites present.

If normal echogenicity and shape, but very small: consider portosystemic shunt

Portal triad: 1) Portal vein
2) Hepatic artery
3) Bile duct

(Largest diameters of these vessels are found at the hepatic hilum—caudal liver)

Bile ducts travel with portal veins, if dilated, you may see “Shotgun Sign” which looks like 2 similar sized circles in the transverse view—like looking down the barrel of a shotgun.

Portal veins have relatively thick, bright walls.

Hepatic veins have thin walls—only bright if at a close to perpendicular angle to ultrasound beam (horizontal on screen). They can be traced back to the cranial abdominal vena cava near the diaphragm.

Liver is likely enlarged if it extends beyond the stomach in longitudinal view without gallbladder in image.

Rounded masses almost isoechoic to adjacent liver and fairly homogeneous are likely primary liver tumors. Primary liver tumors are hard to tell if benign or malignant, even with histopathology.

Swiss-cheese-like masses (roundish, hyperechoic tissue with many cystic areas that are big and/or small) are most likely bile duct tumors and are not uncommon, especially in cats. Cannot tell if benign or malignant without wedge biopsy. Needle biopsy is usually non-definitive (like biopsying bubble wrap!). They may leak and cause a little ascites. Animals can often live with them for many months if they aren't big enough to cause pressure on the stomach or other organs.

It is not uncommon to have a few faint, hypoechoic nodules less than 1 cm scattered in the parenchyma, which are often areas of hematopoiesis, or regenerative nodules, or areas of steroid hepatopathy. You may want to follow up these cases with a recheck scan in 2-3 months to check for stability. If they are not faint, but more distinct and hypoechoic and over 1 cm—a recheck is highly advised.

If you see **“target” lesions**—lesions with concentric rings of hyperechoic and hypoechoic areas—they are likely metastases.

Gallbladder (GB):

Maximum measurements for a normal canine gallbladder are about 9 x 4 x 4 cm.

Consider pathology/disease if larger.

Feline gallbladders that are larger than about 5 x 3 x 3 cm are enlarged.

Gallbladder wall should be a pencil-line thin and hyperechoic. If a slightly thicker mid-gray layer is on the inner side of the thin hyperechoic wall, it is probably due to GB contraction post meal.

If there is a **“triple line sign”**, the wall is three concentric layers of hyperechoic-hypoechoic-hyperechoic—it indicates wall edema.

Dog's GB's can normally be up to half full of sludge.

Cat's GB's normally have NO sludge.

(FYI, Human's GB's normally have NO sludge.)

Sludge must be gravity dependent and creating a layer, or mucocele is suspected.

Mineralized, hyperechoic sludge should lie in a more gravity-dependent layer than mid-gray sludge.

Small, mid-gray, round protrusions may be polyps (will not change position with gravity) or stuck sludge balls.

Stones should roll to the gravity dependent side, but may be “stuck” and are sometimes freed by ballotment.

If multiple small blebs are seen protruding from the walls into the lumen, often covering much of the walls, these are hyperplastic mucinous glands, and may be due to Cushing’s Disease.

Spleen:

Usually very smooth echotexture; hyperechoic tissue with smooth-walled, visible veins. Older dogs and sometimes cats will often have very hyperechoic (white) nodules along the hilar side of the spleen next to veins—benign fibrofatty nodules.

It is not uncommon to have a few faint, hypoechoic nodules less than 1 cm diameter scattered in parenchyma, which are often areas of hematopoiesis. You may want to follow up on these cases with a rescan check in 2-3 months for stability. If they are not faint, but more distinct and hypoechoic and over 1 cm diameter—a recheck is highly advised.

Rarely, you may see many scattered pinpoint hyperechoic foci. In humans, these are often tiny granulomas from previous infections such as histoplasmosis.

Heterogeneous, partially cystic masses are very suspicious for malignancy. But “benign” tumors can also cause severe internal bleeding.

Duodenum/Jejunum: 5 layers/striations/stripes inner to outer:

Lumen/mucus/ingesta—hyperechoic, or anechoic/hypoechoic if fluid/mixture

Mucosa—hypoechoic, **thick**

Submucosa—hyperechoic, thin

Muscularis—hypoechoic, thin

Serosa—hyperechoic, thin

Normally the wall thickness is less than 6 mm.

You may see indentations of the lumen into the duodenal mucosa where Peyer’s Patches are located.

Jejunum: Wall layers same as duodenum, but often slightly thinner mucosa.

Normally the wall thickness is less than 5 mm.

Distal Ileum: Equal size wall layers. Overall diameter should be $\leq$ to 1 cm.

Mesenteric Lymph Nodes: Should not be at or over 1 cm thick, but thicker than 6 mm indicates probable inflammation and is suspicious for neoplasia.

Medial Iliac Lymph Nodes: Should not be at or over 1 cm thick and/or not thicker than the diameter of the common iliac artery at the aortic trifurcation.

Sublumbar Lymph Nodes: Should not be at or over 1 cm and/or not thicker than common iliac artery diameter.

Vena cava: walls will “touch” the liver, may be tapered in size, may change size with respiration, and can be compressed more caudally with manual compression.

Aorta: walls will not touch the liver, is a consistent size along the liver, and is non-compressible along its course. Aorta trifurcates into the common iliac arteries and the sacral artery.

Normal echogenicity comparisons:

Liver hypoechoic to (darker than) spleen

Liver hypoechoic to falciform fat

Left kidney hypoechoic to (darker than) spleen

Right kidney isoechoic or slightly hypoechoic to (the same shade of gray, or slightly darker than) liver

Kidneys isoechoic to (same shade of gray as) each other

Pancreas hyperechoic (brighter than) liver

Echogenicity of Masses:

If very dark, but not quite anechoic (without echoes), think lymphoma first, then other aggressive neoplasms. Usually, **very hypoechoic** tissue means densely packed sheets of cells—neoplasia. Try turning on color or power doppler to look for internal blood vessels.

If bright, more likely to be benign—fatty, fibrous

If hypoechoic organ tissue, think edema or neoplasia

If heterogeneous, think neoplasia or inflammation

A-FAST: Abdominal Focused Assessment with Sonography for Trauma/Triage:

Evaluate 4 sites for fluid using both longitudinal and transverse views:

- 1) Diaphragmatic-hepatic **DH**: Just caudal to the xiphoid process (see liver and diaphragm)
- 2) Cysto-colic **CC**: Midline over the urinary bladder
- 3) Hepato-renal **HR**: Right flank region
- 4) Spleno-renal **SR**: Left flank region

Chest cavity:

Heart: Check for pericardial effusion. If present, check for a mass, especially heart-based or right-atrial mass. Some obese animals have a visible layer of fat in their pericardium which can be mistaken for fluid. Fat will be not quite anechoic and will have very thin bright lines/dots (septations/veesels) scattered within it.

Thorax/Lungs: Check for pleural effusion, atelectatic lung, subpleural masses, chest wall or mediastinal masses. Masses will only be visible if there is a sonographic “window” such as heart or chest wall. Gas/air will obscure many lung masses that are visible on x-rays.

A-lines: Dry lungs. Horizontal, artifactual repetitions of the pleural line/surface displayed at regular intervals.

B-lines: Wet lungs. Comet tail artifacts (lung rockets) indicating subpleural interstitial edema. Extend from pleural surface all the way to bottom of visible image. The more present, the “wetter” the lungs in that window.

Irregularly thickened, blurred pleural lung surface seen with pneumonia.

No visible lung sliding (Glide Sign) in pneumothorax.

Hypoechoic nodules/various shapes with consolidations and tumors.

VetBLUE: Veterinary Bedside Lung Ultrasound Exam:

Performed in sternal recumbency, standing, or right/left lateral recumbency (safer positions for patients with respiratory distress.

6 Signs:

- 1) **Gator Sign:** 2 ribs are alligator’s eyes, pleural line is its bridge of nose
- 2) **Glide Sign:** Normal lung movement of visceral pleura over the parietal pleura with respiration (parietal pleura is always static)
- 3) **Shred Sign:** Consolidation with aeration (Air bronchogram on TXR)
- 4) **Tissue Sign:** Consolidation without aeration. Hepatization of lung.

- 5) **Nodule Sign:** Organized consolidation. Often tumor/mass.
- 6) **Wedge Sign:** Pulmonary Thrombo-Embolism (PTE)

T-FAST: Thoracic Focused Assessment with Sonography for Trauma:

Evaluate 5 sites of thorax to rule in / rule out presence of air or fluid in pleural space, and RI/RO fluid in pericardial space:

Chest Tube Site (CTS) on right and left

Pericardial Chest Site (PCS) on right and left

Diaphragmatic-Hepatic view (DH)

Testicles:

Should be smooth, mid-level gray, with a longitudinal hyperechoic line down the center which is the mediastinum testis. The mediastinum testis is contiguous with the tunica albuginea and receives the blood vessels, lymphatics, nerves, and ducts that serve the testis (testicular hilum).

The epididymis may be visible from the caudal end of teste, along the testis, and on up to the cranial end of testis—it is tubular shaped and more hypoechoic than testis.

Masses may be obvious, or only small and hypoechoic.

Testicular Microlithiasis: Multiple pinpoint echogenicities (like stars in the night sky) indicate tiny mineralizations in the seminiferous tubules. This increases the chances of testicular cancer in men somewhat, but clinical significance in canines is currently unknown.

Uterus:

Seen dorsal to bladder and urethra. Ventral to colon. Usually the uterine body/cervix is dorsal to the caudal bladder and the horns split off dorsal to a distended bladder.

An enlarged, usually hypoechoic or heterogeneous uterine stump usually indicates an infected/inflamed uterine stump.

Fluid in the uterus may be pus, edema, serum, or blood.

If pregnancy evaluation is desired:

Possible, but difficult, to see **gestational sacs** around 18 days post last breeding.

Can reliably see **heartbeat** 28 days post last breeding. Also, it seems fewer feti are resorbed once a body and heartbeat are seen, so fetal count is more reliable then.

Easier to count fetal numbers before 35 days, but one whole uterine horn may be hiding in bowel gas, so don't depend on number counted by ultrasound.

For a more exact fetal number, recommend x-ray after 45 days.

If breeding dates are unknown or numerous, the following calculations can be used to roughly estimate gestational age (GA)--starting from the day of LH surge:

For Less than 40 days GA: $GA = (3 \times CRL) + 27$ (± 3 days)

(From Vet. Diag. U/S, pg. 150, 1995 Nyland/Mattoon--W.B. Saunders)

Anal Gland/Sacs:

Recommend using gel or KY jelly instead of alcohol--in case of small scrapes/cuts in the mucosa that would be painful with alcohol. Should have minimally thick, smooth, hyperechoic walls, oval to round in shape, and contain hypoechoic material. Usually measure about 1.5 x 1.0 cm. Check for nodules, or irregular borders, or masses.