SMALL ANIMAL ABDOMINAL ULTRASOUND: WHAT CAN I LEARN FROM THE STUDY?

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Veterinary Ultrasonography has become an important part of the daily practice of veterinarians due to reducing cost of ultrasound machines and better veterinary ultrasound training programs which are available in the teaching institution, organized by the veterinary ultrasound society and sometimes by the ultrasound machine vendors; and availability of many good small animal ultrasound textbooks or manuals. Ultrasound is more acceptable because there is no radiation hazard and is considered to be easier to perform in diagnosis certain diseases. Ultrasound is useful to evaluate the internal architecture of organs especially the evaluation and assessment of organ parenchyma. Unlike radiography, there is no superimposition of structures/ organs and the contrast and resolution are superior. Ultrasound is sensitive to detect abnormalities when there is a change of echogenicity, echotexture, size and shape of the organ system. Function of the abdominal organs such as peristalsis movement of the gastrointestinal tract and blood flow could be studied with ultrasound. Although ultrasound is sensitive in detecting changes associated with abnormalities, the specificity is low. This means that many changes / abnormalities detected have multiple or a long list of differential diagnoses. In many occasions, it is impossible to rank the differential diagnoses. Thus ultrasound guided fine needle aspiration and/or biopsy is recommended to obtain samples for cytology / histology studies to confirm the diagnosis. Abdominal ultrasound is strongly recommended to be performed only when it is indicated. If it is performed in animals as a screening test, this should be interpreted with care as incidental findings of non-clinical significance such as splenic and hepatic benign nodules may be detected. One of the disadvantages of ultrasound is that it is operator dependent. Thus veterinarians and technicians should be properly trained to perform ultrasonography.

Ultrasound evaluation of the internal organs involves recognizing the normal and abnormal changes of the organ examined. Ultrasound abnormalities that are commonly encountered are changes of the echogenicity and echotexture, and alteration of the size and shape of the internal organs. All these changes should be carefully noted. It is important to note whether the abnormality is diffuse, multifocal or only involves a focal area. As previously described, the changes detected on ultrasound are not specific. Each abnormality should not be interpreted separately but a global interpretation of all the abnormalities detected is required. Thus careful documentation of all the abnormalities is important and this will help to formulate a meaningful differential diagnoses.

**ECHOGENICITY** is the characteristic ability of a tissue or substance to reflect sound waves and produce echoes. When a tissue reflects more sound waves, it appears bright on the monitor and it is termed hyperechoic. When a tissue reflects less sound waves, it appears dark on the monitor and it is termed hypoechoic. Bone, gas and organ boundaries are the most hyperechoic because they reflect most of the sound waves while fluids such as urine and bile are the least because most of the sound waves penetrate the fluid without being reflected. Urine and bile are normally anechoic (without any echoic reflection). When fluid contains cells, debris or protein (such as a hemoabdomen), the fluid will become slightly echogenic and is termed hypoechoic. Other organ parenchyma and soft tissues have intermediate echogenicity,
but each differs slightly from the other. One of the main iatrogenic alterations of the organ echogenicity is the wrong machine setting. Too high of a gain setting will make the organs appear hyperechoic and too low of a gain setting will make the organs appear hypoechoic. Thus, echogenicity comparison with other organs as an internal control at similar depth and instrument gain settings is important (FIG 1). The echogenicity of the spleen, liver and kidney are consistently evaluated during ultrasound examination. Theoretically, the spleen is hyperechoic to the liver and kidneys, the liver should be hyperechoic or isoechoic to the renal cortex. The renal cortex is more hyperechoic then the renal medulla. The prostate of an intact male has the echogenicity that is nearly similar to spleen. Changes of the organ echogenicity may be either more echogenic (hyperechoic) or less echogenic (hypoechoic). The changes of the echogenicity could be diffuse, focal or multifocal. It is more difficult to differentiate diffuse parenchymal disease from focal parenchymal disease.

**ECHOTEXTURE** of a tissue refers to a small or large dot size (fineness or coarseness) and dot spacing. Echotexture could be homogeneous (uniform) or heterogenous (non-uniform). The spleen has a fine echotexture and the liver has a coarse echotexture. Normal coarse echotexture appearance of the liver is due to the presence of a visible hyperechoic wall of the portal veins and medium echogenicity of the liver parenchyma. Diffuse change of the echotexture of an organ most likely indicates disease involving the entire organ. The presence of diffuse small nodules may produce the appearance of coarse echotexture. This is commonly seen in liver and spleen. The presence of a mass of nodules causes changes of both echogenicity and echotexture of the organ examined. All masses and nodules could be classified as isoechoic, hyperechoic, hypoechoic, anechoic, mixed echogenic and target lesion. It is very challenging to detect an isoechoic mass/ nodule on ultrasound since the echogenicity is similar to the surrounding tissue. It is suspicious when there is displacement of the adjacent blood vessels and the capsule. As a general rule, anechoic nodules most likely represent benign cysts. The presence of distal acoustic enhancement artifact helps to determine the nature of the anechoic nodule as a cyst. An abscess is an uncommon ultrasound finding. It may appear as a mass with variable echogenicity; however, it is more commonly seen with a centralized anechoic to hypoechoic region with an irregular, poorly defined hyperechoic margin. Comet tail artifact is present when there is gas in the abscess due to gas producing bacteria.

In the liver and spleen, the presence of a mass and/or nodules is a non-specific finding except when a target lesion is present. Splenic and hepatic neoplasia, nodular hyperplasia, hepatic necrosis and hematoma may all appear similar on ultrasound; however, the presence of target lesions in the liver and spleen is highly suggestive of malignancy. Spleen myelolipoma can be diagnosed confidently as they appear as hyperechoic nodules located adjacent to the vessels. They may be rounded or triangular in shape. The presence of a solid mass / nodule in the kidneys is usually due to neoplastic process. Again, the echogenicity and pattern is not characteristic of tumor type although a hypoechoic mass is highly suggestive of lymphosarcoma. Complex renal masses appear as a mixture of anechoic, hypoechoic and hyperechoic components where the anechoic areas are also associated with hemorrhage or necrosis. When present, they are most likely to be a hematoma, granuloma, abscess, primary or secondary neoplasia. A more specific change that could be detected on renal ultrasound is renal infarction. Old cortical infarcts appear as a hyperechoic wedge-shaped area when the broader base is at the surface of the kidney.

Organ **size** estimation using ultrasound is subjective. Interpretation of the ultrasound examination based on size alone is not advisable. When there is suspected change in the size
of a certain organ, it should be interpreted with other signs of disease such as change of echogenicity and presence of clinical signs. The important practical aspect of size measurement in ultrasound is for future comparison in follow up examinations. This could be useful to determine whether there is a progression of disease or response to treatment. There is no reliable way to measure the size of the liver. Rounding of the margins and excessive caudal extension of the liver suggest hepatomegaly. A small liver is suspected when there is poor visualization of the liver. The size of the spleen in dogs and cats varies depending on many factors. Sonographic determination of splenomegaly is often subjective. A more reliable way to measure the size of spleen is through radiography. In cats, the spleen is always small and an enlargement of the spleen is easier to recognize. Although a positive correlation of kidney length and volume with body weight has been reported, it is not widely used clinically due to the wide range of standard deviation. However, linear kidney measurement in cats is more reliable as there is less variation of the body size. It is more difficult to determine mild enlargement of the kidneys when there is no alteration of the echogenicity and echotexture. Slightly smaller kidney size is commonly seen in older dogs and cats due to chronic renal disease. A mild increased size of the renal pelvis has been reported to be normal, secondary to intravenous fluid administration, or associated with disease condition such as pyelonephritis and ureter obstruction. Marked dilatation of the renal pelvis (hydronephrosis) is due to obstruction of the ureter. The width of the pancreas in dogs and cats is 1-3 cm and 1 cm respectively. A detectable pancreatic change of echogenicity or contour is usually accompanied with an increase in the size of the pancreas. Unfortunately, size change does not always mean that there is pancreatic pathology. The canine prostate size is variable. Its size increases with age and is small in neutered males. Although there are studies indicating prostate size estimation using ultrasound is reliable, it is still very subjective as differentiating between normal and diseased prostate is difficult.

The volume of the gallbladder and urinary bladder varies in both dogs and cats. Some of them appear large but have no clinical significance. The wall of the gallbladder should appear as a thin echogenic line in normal dogs and cats. Thickening and the presence of a measurable gallbladder wall most likely indicates edema or inflammation of the wall. The diameter of the common bile duct in dogs and cats is < 3mm and < 4mm respectively. Dilation of the common bile duct most likely indicates obstruction. The urinary bladder wall should be < 2.3 mm for dogs and < 1.7 mm for cats. Increased urinary bladder wall thickness should be interpreted with other changes and history. Thickness of the gastrointestinal tract in normal dogs and cats has been reported. Generally, the gastric thickness of dogs and cats should be less than 5mm and 3.6 mm respectively. The thickness of the small intestines in cats is more consistent and mostly < 2.5 mm. As for dogs, the thickness of the small intestines varies depending on the body size. However, it should be less than 6 mm for the duodenum and 5 mm for jejunum. The thickness of the wall of the colon is 2-3 mm in dogs and 1.4-2.5 mm in cats. Increased wall thickness without disruption of the five layer appearance of the gastrointestinal tract is usually due to inflammatory bowel disease except when there is increased thickness of the muscularis layer, which may indicate lymphosarcoma. A normal adrenal gland size has been reported in dogs. The maximal diameter of the adrenal gland has been found to be the most reliable indicator of its size. As a general rule, a diameter of 7.4 mm has been suggested to be used as the upper limits of normal. Unfortunately, overlapping in size between normal dogs and those with adrenal gland abnormality exist. Approximately 25% of dogs with pituitary dependent hyperadrenocorticism (PDH) do not have adrenal gland enlargement, and about 20% of dogs without any evidence of adrenal diseases had adrenal size more than the proposed upper
limits of 7.4 mm. Enlargement of the canine adrenal glands is suggestive of PDH, neoplasia or nodular hyperplasia. In many instances, abnormalities of the adrenal glands lead to an increase in size alone without any nodules or masses. In cats, a study using 10 normal adult cats showed that the normal size to be 4.3 ±0.3 mm.