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ORIGINAL INVESTIGATION

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ACVR and ECVDI consensus statement for the standardization of the abdominal ultrasound examination

Gabriela S. Seiler[1] | Eli B. Cohen[1] | Marc-André d'Anjou[2] | John French[3] | Lorrie Gaschen[4] | Stephanie Knapp[5] | Rochelle M. Salwei[6] | H Mark Saunders[7]

[1]Molecular Biomedical Sciences, North Carolina State University, Raleigh, North Carolina, USA

[2]Animages Inc, Longueuil, Quebec, Canada

[3]Antech Imaging Services, Fountain Valley, California, USA

[4]Department of Veterinary Clinical Sciences, Louisiana State University, Baton Rouge, Louisiana, USA

[5]BluePearl Veterinary Partners of North Carolina, Cary, North Carolina, USA

[6]IDEXX Telemedicine Consultants, Clackamas, Oregon, USA

[7]Lynks Group, PLC Veterinary Imaging, Shelburne, Vermont, USA

Correspondence
Gabriela S. Seiler, Molecular Biomedical Sciences, College of Veterinary Medicine, North Carolina State University, 1052 William Moore Drive, Raleigh, NC 27607, USA.
Email: gsseiler@ncsu.edu

Abstract

This consensus statement is designed to provide a standard of care document and describes the ACVR and ECVDI definition for performing a standard abdominal ultrasound examination in dogs and cats. The ACVR and ECVDI define a standard abdominal ultrasonographic examination as a complete exam of the abdominal organs which is appropriately documented. The consensus statement intends to provide guidance to veterinary sonographers and veterinarians for the performance and documentation of high-quality diagnostic ultrasound examination. The document may also serve as a teaching aid for veterinary students, veterinarians, and residents in diagnostic imaging who seek proficiency in diagnostic ultrasound. Finally, it may serve an additional role in educating the public as to what a high-quality abdominal ultrasound examination should entail.

KEYWORDS
abdominal, consensus, standard, ultrasound

1 | INTRODUCTION

Consensus Statements of the American College of Veterinary Radiology (ACVR) and European College of Veterinary Diagnostic Imaging (ECVDI) establish position statements and other communications related to the practice of diagnostic imaging and radiation oncology. Best practices for medical physics, DICOM standards, and related equipment guidelines may also be communicated in the form of consensus statements. Consensus statement topics provide veterinarians wih imaging guidelines, appropriate use criteria, selection, acquisition, and documentation of diagnostic imaging studies, interventional imaging procedures, and radiation therapy for veterinary patients. The ACVR supports collaboration with other veterinary specialties for the formation of consensus statements to improve overall delivery of care for veterinary patients. Evidence based medicine is the foundation of Consensus Statements and Communications. If the evidence is conflicting or lacking beyond the scope of current information available in the veterinary literature, the ACVR recommendations are based upon the experience and best judgement from leaders in the field. Consensus Statement Communications are intended as a guideline toward establishing standard of care with respect to the use of imaging modalities and the practice of radiation oncology. Consensus statements are not intended as a substitute for clinical judgement.

This consensus statement is designed to provide a standard of care document and describes the ACVR and ECVDI definition for performing a standard abdominal ultrasound examination in dogs and cats. The ACVR and ECVDI define a standard abdominal ultrasonographic examination as a complete exam of the abdominal organs which is appropriately documented. The consensus statement intends to provide guidance to veterinary sonographers and veterinarians for the performance and documentation of high-quality diagnostic ultrasound examination. The document may also serve as a teaching aid for

veterinary students, veterinarians, and residents in diagnostic imaging who seek proficiency in diagnostic ultrasound. Finally, it may serve an additional role in educating the public as to what a high-quality abdominal ultrasound examination should entail. The document is not intended to establish a legally binding standard of care. The committee recognizes that deviation from, or abbreviation of this ultrasound examination protocol may be necessary depending on individual indications and limitations dictated by a patient's health and compliance. Also, findings in each individual patient frequently necessitate acquiring and recording additional image planes and approaches that cannot all be covered in this document.

This consensus panel is comprised of board-certified veterinary radiologists utilizing a modified Delphi method followed by online discussion and meetings for consensus building and recommendations.[1–3] For each topic, a list of content to be included was generated which was subsequently transformed into a survey that was sent out to the committee. On average, a consensus was reached for 70–80% of line items, and all members included comments on the items they did not agree with as written. Taking comments into account, an amended survey was generated and sent out again until consensus was reached for all items. In most instances, the consensus was reached after two surveys. The committee had three meetings where topics that needed further discussion were addressed and decided on. Two additional advisors (also board-certified veterinary radiologists) have provided input and recommendations and the ACVR and ECVDI members had a chance to provide input.

This document describes recommendations for a full abdominal ultrasound examination in dogs and cats. The panel recognizes that abbreviated ultrasound examinations limited to a specific organ system, are sometimes used, but is of the opinion that a full comprehensive ultrasound examination should be the standard of care in most cases, particularly if a limited amount of clinical and clinicopathologic information about the patient is available. This document does not address point-of-care ultrasound examinations which are binary methods to answer specific questions and have their own indications and methodologies.

Finally, it is important to acknowledge that performing an abdominal ultrasound examination following the proposed guidelines is only the first step to a comprehensive examination and does not negate the need for proper training. Importantly, a high-quality abdominal ultrasound examination includes interpretation of the findings by a board-certified veterinary radiologist in the context of the patient's history, and clinical and clinicopathologic findings based on current knowledge of the literature.

2 | ULTRASOUND METHODOLOGY

2.1 | Ultrasound equipment

Minimal requirements for abdominal ultrasound in dogs and cats include transducers with a frequency range between 5 and 18 MHz, ideally including linear transducers for imaging of superficial structures and small patients such as cats. Curvilinear transducers with lower frequencies are typically needed for penetration of deeper structures and larger animals. Additional transducers with smaller footprints such as sector/phased array may be helpful in imaging some structures, as when using an intercostal approach. The highest frequency for adequate tissue penetration should be selected for optimal axial image resolution. The focal zone should be continually adjusted to the area of interest to improve lateral resolution and to reduce artifacts when available, particularly in the region of the urinary bladder. Color and Power Doppler are an important tool to evaluate abdominal lesions and should be available on any system used for abdominal ultrasound imaging. If video clips are to be sent for telesonography remote interpretation, the encoding process, and video clip quality is important, and should be a consideration when purchasing equipment. It is the responsibility of the sonographer to understand the optimal use of the ultrasound equipment, including knowledge of how the ultrasound equipment interacts with tissues, recognition, and interpretation of various artifacts, and optimization of settings such as depth, gain, time gain compensation, frequency, and focal zone throughout the study as needed. It is beyond the scope of this consensus statement to make recommendations on specific equipment, given that the technology is constantly evolving. It is the responsibility of the sonographer and the interpreting radiologist to determine if the available equipment is sufficient to perform the study indicated.

2.2 | Patient signalment and history

The following information is to be available and is required as a part of the documentation process prior to the ultrasound examination: complete patient signalment, indications for the examination, a concise history with a summary of supporting clinical and physical examination findings, and a list of tentative clinical differential diagnosis.

2.3 | Patient preparation

Patients should be prepared for abdominal ultrasound by fasting for at least 8 h to minimize interference from gastric content, particularly when imaging the gastrointestinal tract and cranial abdominal structures. However, it is acknowledged that this may not always be possible. The haircoat must be clipped and the skin prepared with alcohol and/or coupling gel. Exceptions may be made on an individual basis in patients with skin conditions that do not allow the use of alcohol or gel, or in animals with thin or absent hair.

2.4 | Sedation

Many patients can be manually restrained for ultrasound imaging. Addition of sedation should be strongly considered for anxious, noncompliant, or aggressive patients, patients with abdominal pain, and when performing tissue sampling procedures. Sedation can also be helpful for examination of the cranial abdomen in deep-chested dogs, or for tracing small structures such as ureters, for example in cats with ureteral obstruction. In general, sedation yields a higher quality and

more efficient examination. Since it can have effects on organ size and appearance and blood flow, administration and type of sedation should be noted in the history and taken into account when interpreting the images.

2.5 | Doppler imaging

In general, Color, Power, or Spectral Doppler ultrasound imaging with appropriate velocity scale for the vessel evaluated, should be applied whenever there is a question about vascular patency, vascular malformation, or perfusion characteristics of a lesion or organ. Spectral Doppler adds information about waveform characteristics and pulsatility which can be important to differentiate arterial and venous blood supply. Some specific indications for Doppler examinations are listed under the respective organ systems.

2.6 | Contrast-enhanced ultrasound

Ultrasound contrast agents, if available, can provide additional information about perfusion characteristics of organs or lesions for specific indications. Further description of methodology and indications for contrast-enhanced ultrasound is beyond the scope of this document.

2.7 | Image acquisition and interpretation

Since ultrasound is a real-time imaging modality, a weighted examination based on clinical presentation and ultrasound findings is commonly performed. Ultrasound is highly user dependent with substantial limitations that cannot be overcome after study completion. Interpretation at the time of the examination being performed by a board-certified veterinary radiologist is therefore considered to be the gold standard. If a board-certified veterinary radiologist is not available to perform the ultrasound examination, it is recommended that the images are acquired by a sonographer (R.D.M.S.) or veterinary technician (R.V.T.) trained by a veterinary radiologist, or a veterinarian who has completed a training program approved by the ACVR or ECVDI, or who was trained by a board-certified veterinary radiologist.

A written report detailing and interpreting the findings is an essential part of any ultrasound examination and is to be included into the patient's medical record. The report should be written by the interpreting board-certified veterinary radiologist. If the images are not acquired or interpreted by a board-certified veterinary radiologist, the person obtaining the images should document their findings in a written report that should be approved and signed by the veterinarian holding the Veterinarian-Client-Patient Relationship (VCPR), or submitted with the images for teleradiology review. A basic report should include description of organ size, shape, and echogenicity, and if normal or abnormal. If there are factors that limited interpretation such as a large amount of effusion or body fat, poor patient compliance, or poor image quality this should be mentioned and detailed in the report. Any interventional procedures should be described. The report should conclude with a final assessment and ranked differential diagnoses. The clinical question should also be addressed if not contained within the conclusions. Recommendations can be made in the report as appropriate, understanding that this may be amended at the discretion of the veterinarian holding the VCPR.

2.8 | Documentation of ultrasound images

Documentation should include a complete set of images and video clips as listed for each organ and in Supporting Information 1. Images should be in DICOM format and should be archived in retrievable format for a duration determined by the governing professional agency. DICOM format should be the standard for images to be submitted for teleradiology consultation. Ultrasound images must be labeled with patient identification, hospital name, examination date, and the organ or site imaged, and measurements where required (see Supporting Information 1). For larger organs such as the liver, the location within the organ should be indicated. If the organ of origin of a lesion is not known, the location within the abdomen should be indicated and a video clip should be recorded to provide regional landmarks. Images are to be oriented with cranial to the left and caudal to the right. Video clips should be recorded while slowly sweeping through or tracing a structure of interest. The duration of a video clip should be 5–10 s and not more than 20 s. Video clip length can be adjusted based on anatomy or pathology being examined, and preference of the interpreting board-certified veterinary radiologist. Anatomic landmarks should be included when possible.

In the following, specific recommendations for the acquisition of still images and video clips are made for each organ or system. This approach will have to be expanded or modified in presence of pathology based on the sonographer's best judgement. Select measurements are recommended to be included on still images where normal values and use have been established in the literature. If a structure is small, and measurement would obscure details of this structure, separate images with and without measurements may be useful. It is the panel's opinion that still images of all abdominal organs as outlined below should be recorded even if normal, whereas documentation of video clips will be dependent on findings. The panel recognized that each institution or practice has their own protocols and ways of documenting patient images, but we suggest that the provided list of still images be adopted for consistency of documentation. If images are acquired by a non-radiologist sonographer and interpreted by a board-certified veterinary radiologist subsequent to image acquisition, extended documentation including video clips as outlined below is recommended. Abnormal findings should always be documented in detail with still images and video clips as deemed appropriate.

3 | EXAMINATION OF ORGAN SYSTEMS

3.1 | Hepatobiliary system

The examination of the liver should include longitudinal and transverse planes of the liver parenchyma (Figure 1). Effort should be made to include liver lobe extremities. Intercostal windows may be needed

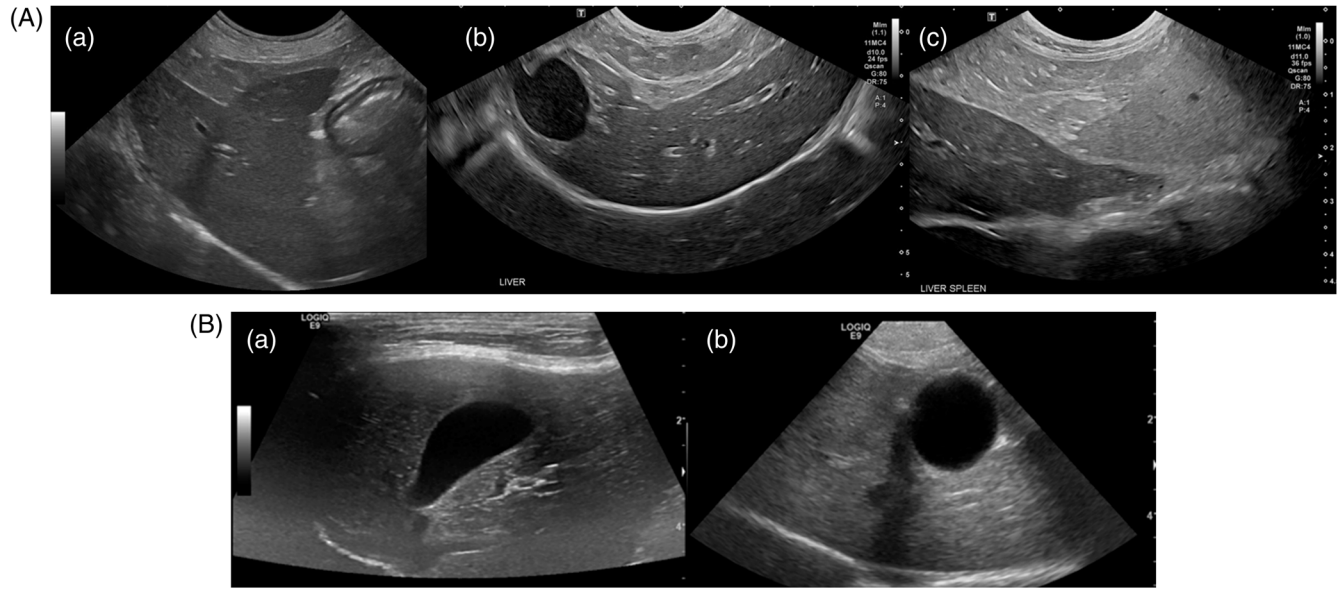

FIGURE 1 A, B-mode longitudinal (a), and transverse (b) ultrasound images of the liver and image of liver spleen comparison (c) obtained with a microcurved ultrasound transducer. B, Longitudinal (a) and transverse (b) B-mode ultrasound images of the gallbladder obtained with a linear (a) and sector (b) transducer.

to evaluate the craniodorsal aspect of the liver parenchyma particularly in deep-chested dogs or if the liver is small. Echogenicity of the liver should be compared with echogenicity of the spleen or the falciform fat (especially in cats). Split screen images can be used to compare liver and spleen echogenicity, but care should be taken to not alter imaging parameters such as depth, gain and/or time gain compensation, and focal zone for the two images. Homogeneity, heterogeneity, and parenchymal attenuation and texture should be evaluated. Any parenchymal lesions should be characterized by their echogenicity relative to the surrounding liver parenchyma, homogeneity or heterogeneity, texture, presence of cystic components, size and shape (including measurements in two planes if possible). Lesion location within a specific lobe if possible, or at a minimum within the left, right or central liver should be indicated. The anatomic spatial relationship of lesions with major vascular pathways and biliary structures should be established and described. The largest lesion should be documented and measured if numerous. The gallbladder should be imaged in both longitudinal and transverse planes. Gallbladder contents should be evaluated and it should be noted if they are mobile (gravity dependent or suspended) or not. It is recommended to re-image the gallbladder at the end of the examination to allow suspended contents to settle. When visible, the intrahepatic biliary ducts, cystic duct and common bile ducts should be evaluated and the intraluminal diameter as well as wall thickness measured if visible.[4–7] Color or Power Doppler ultrasound may be used to differentiate biliary structures from hepatic vasculature. The liver hilus should be investigated for the presence of enlarged hepatic lymph nodes in particular if parenchymal liver abnormalities are present. Recommended image documentation for the hepatobiliary system is detailed in Table 1.

If there is a suspicion of a portosystemic shunt or other portal vascular abnormalities, the portal venous system should be traced according to published guidelines using Color Doppler ultrasound (with appropriate velocity scale) where applicable.[8–12] The PV/Ao ratio can be performed near hilus of the liver in patients with suspected portosystemic shunt.[8] In some patients Computed Tomography may be better for identification and anatomic description of a portosystemic shunt.[13]

3.2 | Spleen

The full extent of the spleen should be traced both in longitudinal and transverse planes from the dorsal extremity to the ventral extremity (Figure 2). Multiple passes may be necessary to evaluate the entirety of the splenic parenchyma. Examination of the spleen includes imaging of the dorsal extremity. Left intercostal windows commonly have to be used in large or deep-chested animals. The splenic hilus and intraparenchymal splenic vessels should be examined with the use of Color, Power, or Spectral Doppler ultrasound if indicated. If vascular lesions are suspected, the splenic vasculature should be traced to and away from the spleen as far as possible. Document focal lesions and measure in two planes. The largest lesion should be measured if multiple similar lesions are present. Splenic thickness should be measured at the level of the hilus in a longitudinal plane. There are published normal values for cats but not for dogs.[14–16] It is the opinion of the majority of the panel that recording the size of the spleen has value in dogs as well in particular for follow-up examinations in the same patient. Other subjective criteria for splenic enlargement such as rounding of splenic margins, indentation of the urinary bladder, presence of a large portion of the spleen in both the left and right abdomen are equally important

TABLE 1 Recommended image documentation of the hepatobiliary system

	Still images		Video clips
1	Representative longitudinal and transverse images of the liver parenchyma and vasculature	1	Sweep through all liver lobes in longitudinal and transverse planes
2	Liver and spleen comparison (if needed with split screen image). Liver and falciform fat comparison in cats	2	Gallbladder, cystic duct, and common bile duct
3	Parenchymal liver lesions with measurements in two planes (largest and most representative, if many)	3	Liver hilus with associated structures
4	Gallbladder wall and contents with wall thickness measurement if abnormal		
5	Common bile duct with measurement of intraluminal diameter and wall thickness if visible		
6	Hepatic lymph nodes with thickness measurement if visible		
7	Portal vein and aorta diameter at portal vein entrance into the liver if a portosystemic shunt is suspected		

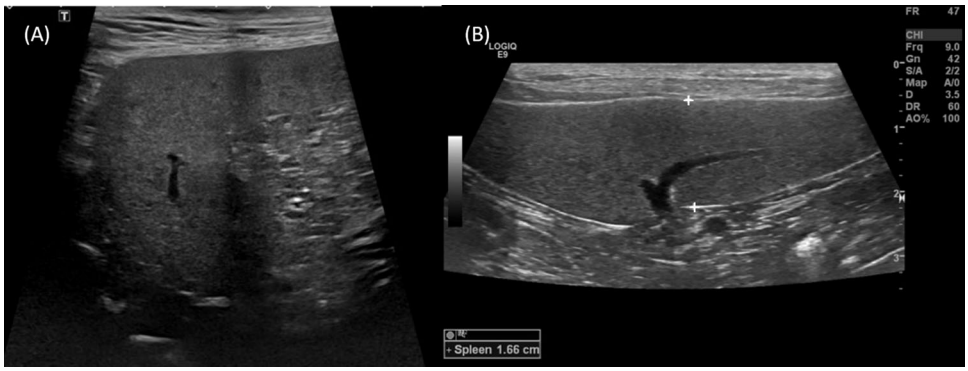

FIGURE 2 Longitudinal images of the dorsal extremity (A) and splenic hilus (B) with thickness measurement, obtained with a linear transducer.

TABLE 2 Recommended image documentation of the spleen

	Still images		Video clips
1	Representative areas of the dorsal and ventral splenic extremities and body	1	Representative portion of the splenic parenchyma with Color or Power Doppler if indicated
2	Splenic hilus with measurements in a longitudinal plane		
3	Splenic lesions with measurements		

for assessment. Recommended image documentation for the spleen is detailed in Table 2.

3.3 | Gastrointestinal tract

Examination of the gastrointestinal tract includes imaging of the stomach, pyloroduodenal junction, duodenum, jejunum (Figure 3), ileum, ileocecocolic junction, and colon. Fasting of 8 to12 hours is recommended especially in patients suspected to have gastrointestinal signs. If a patient is not fasted the examination can still be performed in many instances, but may have to be postponed if an area of interest is obscured by ingesta. Each gastrointestinal segment should be examined in longitudinal and transverse planes. As many jejunal segments as possible should be included. If mechanical ileus is suspected, an effort should be made to trace the entirety of the gastrointestinal tract. If this is not possible, all abnormally dilated intestinal segments should be traced orad and aborad until obstruction is confirmed or ruled out. For each gastrointestinal segment, the wall layering, thickness, echogenicity of the mucosa, and luminal contents should be evaluated and documented.[17–24] For wall thickness measurements, calipers are set at the hyperechoic border of the serosa and the hyperechoic mucosal luminal interface. Measurement of small intestinal wall thickness is variably reported in the literature in both a longitudinal or transverse plane.[17–20] The panel's consensus is that small intestinal wall thickness should ideally be measured in a longitudinal plane to avoid measurement error caused by obliquity and care should be taken that both walls are equal in wall layer definition and wall thickness to

FIGURE 3 A, Ultrasound images of the gastric fundus (a), body (b), and pyloric antrum (c) with wall thickness measurements, as well as pyloroduodenal junction (d), obtained with a microcurved transducer. B, Longitudinal (a) and transverse (b) B-mode ultrasound images of the duodenum with wall thickness measurement, obtained with a linear transducer. C, Longitudinal (a) and transverse (b) B-mode ultrasound images of the jejunum with wall thickness measurement, obtained with a linear transducer. D, Longitudinal (a) and transverse (b) B-mode ultrasound images of the feline ileocecocolic junction, obtained with a linear transducer. E, Longitudinal (a) and transverse (b) B-mode ultrasound images of the colon with wall thickness measurement, obtained with a linear transducer.

TABLE 3 Recommended image documentation of the gastrointestinal system

	Still images		Video clips
1	Gastric fundus, body, antral and pyloroduodenal locations in at least one or both planes, if possible, with wall thickness measurement	1	Representative areas of the stomach including the gastric fundus, body, antrum, pyloroduodenal junction and duodenum
2	Duodenum (descending portion) in at least one or both planes if possible, including wall thickness measurement	2	Tracing a representative jejunal segment
3	Representative jejunal segment (multiple if not uniform in appearance) in at least one or both planes if possible, including wall thickness measurement	3	Ileocolic junction in cats and if visible in dogs
4	Ileocecocolic junction in cats, and if visible in dogs in at least one or both planes if possible	4	Tracing a representative area of the large intestine
5	Representative large intestinal segment (multiple if not uniform in appearance) in at least one or both planes if possible, including wall thickness measurement		

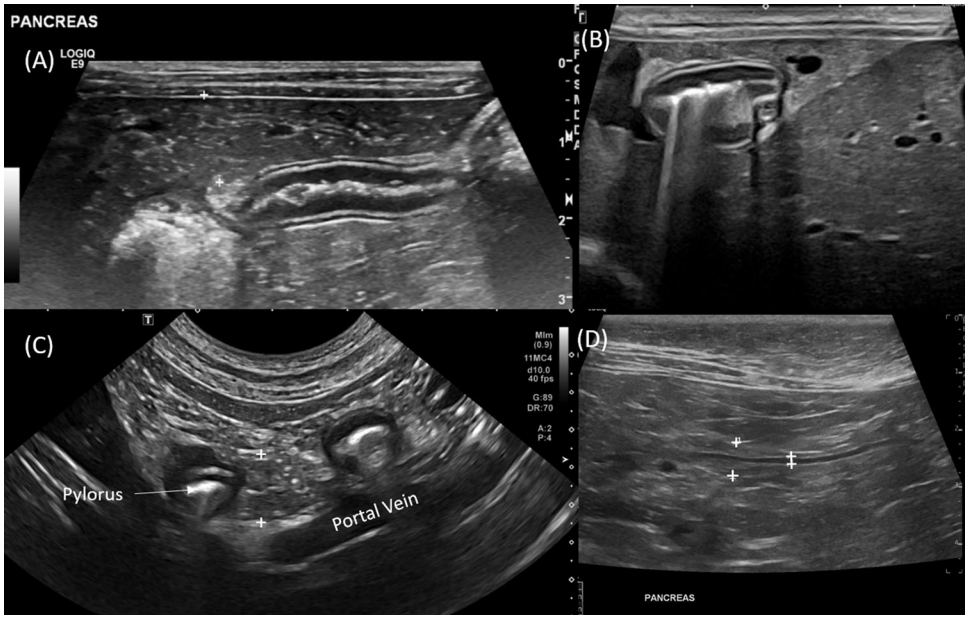

FIGURE 4 Longitudinal (A) and transverse (B) B-mode ultrasound images of the right lobe of the canine pancreas with measurement, longitudinal (C) ultrasound of the body of the pancreas (indicated by calipers), and longitudinal (D) ultrasound image of the left lobe of the feline pancreas with measurement of the pancreas and pancreatic duct, obtained with a linear (A,B,D) and microcurved (C) transducer.

ensure reliable transducer placement in the center of the bowel loop. If measured in transverse, care should be taken to obtain a view perpendicular to the long axis of the bowel loop to avoid obliquity. Gastric wall measurements should be performed between two rugal folds in a transverse image plane. Degree of luminal distension should be noted as it may affect wall thickness measurements. If clinically indicated, peristalsis of the stomach and jejunum should be assessed over the time period of one minute. The stomach should be scanned from the fundus to the pyloroduodenal junction. Intercostal windows may be necessary in some dogs to document the fundus and the pylorus. The duodenum should be scanned either from a subcostal or intercostal window depending on body conformation. The jejunum should be traced at the cranial, left, caudal, and right parts of the abdomen. The ileocecocolic junction should be identified in cats, and an attempt should be made to identify the ileocolic and cecocolic junction in dogs, typically in the mid-right abdomen. The large intestine should be traced to include the cecum, ascending, transverse and descending colon to the pelvic inlet. Recommended image documentation for the gastrointestinal tract is detailed in Table 3.

3.4 | Pancreas

The left and right lobes and body of the pancreas should be examined in longitudinal and transverse planes from end to end (Figure 4). Although the left lobe may be difficult to see in dogs, and the right lobe may

TABLE 4 Recommended image documentation of the pancreas

	Still images		Video clips
1	Left and right lobes (if visible) and body of the pancreas in at least one or both planes if possible	1	Left and right lobes and body of the pancreas including their regional landmarks
2	Pancreatic duct with measurements if visible		

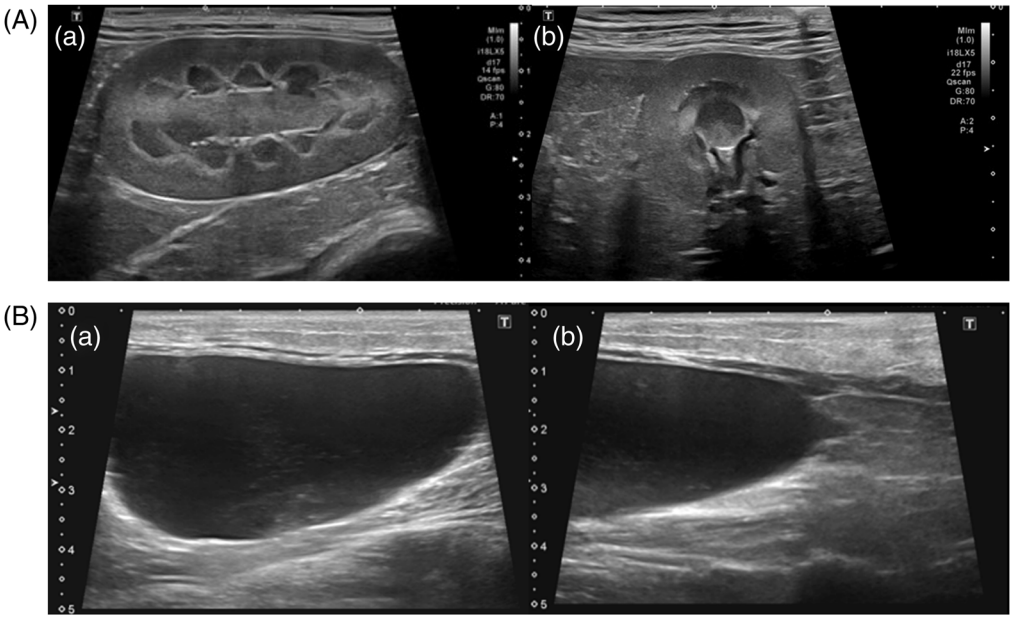

FIGURE 5 A, Longitudinal (a) and transverse (b) B-mode ultrasound images of a canine left kidney obtained with a linear transducer. B, Longitudinal B-mode ultrasound images of a canine urinary bladder, body (a), and trigone (b), obtained with a linear transducer.

be difficult to see in cats, the panel considered it important that an attempt should be made to examine the entire organ. Anatomical landmarks should serve to locate the pancreas and if the pancreatic tissue is not readily identified, these landmarks should be included in the field of view when documenting images. Specifically, the landmarks to include are the duodenum for the right lobe, the pylorus, portal and pancreaticoduodenal vein for the pancreatic body, and stomach, spleen, splenic vein, and left kidney for the left lobe in cats, and stomach and transverse colon in dogs. If landmarks cannot be shown in still images, video clips of the pancreas and its landmarks should be included. While a subcostal approach should allow a clear visualization of the pancreas in some animals, a right intercostal approach is often required particularly in deep-chested dogs to better interrogate the body or the right lobe of the pancreas. The pancreatic duct should be examined and its luminal diameter measured if dilated.[25–29] Changes in the peripancreatic fat should be noted. If the pancreas is not visible or not examined, this should be stated in the report. Recommended image documentation for the pancreas is detailed in Table 4.

3.5 | Urinary tract

The examination of the urinary tract should include the left and right kidney, ureters (if visible), urinary bladder, and urethra (Figure 5). In the male dog, clinical indications may necessitate examination of the membranous and penile urethra. The left and right kidney should be examined in multiple longitudinal and transverse images from pole to pole. In a transverse plane, the renal hilus should ideally be pointing to 6 o'clock to reduce anisotropy. The length of the kidney should be obtained at its greatest dimension in a longitudinal (either sagittal or dorsal) plane.[30–31] Published methods and normal values are available using renal length/aorta or L5/6 measurements, renal cortical thickness, renal cortex to aorta ratios, and cortex/medulla ratios.[32–34] It is the opinion of the panel, however, that these measurements are not necessary to routinely obtain in every patient but can be used when indicated. The shape, cortical echogenicity, and corticomedullary distinction of each kidney should be evaluated and recorded. The cortex, medulla, and size of the renal pelvis should be evaluated. Measurement of any focal abnormalities should be made in two dimensions. Comparison of the cortical echogenicity of the left kidney to the spleen and right kidney to the caudate lobe of the liver are described in the literature, but a large degree of variability limits clinical use.[35–38] If dilation of the renal pelvis is identified, measurement of the pelvis should be made in a transverse plane at the widest point, ensuring to avoid inclusion of the proximal ureter. Ultrasonographic evaluation of the left and right ureter should be performed, if identified. If possible, the ureter should be followed from the renal pelvis to the ureterovesical junction or to its most caudal visible point. If ureteral dilation is present,

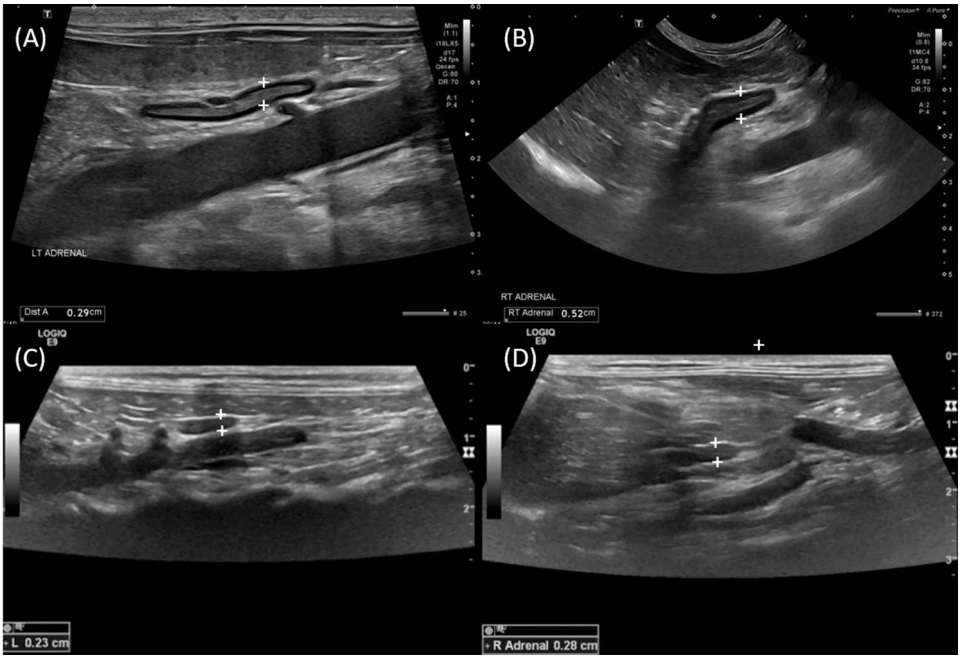

FIGURE 6 Longitudinal B-mode ultrasound images of the left (A) and right (B) canine adrenal glands with measurements, obtained with a linear transducer (left) and microcurved transducer (right). Longitudinal B-mode ultrasound images of the left (C) and right (D) feline adrenal glands with measurements, obtained with a linear transducer.

measurement of the overall and mural diameter, if thickened, should be made as well as any focal abnormalities. The echogenicity of the surrounding fat should be assessed. Color or Power Doppler ultrasound may be used to document areas of infarction or other vascular lesions, and for distinguishing a dilated ureter from a vessel.

The urinary bladder should be imaged in longitudinal and transverse planes beginning at the apex and passing caudally through the trigone and ureterovesicular papillae to the level of and including as much of the proximal urethra as can be seen before it is shadowed by the pelvis. A measurement of bladder wall thickness can be made, although bladder wall thickness can be variable based on the degree of distension and volume of urine within the lumen as well as the body size of the patient.[39] If the degree of distension is thought to affect bladder wall assessment this should be noted in the report. Measurement of any focal abnormalities within the bladder should be made in at least two dimensions. Characterization of mural vs. intraluminal lesions can be improved by the use of Color or Power Doppler interrogation, positional variation, and ballottement. Recommended image documentation for the urinary system is detailed in table 5.

3.6 | Adrenal glands

Examination of the adrenal glands should be included as part of a complete abdominal ultrasound examination in dogs and cats (Figure 6). The right and left adrenal glands are located medial, and typically cranial to the kidneys. Vascular landmarks should serve to locate the adrenal glands and include the aorta, left renal artery or vein, and the cranial mesenteric and celiac arteries for the left adrenal gland, and the caudal vena cava, and cranial mesenteric and celiac arteries for the right adrenal gland. The phrenicoabdominal vessels may serve as landmarks for both adrenal glands. Color or Power Doppler imaging aids in differentiating the adrenal glands from adjacent vasculature. If not visible or not examined this should be stated in the report. Once identified, the adrenal glands should be evaluated a longitudinal plane. Maximal adrenal gland thickness, shape, echogenicity, and presence of mineralization should be evaluated. Maximal thickness of the adrenal glands should be measured at the caudal pole in a longitudinal plane and documented.[40–45] Color or Power Doppler imaging should be used in patients with adrenal nodules/masses to determine adrenal mass vascularity and adjacent major vessels such as the caudal vena cava, phrenicoabdominal and renal veins for compression or invasion. Recommended image documentation for the adrenal glands is detailed in Table 6.

3.7 | Genital tract

3.7.1 | Female

Examination of the ovaries in two planes should be included as part of a complete abdominal ultrasound examination in intact female dogs and cats (Figure 7). If not visible or not examined this should be stated in the report. Ovarian lesions should be documented and measured at maximal dimension of the lesion(s). The ovariectomy site should be evaluated in spayed female dogs and cats, if there is a clinical concern. The uterine horns (left and right), uterine body, cervix, and pre-pubic aspects of the vagina should be traced from the ovaries to the pelvic

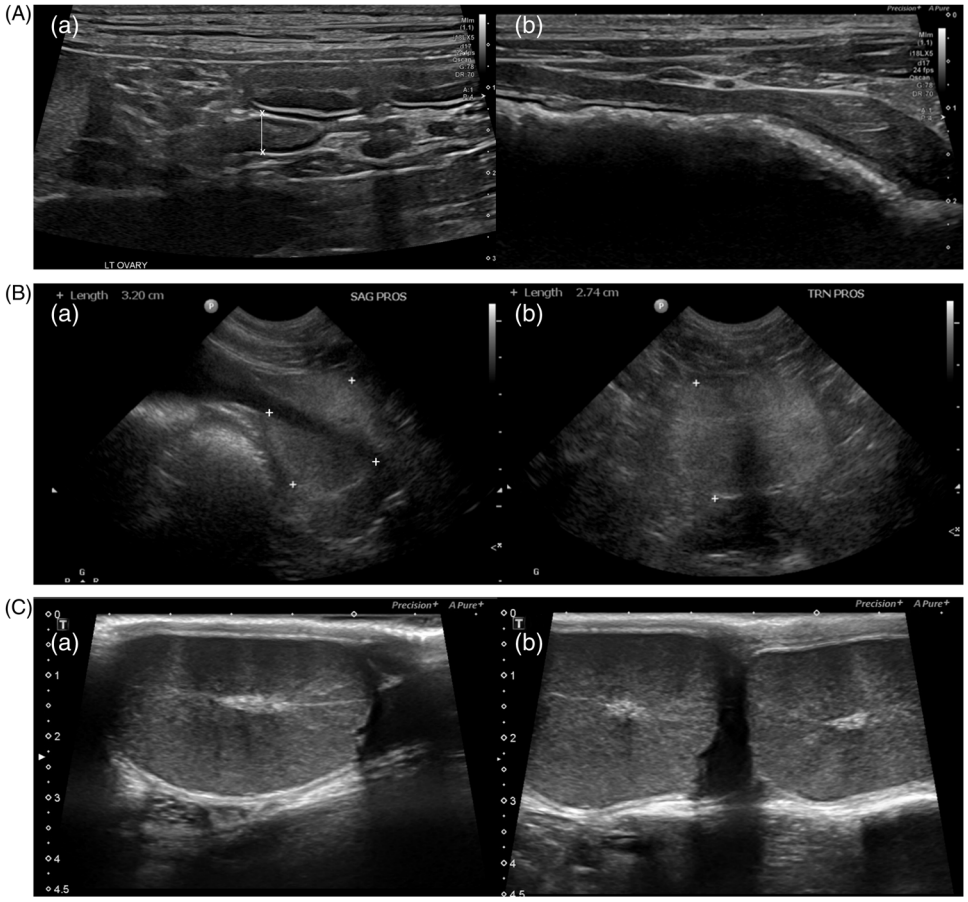

FIGURE 7 A, Longitudinal B-mode ultrasound image of the left ovary with measurement (a), and longitudinal B-mode ultrasound image of the uterine body and cervix (b), obtained with a linear transducer. B, Longitudinal (a) and transverse (b) B-mode ultrasound images of the prostate with measurements obtained with a microcurved transducer. C, Longitudinal (a) and transverse (b) B-mode ultrasound images of the testes obtained with a linear transducer.

TABLE 5 Recommended image documentation of the urinary system

	Still images		Video clips
1	Left and right kidney in longitudinal and transverse	1	Left and right kidney in longitudinal and transverse
2	Left and right renal length measurement	2	Tracing the ureters from origin to insertion or as far as possible if abnormal
3	Renal pelvis in transverse with measurement if distended	3	Urinary bladder including the apex through the trigone including the ureterovesical junctions and proximal urethra in longitudinal and transverse
4	Urinary bladder apex and/or body depending on indication, and trigone with measurement of wall thickness if abnormal		

TABLE 6 Recommended image documentation of the adrenal glands

	Still images		Video clips
1	Both adrenal glands in longitudinal with maximal thickness measurement	1	Adrenal gland abnormalities including vascular landmarks
2	Adrenal nodules/masses in longitudinal, and if feasible transverse with measurement	2	For adrenal masses Color or Power Doppler examination of adjacent vasculature

TABLE 7 Recommended image documentation of the genital system

	Still images - Female		Video clips - Female
1	Left and right ovaries in intact female dogs and cats at maximal dimension.	1	Ovaries, uterine horns (left and right), uterine body, cervix and pre-pubic aspects of the vagina if clinically indicated
2	Uterine horns (left and right), uterine body, cervix and pre-pubic aspects of the vagina	2	Tracing each mammary chain in transverse if abnormalities are present
3	Representative gestational sacs and fetuses in pregnant dogs and cats.	3	Fetuses documenting heartbeat if present
4	Fetal heart rate using M mode with calipers documenting heart rate calculation		
5	Focal abnormalities of the mammary chain in at least one image plane		
	Still images - Male		Video clips - Male
1	Longitudinal and transverse images of the prostate with measurements	1	Longitudinal and transverse planes of the prostate in both intact and neutered male dog
2	Both testes in at least one image plane at the points of maximal dimension to include the median raphe or mediastinum testis.		

inlet. In the spayed female, the uterine stump should be investigated between the urinary bladder neck or urethra and descending colon, recognizing that there is some variability in location. Abnormalities of the uterine pedicle in a spayed female should prompt a thorough search for any ovarian remnants, as sex hormonal influence is a possible contributing cause. Ultrasound can be used for confirmation of pregnancy as early as 21 days, (but reliably after day 25 to 35) post breeding in dogs and 10–25 days post breeding in cats, and can be used for gestational aging, and assessment of fetal stress and viability.[46–50] It is not generally considered reliable for quantification of litter size. Fetal heart rate should be assessed with M-mode placed across the short axis of the heart. If clinically indicated, each mammary gland and adjoining soft tissue should be assessed in the transverse plane, scanning along the chain, with transverse and longitudinal images obtained of any focal enlargement, nodules, masses, or heterogeneity. It is beyond the scope of this consensus statement to discuss fetal imaging in detail.

3.7.2 | Male

The prostate and prostatic region should be assessed by imaging the prostatic urethra between the bladder trigone and cranial aspect of the pelvic canal. The prostate should be examined in longitudinal and transverse planes from cranial to caudal, with measurements obtained at the greatest diameter of both planes, attempting to remain perpendicular to the axis of the prostate or urethra to avoid distortion when possible.[51] Measurements of any focal abnormalities should be documented along with the location within the prostate. If the lobes are asymmetrical, this should be documented. If the prostate gland is suspected to be enlarged (including presence of paraprostatic lesions), assessment of the adjacent structures such as the periprostatic fat, colon, urinary bladder, and ureters should be performed to assess for presence or absence of obstructive processes. The testes, scrotum, epididymides, and associated vasculature should be assessed in the intact male dog as a part of a complete abdominal ultrasound examination, even if no related clinical signs are present, and abnormalities should be documented. Thorough evaluation of the abdomen from the caudal aspect of the kidneys to the inguinal ring and scrotum should be performed when there is a concern for retained testes. The unique blood supply of the testis can aid in identification.

Recommended image documentation for the genital system is detailed in Table 7.

3.8 | Lymph nodes, mesentery, and omentum, great vessels, peritoneal, and retroperitoneal space

The examination of the lymph nodes should include identifying the medial iliac and jejunal lymph nodes.[52–53] The short axis diameter of the lymph node should be measured (Figure 8). Anatomic landmarks should be used to evaluate the colic, pancreaticoduodenal, hepatic, splenic, gastric, renal, periaortic, internal iliac, sacral, and inguinal lymph nodes even though they may not always be visible.[54–55] If there is a concern for, or known pathology affecting one of the organs or regions drained by these lymph nodes, then careful attention should be made to identify and document the lymph node of concern.

The aorta, caudal vena cava, and portal vein as well as their major branches may serve as landmarks for the identification of lymph nodes. Luminal contents, diameter, wall abnormalities, congenital malformations, and presence of blood flow should be evaluated with Color, Power, or Spectral Doppler if clinically indicated. [55,56]

The surrounding abdominal fat along with the peritoneal and retroperitoneal spaces should be continuously evaluated while examining all abdominal organs. The peritoneal and retroperitoneal space should be evaluated for free fluid or gas. Additionally, a systematic evaluation of the omentum and mesentery including overlapping sweeps in both transverse and longitudinal planes should be performed. Recommended image documentation for the lymph nodes, mesentery, and omentum, great vessels, and peritoneal and retroperitoneal space is detailed in Table 8.

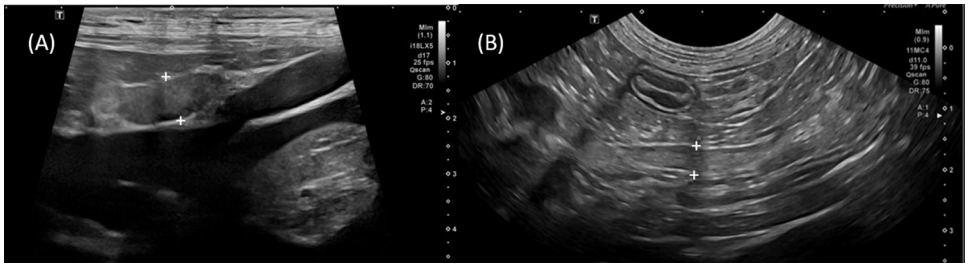

FIGURE 8 Longitudinal B-mode ultrasound images of the right medial iliac (A) and a jejunal lymph node (B) with measurements, obtained with a linear and curvilinear transducer, respectively.

TABLE 8 Recommended image documentation of the lymph nodes, mesentery and omentum, great vessels, peritoneal and retroperitoneal space

	Still images		Video clips
1	Medial iliac and jejunal lymph nodes in longitudinal	1	If discrete medial iliac lymph nodes are not identified then a video clip in longitudinal and transverse of the region of the lymph nodes including both the left lateral aspect of the aorta and right lateral aspect of the caudal vena cava at the level of the aortic trifurcation between the deep circumflex and external iliac arteries should be acquired
2	Any abnormal lymph nodes in longitudinal with measurements	2	If discrete jejunal lymph nodes are not identified then video clips of the region of the jejunal lymph nodes along the cranial mesenteric artery and vein.
3	Abnormalities of the peritoneal and retroperitoneal fat/space including free fluid and gas	3	Abnormal portions of the abdominal fat with anatomical landmarks
4	Abnormalities of the abdominal vasculature	4	Abnormalities of the peritoneal and retroperitoneal space with anatomical landmarks
		5	Abnormalities of the abdominal vasculature

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LIST OF AUTHOR CONTRIBUTIONS

Category 1

a. Conception and Design: Seiler, Cohen, D'Anjou, French, Gaschen, Knapp, Salwei, Saunders
b. Acquisition of Data: Seiler, Cohen, D'Anjou, French, Gaschen, Knapp, Salwei, Saunders
c. Analysis and Interpretation of Data: Seiler, Cohen, D'Anjou, French, Gaschen, Knapp, Salwei, Saunders

Category 2

a. Drafting the Article: Seiler, Cohen, D'Anjou, French, Gaschen, Knapp, Salwei, Saunders (b) Revising Article for Intellectual Content: Seiler, Cohen, D'Anjou, French, Gaschen, Knapp, Salwei, Saunders

Category 3

a. Final Approval of the Completed Article: Seiler, Cohen, D'Anjou, French, Gaschen, Knapp, Salwei, Saunders

Category 4

a. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved: Seiler, Cohen, D'Anjou, French, Gaschen, Knapp, Salwei, Saunders

CONFLICT OF INTEREST

The authors declare no conflict of interest.

PREVIOUS PRESENTATION DISCLOSURE

Parts of this work have previously been presented at the 2020 ACVR Annual conference.

REPORTING GUIDELINE CHECKLIST DISCLOSURE

No reporting checklist was used. The following reference list includes specific articles to support evidence-based recommendations in this consensus statement. While not listed below, the consensus statement has been generated in concordance with textbooks of veterinary ultrasonography.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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