INDICATIONS AND TECHNIQUE OF ULTRA SONOGRAPHY IN SMALL ANIMALS

Warsha Chaudhary[1], Raunak Chaudhary[2]
[1]PhD Scholor, Department of Veterinary Medicine[1], Post Graduate Institute of Veterinary Education and Research, Jaipur
[2]P.G Scholar, Department of Veterinary Parasitology NDVSU, Jabalpur

ABSTRACT

Sonography is an increasingly vital imaging tool in veterinary medicine, gaining popularity due to its non-invasive nature and rapid diagnostic capabilities. Just like in human healthcare, veterinary sonography is used for a wide range of clinical indications. In general, veterinary practice, it is particularly valuable for investigating chronic disease processes where the underlying cause is unclear, as it provides a comprehensive overview of the internal organs. A frequent reason for conducting an ultrasound in animals is chronically elevated liver enzymes. When routine blood work shows persistently high liver enzyme levels, it often prompts further imaging to assess potential underlying issues, such as liver inflammation, tumors or bile duct obstructions. Ultrasound helps veterinarians obtain detailed insights into the liver's structure and surrounding organs, aiding in both diagnosis and guiding treatment plans.

Keywords: Ultrasound, diagnosis, non-invasive, rapid diagnostic

I. INTRODUCTION

Ultrasound is a crucial diagnostic tool in veterinary medicine but is rarely a replacement for radiography. Instead, it is typically part of a broader diagnostic approach. Initial radiographic imaging is generally recommended before an ultrasound to provide a comprehensive assessment, particularly with two standard projections taken at right angles to enhance visualization. However, there are exceptions: for instance, when a patient is in respiratory distress and cannot tolerate the stress of radiography, or in cases of pregnancy where avoiding ionizing radiation is necessary. If neoplasia is suspected, thoracic radiographs are often performed first to check for pulmonary metastasis, using right and left lateral projections taken during inspiration for optimal imaging.

Sonography has a wide range of clinical applications, including evaluating palpable masses, cardiac murmurs, abnormal blood work, and unclear clinical signs such as hematuria, jaundice, or unexplained weight loss. It's particularly useful for diagnosing conditions affecting the urinary tract, gastrointestinal system, endocrine disorders, neoplasia, trauma, and fever of unknown origin. It also plays a significant role in identifying immune-mediated diseases.

In companion animals like dogs and cats, common findings via ultrasound include nonspecific inflammatory bowel disease and pancreatitis. Inflammatory bowel disease often presents with a thickened bowel wall, especially in the muscularis layer. Pancreatitis, on the other hand, is characterized by an enlarged and hypoechoic pancreas. Additionally, ultrasound is effective for detecting foreign bodies like plastic, fabric, and wood, which are typically not visible on standard radiographs.

A primary use of ultrasound in veterinary practice is cancer staging. When a mass is detected—whether palpable, visualized on an X-ray, or found during an external exam—ultrasound is employed to evaluate the extent of tumor invasion, assess metastases, and guide biopsy procedures. Common cancers in animals include

lymphoma, mast cell tumors, transitional cell carcinoma, and hemangiosarcoma's. In specialty veterinary clinics, ultrasound is also utilized to monitor the progress of radiation treatments and to track the progression of specific diseases.

Moreover, ultrasound-guided biopsies have become a standard practice due to their ability to improve diagnostic accuracy, speed, and safety. The guidance provided by ultrasound increases the likelihood of obtaining representative tissue samples, which is essential for accurately diagnosing and classifying neoplasms. As a result, ultrasound is an invaluable tool in both the diagnostic and therapeutic management of cancer in veterinary patients.

II. PATIENT PREPARATION

Proper preparation is essential for obtaining high-quality ultrasound images in veterinary practice. Ideally, animals scheduled for a sonogram should be fasted for at least 12 hours prior to the examination (Mattoon et al., 2014). Fasting helps minimize food and gas in the stomach, which can obstruct the view of the gastrointestinal lumen and obscure nearby structures. Additionally, a full colon with faecal material can hinder a thorough assessment of the colonic wall and adjacent organs, potentially leading to incomplete diagnostic findings.

Before the ultrasound, it is also beneficial to allow the animal to urinate and defecate unless a full bladder is specifically required for the examination. For example, in cases of suspected urinary tract issues, a distended bladder may be necessary to evaluate the bladder wall and lumen properly.

One of the key factors in obtaining clear sonographic images is ensuring optimal contact between the transducer and the skin surface. Air trapped in the animal's fur can reflect sound waves, leading to poor image quality. Therefore, the area to be examined must be shaved or clipped. For abdominal ultrasounds, the abdomen is typically shaved from the xiphoid process (lower end of the sternum) to the pubis, allowing for better conductivity of sound waves and eliminating the interference caused by hair. This preparation ensures that the ultrasound transducer has direct contact with the skin, reducing the likelihood of artifacts and improving image clarity.

III. PATIENT RESTRAINT

In veterinary medicine, handling a combative patient presents an additional challenge, especially during procedures like sonograms and biopsies. Typically, these procedures are performed without the need for sedatives, with the animal being positioned and restrained by an assistant. For most dogs and cats, positioning on their dorsal side in a padded v-trough or on their side with restraint is sufficient. In some cases, animals may even relax or fall asleep during the procedure if they are comfortable. However, there are instances when an animal may find the experience distressing, requiring some form of chemical restraint.

For dogs, a variety of sedative combinations are available, and the appropriate choice depends on the individual case. A combination of acepromazine and buprenorphine is commonly used due to its safety and effectiveness when properly dosed. Another option is the combination of diazepam and buprenorphine. However, the use of certain drugs, such as α2 agonists (e.g., medetomidine), should be approached with caution in some cases.

For cats, sedative protocols vary based on the patient's health and the level of sedation required. For mild sedation in otherwise healthy cats, a combination of acepromazine and buprenorphine is effective. For stronger sedation, ketamine combined with either midazolam or diazepam is often used, although it may not be as effective in more anxious cats, such as those from oriental breeds. In these cases, creating a quiet, dark environment can enhance the sedative effect. For older or sick cats, buprenorphine alone may be sufficient for gentle restraint. Additionally, in some instances, a lower dose of sedation may be all that's needed, or no

sedation at all if a cat muzzle is employed. Cat muzzles are a low-cost, practical tool frequently used in ultrasound clinics for managing uncooperative patients.

In veterinary sonography, proper restraint and patient preparation are essential for obtaining high-quality images. When annotating the images, the sonographer should use anatomical terms specific to veterinary practice, such as "cranial" and "caudal" instead of "superior" and "inferior," and "ventral" and "dorsal" instead of "anterior" and "posterior." For example, the "cranial mesenteric artery" is the correct terminology rather than the "superior mesenteric artery." These standardized terms help ensure accurate communication and documentation of findings.

IV. TECHNIQUE

There is a number of different ways in which to conduct an ultrasound examination but some standard rules apply.

V. PATIENT POSITION

For abdominal imaging the animal may be placed in right lateral or dorsal recumbency for the examination; which is chosen is a matter of personal preference. However, it is often the case that many examinations, if thorough, will require the patient to be placed in right-lateral and dorsal and often in left-lateral recumbency as well. The size and shape of the patient, the area of interest and the pathology present dictate this.

For non-cardiac thoracic examinations, the animal is usually placed with the affected side uppermost. In some situations where there is a small volume of free fluid or where the lesion is separated from the thoracic wall by a small volume of air-filled lung, it may be preferable to have the affected side dependent to reduce these effects. Therefore, the position chosen is such that the area of interest is fully and clearly seen. It can also be helpful to use positioning to reduce the deleterious effects of gas within the organs.

The bladder is surveyed in sagittal and transverse planes, searching for any abnormalities. A common pathological finding is a growth in the bladder secondary to transitional cell carcinoma. These masses tend to be located in the trigone of the urinary bladder, and can often be linked clinically to a dog/cat straining to urinate. Also noted during this survey is the prostate in the male dog (Nyland *et al*, 2014). In female dogs, the uterus can also be observed if the female has not been spayed.

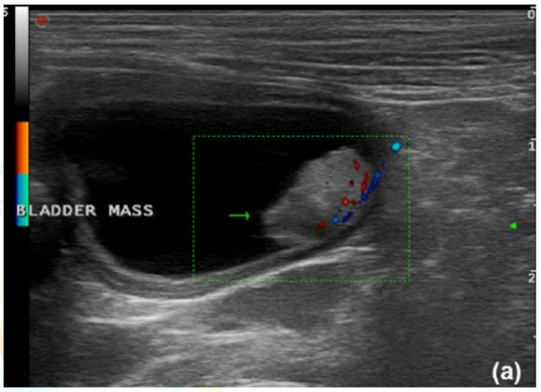

Fig. 1: Color Doppler image of the canine bladder showing a vascularized mass in the trigone that was shown to be a transitional cell carcinoma on biopsy

The medial iliac lymph nodes (MILNs) are surveyed in a longitudinal plane, and they are the most consistently visualized abdominal lymph nodes due to their size and relatively constant location. Located parallel to the distal aorta and caudal vena cava at the level of the fifth and sixth lumbar vertebrae, the MILNs are seen as long, thin structures with homogenous echotexture (Nyland *et al*, 2014). They may not always be identifiable due to overlaying bowel filled with gas, but this is usually a sign of normalcy. The upper limits of normal for these lymph nodes are 4 cm in length, 2 cm in width, and 0.5 cm in thickness in adult dogs.

When surveying the kidneys, it is typical to start on the left. Contrary to humans, the left kidney is the easiest to locate in canines. Animal kidneys also differ slightly in appearance compared to human anatomy.

They have a homogenous cortex, which is moderately hypoechoic. Unlike in humans, the medullary region is often nearly anechoic; for those unfamiliar with animal kidneys, it can mimic the appearance of hydronephrosis. Kidneys should possess a well-defined cortico-medullay definition. Animal kidneys can acquire many of the other same disease processes as humans such as chronic renal disease, obstructive renal disease, nephrolithiasis, cortical infarct, pyelonephritis, polycystic renal disease, renal adenocarcinoma, and renal lymphoma (Nyland *et al*, 014).

Fig.2: Gray-scale image of an adult canine kidney with hydronephrosis

The adrenal glands should be surveyed and imaged after the same sided kidney is observed. Located medial and cranial to the kidney, the adrenal gland is homogenous in echotexture. It tends to be shaped similar to a peanut on the left side and a check mark on the right side in dogs. The maximum thickness should be taken, generally at the caudal pole, and should not exceed 7.4 mm. In the cat, the adrenal glands tend to be more oval in shape and more hypoechoic. Animals can present with various adrenal pathology, including hyperadrenocorticism (Cushing's disease) and adrenal neoplasia (Nyland *et al,* 2014).

The liver in small animals serves the same physiological purpose as in humans, with very similar appearing anatomy. Typical portal vein velocity ranges from 10-25 cm/ sec and the caudal vena cava velocity should be between 40-60 cm/sec. Scanning the liver of a dog and/or cat can be quite challenging depending on their body confirmation (Kumar *et al*, 2012). A species such as a deep-chested boxer that has his liver tucked up high under his rib cage may need to be scanned intercostally, which provides a considerable challenge due to the small intercostal spaces (and the uncooperative nature of the dog in some cases). Small animals can have significant hepatic venous congestion, which is often secondary to such diseases as heartworms, pericardial effusion or Budd–Chiari Syndrome. They can also develop intra- and extrahepatic shunts, with a single congenital extrahepatic portosystemic shunt (PSS) being the most common variety; Yorkshire terriers are especially susceptible to this congenital abnormality. In the small animal, an abnormal liver appears sonographically the same as in humans: a coarse echotexture, irregular serosal margins, and nodules of various echogenicity. The differential diagnoses for an abnormal appearing liver are equally broad, from benign nodular hyperplasia, to lymphoma, to toxicity, just to mention a few more common reasons. An example of a canine liver with multiple hypoechoic nodules is shown.

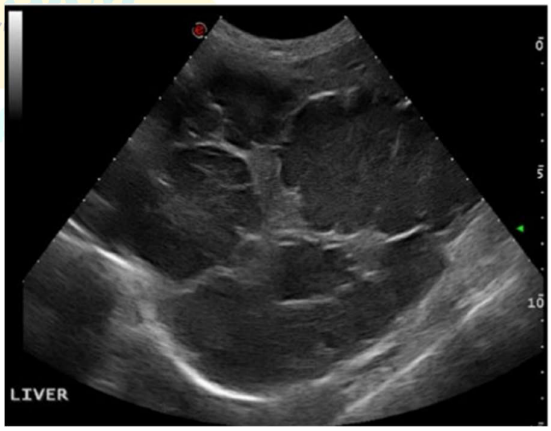

Fig. 3: Gray-scale image of an adult canine liver showing multiple hypoechoic nodules

The normal gallbladder in dogs appears similar to humans. It is round to oval in shape, filled with anechoic bile, and demonstrates a thin, smooth wall (Partington

et al, 2014). It is consistently located in the right lateral liver. Normal cystic and bile ducts cannot usually be observed. Small animals can suffer from many gallbladder pathologies that also plague humans. These include, but are not limited to, cholelithiasis, "sludge," and cholecystitis.

Unlike human pathology, the spleen in dogs and cats is susceptible to a large variety of pathology that can be identified sonographically (Sharpley *et al*, 2012). Splenic hematoma and nodular hyperplasia are the most common noncancerous lesions found in the spleen and account for 20-41% of all splenic lesions. Surgical removal is curative. Hemangiosarcoma is a common malignant tumor of the spleen usually seen in older dogs over years of age, with larger breeds at an increased risk, particularly German shepherds, golden retrievers, Labradors, and poodles (Hylands *et al,* 2006). A spleen with multi-focal nodules that would be consistent with a type of round cell tumor, such as lymphoma or mast cell tumor.

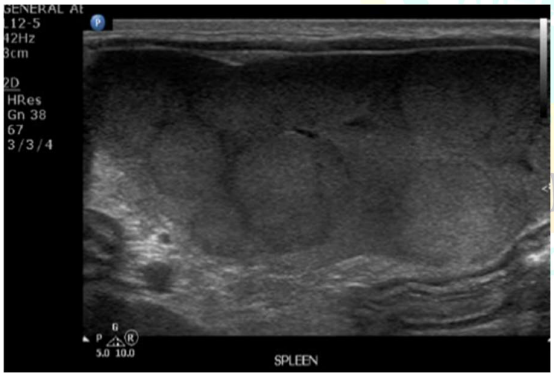

Fig. 4: Gray-scale image of an adult canine spleen showing multifocal nodular disease consistent with lymphoma or mast cell tumour

The pancreas in small animals lies in a slightly different orientation then that of a human. It is divided into right and left limbs, with the right located dorsomedial and adjacent to the descending duodenum and the left coursing caudal to the greater curvature of the stomach (Nyland *et al,* 2014). Pancreatic ducts are not typically visualized sonographically, but the pancreaticoduodenal vein can usually be seen in the right limb in a dog. Small animals can be affected by pancreatitis just like humans, causing marked enlargement and a hypoechoic appearance in the acute stage.

Imaging the gastrointestinal tract is an important part of veterinary medicine that not all human sonographers are proficient. The gastrointestinal tract consists of the stomach, duodenum, jejunum, ileum, cecum, and colon.

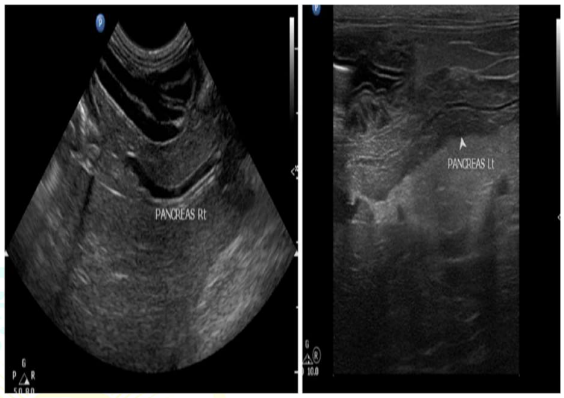

Fig. 5: (a) Gray-scale image of the normal right pancreas in an adult canine. (b) Gray-scale image of the normal left pancreas in an adult canine.

Imaging these areas can be difficult due to gas and artifact, but can be crucial for a correct diagnosis. Fasting of animals receiving an abdominal sonogram is ideal for better visualization (Nyland *et al*, 2014). Changes in the stomach wall and intestines can be caused by adenocarcinoma, lymphoma, polyps, chronic gastritis, uremic gastritis, and ulcers. The small intestines should display all 4 histologic layers: the serosa, muscularis, submucosa, and muscosa. The small intestine is also a common location for a simple obstruction due to a foreign object. The colon has much thinner layers and the lumen is typically not visible due to air artifact. Intussusception can also be diagnosed while imaging the gastrointestinal tract sonographically.

VI. SYSTEM

For abdominal imaging the examination must be conducted in a systematic manner so that each organ is examined from left to right and from cranial to

caudal in two imaging planes, sagittal and transverse. This reduces the possibility of missing small but important lesions.

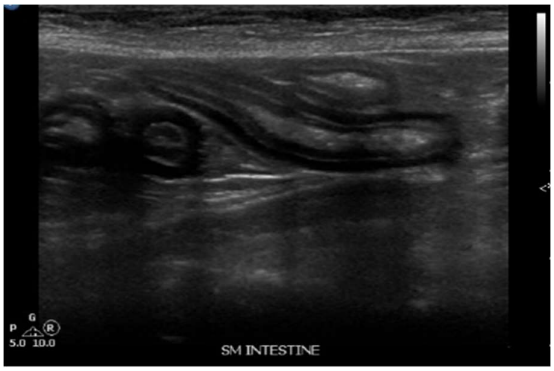

Fig. 6: Gray-scale image of an adult canine small intestine showing diffuse muscularis layer thickening consistent with inflammatory bowel disease

The pattern in which the organs are looked at is immaterial in many ways and it is more helpful to adopt a rigid system of examination. It is often helpful to start with the liver as the hyperechoic interface between the lung and the diaphragm is such an important landmark when imaging the abdomen. The liver is examined fully in two planes and then the liver echogenicity and texture compared with that of the nearby spleen, the falciform fat and the adjacent right kidney. This provides a logical sequence in which it is automatic to look at the liver and compare it with the other organs. It is natural to scan these organs fully while looking at them and the left kidney is almost automatically scanned to compare and contrast with the right. Next, the adrenal glands may be found when in the region of the kidneys, followed by the bladder and finally the stomach and rest of the intestinal tract, including the pancreas. It is important to include an examination of the aortic bifurcation to assess possible medial iliac lymphadenopathy, which may be present in a number of conditions. For the same reason the midabdominal area must be checked for problems within the mesenteric nodes.

VII. TRANSDUCER

Usually in small dogs and cats a 7.5 or 10 MHz transducer may be used. It is often helpful with larger dogs to start the examination using a lower frequency, such as a 5 MHz transducer, and then swapping over to a higher frequency, which will allow a more detailed examination of the individual organs. This provides a general overview before looking at more specific changes.

Echocardiography even in small dogs is usually best performed using a 5 MHz transducer. For areas such as the thorax, a sector, phased array or microconvex transducer is preferred, as these allow uninterrupted penetration between the ribs. For areas such as the abdomen and small parts such as the thyroid, a linear or curvilinear type, as well as the sector and microconvex varieties are suitable. In deep-chested breeds, trying to access the most cranial part of the abdomen with a linear or curvilinear probe can be difficult as they have a large footprint, or end, which will not fit easily under the ribcage; in these cases, a sector transducer may be more practical. It is outside the scope of this text to provide an exhaustive list of all transducer types but in general the higher frequency will provide greater resolution but poorer depth imaging. A general guide is that 5 MHz probes will image to a depth of 15 cm adequately, 7.5 MHz will image to 7 cm and 10 MHz will only image well to a depth of 4–5 cm.

These are the most commonly used frequencies in small animals, but in some very large breed dogs it may be necessary to use 2.5–3.5 MHz, especially for echocardiography. When choosing a transducer, as well as looking at frequency it is useful to look at the size of the footprint. For small parts and small animals, the smaller the footprint the better the skin contact and the easier the examination.

VIII. CONCLUSION

Veterinary sonography is a vital tool in diagnosing a wide range of diseases and conditions in small animals. It plays an essential role in both the diagnostic and

therapeutic management of diseases, including cancer staging and monitoring treatment efficacy. The procedure requires meticulous patient preparation, including fasting, clipping, and appropriate restraint, to ensure optimal imaging results. Sedation may be required for stressed or combative animals, and careful positioning is key to obtaining high-quality sonograms. By following established techniques and protocols, sonography can help veterinarians make accurate diagnoses, guide treatment plans, and improve patient outcomes.

IX. REFERENCE

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