Small animal point of care ultrasound techniques

The role of veterinary point of care ultrasound in determining the presence or absence of specific pathologies is examined by Jantina McMurray DVM; Søren Boysen DVM DACVECC, Faculty of Veterinary Medicine, University of Calgary, Canada

Veterinary point of care ultrasound (VPOCUS) involves brief, focused ultrasound scans performed by the attending clinician. The goal of VPOCUS is to determine the presence or absence of specific pathologies such as abdominal effusion, pleural effusion, pericardial effusion, pneumothorax, and interstitial-alveolar disease. VPOCUS helps confirm uncertain physical exam findings, helps guide the initial diagnostic and treatment approach, and provides a baseline for monitoring response to therapy. VPOCUS is particularly valuable in unstable patients as it allows rapid and non-invasive identification of life-threatening conditions.

Common indications for VPOCUS include, but are not limited to: blunt or penetrating trauma; cardiovascular instability; acute collapse; cardiac arrest; respiratory distress; acute abdominal pain; unexplained anemia; suspected abdominal, pleural, or pericardial effusion; suspected pneumothorax; suspected congestive heart failure; and suspected dehiscence, haemorrhage, or infection in post-operative patients.

The sonographic skills applied in VPOCUS are easily mastered by general practitioners. This article will describe the procedures and common findings for empirically validated small animal VPOCUS techniques: abdominal focused assessment with sonography for triage (AFAST), thoracic focused assessment with sonography for triage (TFAST), and lung ultrasound. These procedures are complementary when performed together and it is recommended that AFAST, TFAST, and lung ultrasound are completed for each patient.

MATERIALS AND PATIENT PREPARATION

An ultrasound machine specifically dedicated for VPOCUS is highly recommended, particularly a portable ultrasound machine that can be transported to the cageside. If a portable machine is not available, the dedicated VPOCUS machine should remain stationed in the triage/resuscitation area. Bring the machine to the patient, not the patient to the machine. A micro-convex curvilinear probe capable of B-mode is ideal for VPOCUS. Frequency settings typically range from 5MHz (dogs >20kg) to 7MHz (dogs and cats ≤20kg).

VPOCUS exams typically do not require shaving patient fur. The fur can be parted and alcohol applied over the scanning site. If image quality is poor due to thick undercoat (eg. some Northern dog breeds) or if greater detail is desired, shaving fur may improve the sonographic image. Alcohol is usually the sole acoustic coupling agent. Alcohol-based hand gels can be used. Ultrasound conducting gel may be used alone or applied following the application of alcohol to enhance image quality; gel should be smoothed against the skin to prevent formation of air bubbles which can interfere with image acquisition.

Patients can be scanned in standing position as well as sternal or lateral (left or right) recumbency. Patients scanned in lateral recumbency may be rolled into a sternal position to access gravity-dependent sites of VPOCUS exams. Patients should never be placed in dorsal recumbency for VPOCUS as this may cause unstable patients to decompensate or even arrest. The order of sites scanned during each VPOCUS procedure is not critical, however, each clinician should develop a systematic and consistent approach.

AFAST

The patient can be positioned standing, in right or left lateral recumbency, or in sternal recumbency with both hindlimbs turned toward the sonographer to allow access to the subxiphoid and bladder areas.

AFAST involves systematic evaluation of four sites in the abdomen (see Figure 1).

Subxiphoid or diaphramaticohepatic (DH) site: this view is obtained by placing the probe just caudal to the xiphoid

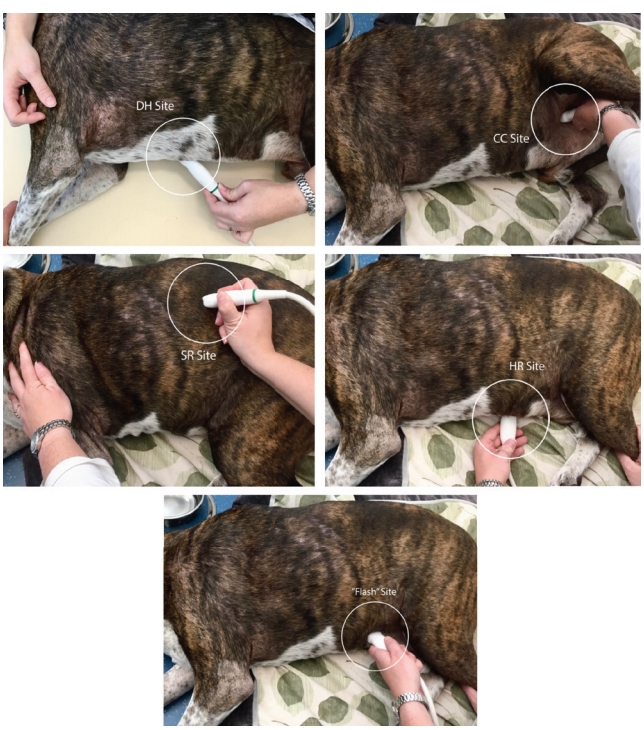

Figure 1: Probe positioning at four abdominal sites as well as the 'flash' site for AFAST. The patient is shown positioned at right lateral recumbancy. DH: diagphragmaticohepatic (subxiphoid). CC: cystolic (bladder). SR: splenorenal (left paralumbar). HR: hepaticorenal (right paralumbar).

process and angling the probe cranially at approximately 45 degrees (the tail of the probe tips towards the hindlimbs). Target structures include the liver lobes, the gallbladder (hypoechoic), the hepatodiaphragmatic interface (white hyperechoic curved line separating the abdominal and thoracic cavities), the heart, the pericardial space, and the pleural space (see Figure 2a).

The caudal vena cava (CVC) can also be visualised at this site (two hyperechoic lines traversing the diaphragm slightly to the right of midline).

Left paralumbar or splenorenal (SR) site: this view is obtained by placing the probe on the left flank, caudal to the last rib and just ventral to the paralumbar muscles. If the target structures are not adequately visualized from this position, the probe can be moved forward to the 12th intercostal space on the left side. Target structures include the left kidney, the spleen (including the tail of the spleen), the left body wall, and the surrounding areas (see Figure 2b).

Bladder or cystocolic (CC) site: this view is obtained by placing the probe just to the non-gravity-dependant side of midline on the caudal abdomen, just cranial to the pelvis, and angling the probe downward toward the gravity-dependent side of the patient's body. In some patients with intra-pelvic or very small bladders, the probe may need to be moved more caudally to visualize the bladder. Target structures include the urinary bladder (particularly the apex of the bladder) and the surrounding areas (see Figure 2c).

Right paralumbar or hepatorenal (HR) site: this view is obtained by placing the probe on the right flank, caudal

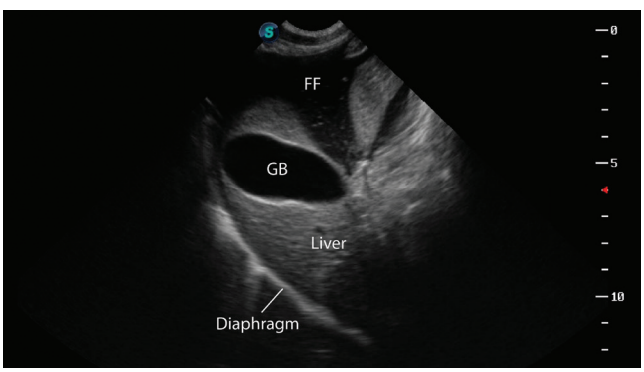

Figure 2a: Target structures at AFAST diaphragmaticohephatic (subxiphoid) site with abdominal effusion present. GB: gallbladder. FF: free fluid.

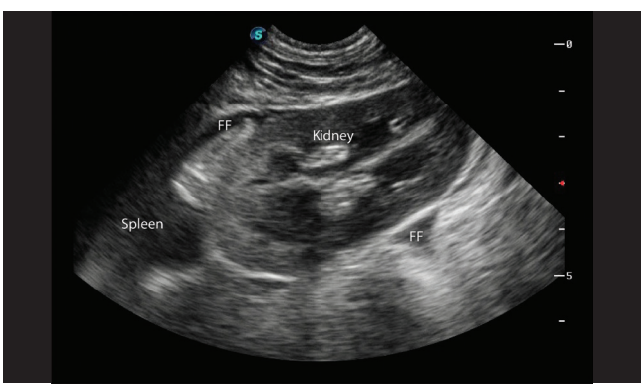

Figure 2b: Target structures at AFAST splenoral (left paralumbar) site with abdominal effsusion present. FF: free fluid.

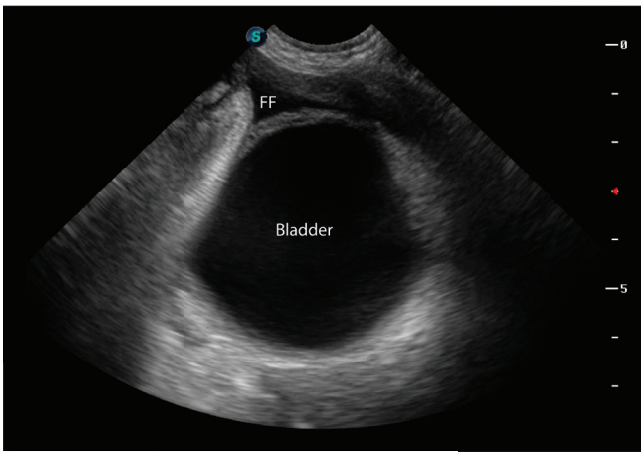

Figure 2c: Target structures at AFAST cystocolic (bladder) site with abdominal effusion present. FF: free fluid.

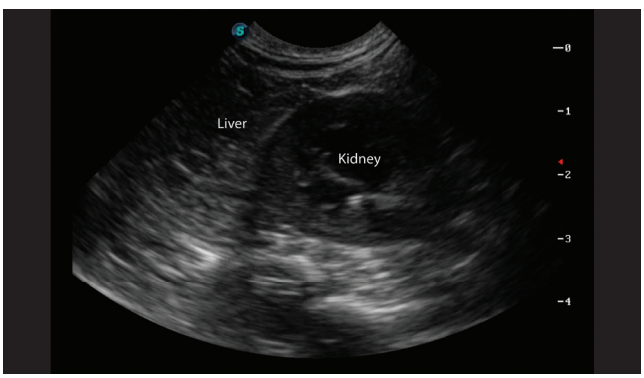

Figure 2d: Target structures at AFAST hepatorenal (right paralumbar) site with no abdominal effusion.

to the last rib and just ventral to the paralumbar muscles. If the target structures are not adequately visualised from this position, the probe can be moved forward to the 11th or 12th intercostal space on the right side. Target structures include the right kidney, the liver, the small intestine, the right body wall, and the surrounding areas (see Figure 2d).

A fifth site is commonly added to the AFAST procedure when assessment of the kidney is not vital. This fifth site (often called a 'flash' scan) replaces or complements the standard gravity-dependant lateral site, allowing assessment for free abdominal fluid on the gravity-dependent side more quickly than localizing the kidney on that side (see Figure 1).

Flash site: this view is obtained by placing the probe just to the non-gravity-dependant side of midline, just cranial to the umbilicus, and angling the probe downward toward the gravity-dependent side of the patient's body. There are no specific target structures at this site, but structures that may be visualized include the tail of the spleen, caudal liver lobes, and small intestine.

At each AFAST site, the probe is fanned through an angle of 45° and moved 2.5cm cranial, caudal, left, and right of the starting point. The ultrasound probe is initially placed in longitudinal orientation. However, transverse orientation can also be used to more fully assess suspected free fluid if images are equivocal or if clinicians want to gain additional familiarity with ultrasound. Image depth should be set at approximately 5cm-10cm for most AFAST sites (depending

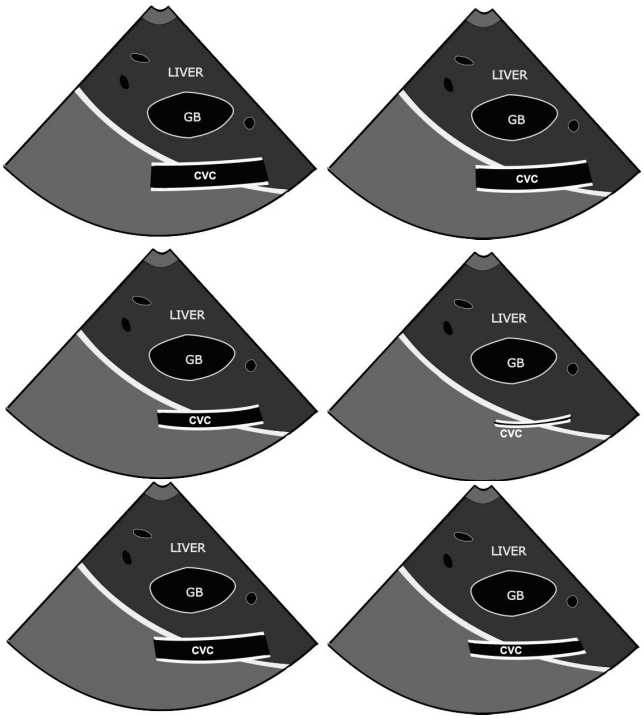

Figure 3. Illustration of respiratory fluctuations in caudal vena cava diameter at the diaphragmaticohepatic (subxiphoid) site. The top panel represents normal respiratory fluctuations (25-50% change in diameter). The middle panel represents respiratory fluctuations >50%, suggesting hypovolemia. The bottom panel represents absent respiratory fluctuations, suggesting volume overload or right-sided heart failure.

on the size of the patient) and 10cm-15cm for the subxiphoid site. Adjust depth settings as needed to ensure optimal image quality.

The primary objective of AFAST is to look for free fluid in the abdomen. Free fluid typically appears as black (hypoechoic) triangles in between the target structures (see Figures 2a-2c) Common sites for free-fluid accumulation include in between liver lobes, at the apex of the bladder, at the cranial and caudal poles of the kidneys, and in between loops of small intestine. Normal hypoechoic abdominal structures can be mistaken for free fluid; structures commonly mistaken for free fluid include the gallbladder, common bile duct, hepatic veins, caudal vena cava, and occasionally the gastrointestinal (GI) wall and/or GI contents. Scanning with the probe in both longitudinal and transverse orientation and adjusting the depth of the image can improve the clinician's ability to accurately assess the presence or absence of small volumes of free fluid during AFAST.

If free abdominal fluid is identified, an abdominal fluid score (AFS) can be assigned according to the number of standard AFAST sites (not including the flash site) that are positive for fluid: AFS 1 has fluid at any one site, AFS 2 has fluid at any two sites, AFS 3 has fluid at any three sites, and AFS 4 has fluid at all four sites. AFAST scans can be repeated after the initial assessment to monitor changes in the amount of free abdominal fluid. An increase in AFS suggests ongoing intra-abdominal fluid accumulation, while a decrease in AFS suggests resorption of fluid.

Abdominocentesis is recommended if free abdominal fluid is identified, particularly in non-trauma patients as the type of fluid is highly variable and cannot be determined by sonography alone. Following centesis, the type of free abdominal fluid (transudate versus modified transudate versus exudate, septic versus non-septic, hemorrhagic versus non-hemorrhagic, etc) can be rapidly determined through cytology and/or biochemical analysis. Ultrasound-guided centesis can help prevent accidental laceration of abdominal organs and/or hollow organ aspiration (ie. intestines, bladder).

In addition to assessment for abdominal free fluid, AFAST also allows estimation of volume status by evaluating changes in the diameter of the CVC with respiration. Although studies in veterinary medicine are lacking, this technique is commonly used in human emergency medicine. The CVC can be visualized at the subxiphoid site as two hyperechoic lines traversing the diaphragm slightly to the right of midline and typically to the right of the gallbladder. Fluctuations in the diameter of the CVC of 25%-50% between inspiration and expiration are considered normal. Respiratory fluctuations in the diameter of the CVC >50% suggest hypovolemia. The absence of respiratory fluctuations in the diameter of the CVC (static distension) suggests increased right atrial pressure (ie. volume overload or right-sided heart failure; see Figure 3).

TFAST

The patient can be positioned standing (preferred positioning for patients in respiratory distress), sternal recumbency, or in right or left lateral recumbency (common positioning if TFAST is combined with AFAST).

TFAST involves systematic evaluation of five thoracic sites (see Figure 4).

Chest tube site (CTS): This view is obtained by placing the probe on the chest wall between the 7th-9th intercostal spaces. If the patient is in lateral recumbency, the probe should be placed at the widest portion of the chest. If the patient is in sternal recumbency or standing, the probe should be placed over the caudal-dorsal area of the lungs. The probe should be in longitudinal orientation (perpendicular to the ribs) and held motionless to assess the presence of a glide sign (described below). Depth should be set at 2cm-6cm for optimal image quality. Target structures include the ribs (hyperechoic structures in the near field on either side of the image with shadows extending to the far field) and the parietal-pleural interface (white hyperechoic curved line stretching between the ribs). The CTS is scanned on the right and left sides; patients in lateral recumbency will need to be rolled into sternal recumbency or standing in order to access the gravity-dependent CTS.

Pericardial site (PCS): This view is obtained by placing the probe over the heart between the 5th-6th intercostal spaces. Probe position can be determined by auscultating to find the area with where the heartbeat is loudest or palpating to find the area where the heartbeat is most strongly palpable. The PCS should be evaluated with the probe in both longitudinal (perpendicular to the ribs) and transverse (parallel to the ribs) orientation and fanned through an angle of 45 degrees to ensure that all target structures are visualized. Depth

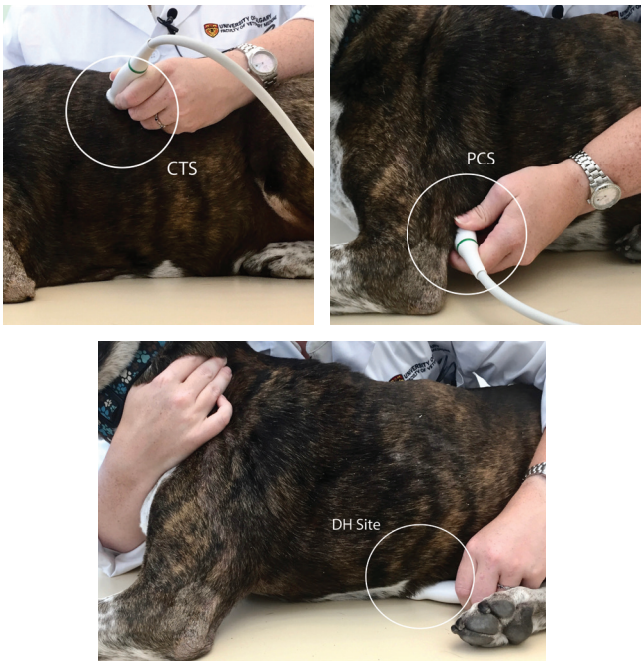

Figure 4: Probe positioning for TFAST. The patient is shown positioned in sternal recumbrancy. The CTS and PCS are repeated on both side of the chest. DH: diaphragmaticohepatic (subxiphoid).

should be set at 5cm-10cm for optimal-image quality. Target structures include the heart (left ventricle, right ventricle, and ventricular septum are usually visible), the pericardial space (hyperechoic line surrounding the heart), and surrounding areas. Ribs, rib shadows, and the parietal-pleural interface may be visible depending on probe positioning. The PCS is scanned on the right and left side; both PCSs are usually accessible with the patient in lateral recumbency, however it may be easier to obtain the gravity-dependent view after the patient has been rolled into sternal recumbency.

Subxiphoid (diaphragmaticohepatic) site: This view is obtained by placing the probe just caudal to the xiphoid process and angling the probe cranially at approximately 45 degrees (the tail of the probe tips towards the hindlimbs). Depth should be set at 10cm-15cm. Target structures include the hepatodiaphragmatic interface (white hyperechoic curvilinear line separating the abdominal and thoracic cavities), the heart, the pericardial space, and the pleural

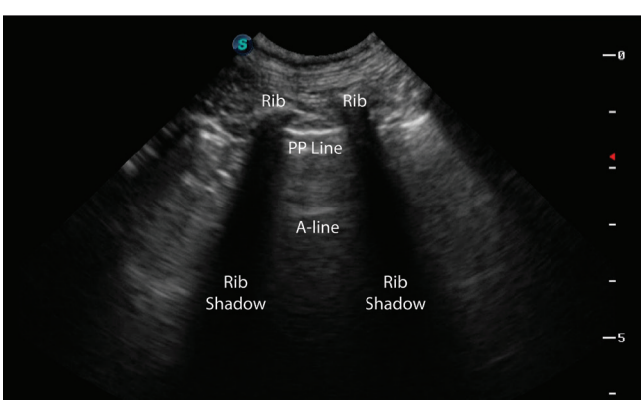

Figure 5a: Target structures at TFAST chest tube site forming the 'bat-sign' or 'gator sign'. A-lines are present. PP line: parietal-pleural interface.

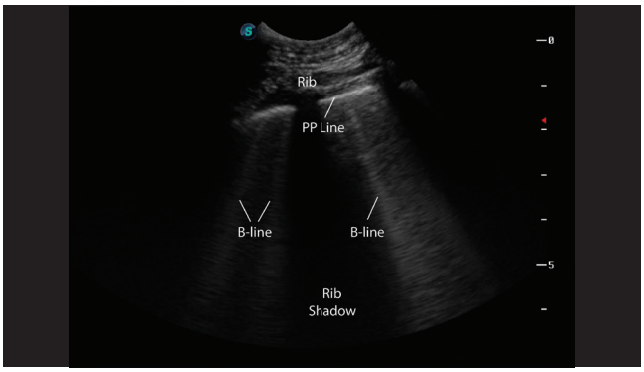

Figure 5b: Three B-lines at TFAST chest tube site PP line: parietal-pleural interface.

space. The subxiphoid site is part of both AFAST and TFAST scans, however, during TFAST attention should be focused on the thoracic structures rather than the abdominal structures. At the CTSs, the ribs (hyperechoic structures in the near field with distal shadowing on either side of the image) and the parietal-pleural interface (white hyperechoic curved line stretching between the ribs) are used as landmarks, forming the 'bat sign' or 'gator sign' (see Figure 5a).

After these landmarks have been identified, certain normal findings may be visualised including A-lines, the glide sign, and the curtain sign.

A-lines appear as horizontal hyperechoic lines that are equally spaced from each other (see Figure 5a). A-lines should not be confused with the parietal-pleural interface: the parietal-pleural interface is the hyperechoic line in the near field that stretches between adjacent ribs while A-lines appear in the far field below the level of the ribs. A-lines are the result of reverberation artifact and can be identified in patients with or without pneumothorax, so A-lines should not be used to rule out pneumothorax. A-lines may or may not be visible in each patient.

The glide sign is the shimmering movement along the parietal-pleural interface when the patient breathes. The glide sign is typically most pronounced along the parietal-pleural interface near the ribs rather than in the centre of the image. The glide sign represents the parietal surface of the lung sliding against the inner chest wall with respiration; therefore, the glide sign is only visible during the dynamic phases of inspiration and expiration and disappears between breaths. Movement of the probe, of the clinician's hand, or of the patient can create a false glide sign, so the probe must be held motionless. It can be difficult to evaluate the glide sign in panting patients or patients with rapid shallow respirations. The presence or absence of a glide sign should be assessed at the CTS in every patient. The presence of a glide sign rules out pneumothorax, while the absence of a glide sign suggests pneumothorax.

The curtain sign is the appearance of abdominal organs (typically liver, stomach, and/or spleen) sliding into view between the ribs when the patient breathes. The curtain sign is a normal finding, however, the presence of the curtain sign means the probe is positioned too far caudally and the probe should be moved cranially until the curtain sign disappears. The curtain sign may or may not be visible in each patient

depending on initial probe positioning and probe movement during TFAST.

The CTS can be used to assess the presence or absence of certain pathologies including pneumothorax and B-lines. Pneumothorax is suggested by the absence of a glide sign.

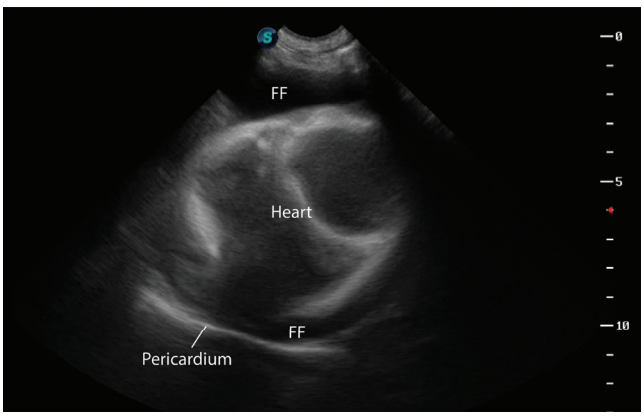

Figure 5c: Pericardial effusion visualised at the TFAST pericardial site. FF: free fluid.

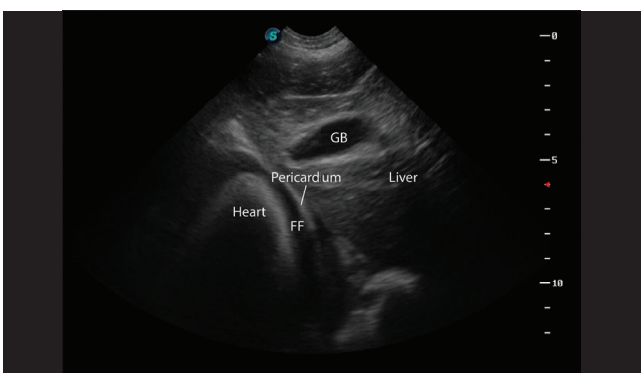

Figure 5d: Pericardial effusion visualised at the TFAST diaphragmaticohepatic (subxiphoid) site. GB: gall bladder. FF: free fluid.

The presence of a glide sign, and the presence of any B-lines (described below) definitively rules out pneumothorax at that site. Diagnosis of pneumothorax based on the absence of a glide sign has low sensitivity and specificity as the glide sign may not be easy to visualise even in healthy patients.

Identification of the lung point can aid sonographic diagnosis of pneumothorax when a glide sign appears to be absent. The lung point is the location at which there is no longer air between the chest wall and parietal surface in a patient with pneumothorax. The lung point can be identified by starting with the probe at the site where the glide sign is absent and then slowly sliding the probe ventrally between the ribs until the glide sign becomes visible; on the ultrasound image, the lung point is identified as the area where the glide is present in one portion of the image but absent in the remaining portion.

B-lines (also called ultrasound lung rockets) are hyperechoic vertical lines that originate at the parietal-pleural interface and extend into the far field, passing through or obliterating A-lines, oscillating side to side with respirations (see Figure 5b). B-lines are believed to result from the presence of a small amount of fluid in the outer 1mm-3mm of the lung.

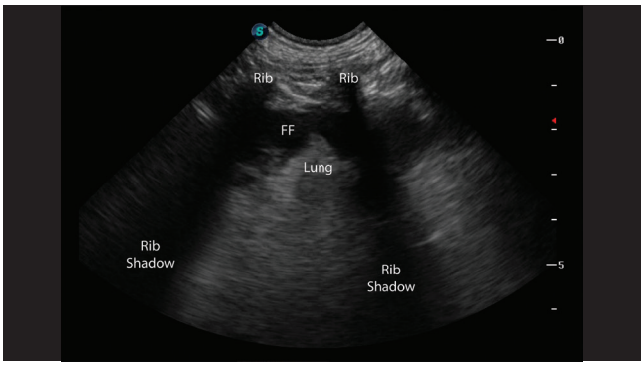

Figure 5e: Pleural effusion visualised at the TFAST pericardial site. FF: free fluid.

The presence of B-lines definitively rules out pneumothorax. 1-2 B-lines per field of view (at one or two thoracic sites) is considered normal.The presence of ≥3 B-lines at any location, particularly if the B-lines are coalescing, indicates interstitial-alveolar pulmonary pathology at the probe location. The differential diagnoses for B-lines are similar to the differential diagnoses for interstitial-alveolar patterns on thoracic radiographs. The severity of lung pathology correlates with the number of B-lines.

The PCS and subxiphoid sites can be used to assess the presence or absence of certain pathologies including pleural effusion and pericardial effusion. Pericardial effusion appears as a hypoechoic band separating the outer wall of the heart from the hyperechoic line of the pericardium (see Figures 5c and 5d).

The probe should be fanned ventrally off the apex of the heart and dorsally to the base of the heart for a thorough assessment of the pericardial space. Pleural effusion at the PCS typically appears as hypoechoic material between the lung and the chest wall, however, pleural fluid may appear as hypoechoic triangles when it accumulates between lung lobes (see Figure 5e).

The probe should be fanned or moved 1-2 rib spaces cranially and caudally from the heart to assess for pleural fluid in this area. Moving and fanning the probe across several rib spaces in this area can help differentiate pleural fluid from pericardial fluid, as pericardial fluid is contained by the pericardium and forms a curved hypoechoic band surrounding the heart while pleural fluid is more diffuse and can often be visualised at multiple locations throughout the pleural space. If pleural or pericardial fluid is identified, ultrasound-guided centesis is recommended to determine the type of fluid (and to relieve cardiac tamponade secondary to pericardial effusion, if present). Serial TFAST scans allow subjective assessment of trends in effusion volume over time.

More advanced point of care cardiology assessments can be performed to evaluate volume status and cardiac contractility, however, detailed description of these techniques will not be covered here.

LUNG ULTRASOUND

VPOCUS lung ultrasound scans are intended to rapidly assess for pulmonary and pleural pathology, particularly the presence or absence of pleural effusion, pneumothorax, and B-lines

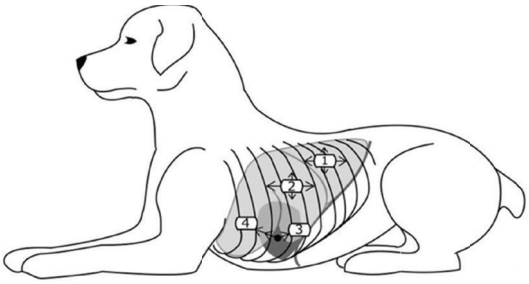

Figure 6: Thoracic sites in regional lung ultrasound protocol.

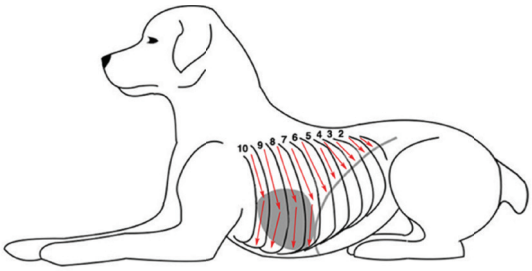

Figure 7: Intercostal sliding lung ultrasound protocol.

indicating interstitial-alveolar disease. Lung ultrasound scans allow a more thorough assessment of the thorax than TFAST. The basic landmarks (bat sign or gator sign), the appearance of normal findings (A-lines, glide sign), and the appearance of abnormal findings (absent glide sign, B-lines, pleural effusion) are the same as previously described for TFAST.

Lung ultrasound can also detect pathologies other than interstitial-alveolar such as nodules and consolidation), however, these techniques require more specific training and will not be covered in this article.

It is important to remember that a VPOCUS lung ultrasound scan with no abnormal findings does not necessarily exclude injury or pathology; pathology located more than a few mm within the lung tissue that does not extend to the lung surface is unlikely to be identified with sonography. It is also important to remember that VPOCUS lung ultrasound scans only evaluate a few specific sites on the thorax and may therefore miss pathology in regions not evaluated during the scan. Finally, patients with no abnormal findings on initial lung ultrasound scans who fail to stabilize or experience persistent clinical signs often benefit from serial lung ultrasound scans.

The two most common lung ultrasound protocols used in small animals include a regional lung ultrasound protocol (Veterinary Bedside Lung Ultrasound Exam or VetBLUE) and an intercostal sliding lung ultrasound protocol.

The regional lung ultrasound protocol involves evaluation of four thoracic sites on each side of the thorax (see Figure 6).

Dorsal-caudal lung region: the probe is placed in the upper third of the thorax at the 9th intercostal space.

Peri-hilar region: the probe is placed in the middle third of the thorax at the 6th intercostal space.

Middle lung region: the probe is placed in the lower third of the thorax near the costochondral junction at the 6th-8th intercostal space. If the heart prevents visualization of the lung field at this site, the probe is moved caudally 1-2 intercostal spaces until the heart is no longer visible.

Cranial lung region: the probe is placed in the lower third of the thorax near the costochondral junction at the 3rd-5th intercostal space. The probe is initially placed over the 4th-6th intercostal space 1cm-3cm above the costochondral junction so that the heart is visible, then the probe is moved cranially one intercostal space at a time until the heart disappears from the field of view. The patient's forelimb may need to be pulled cranially to facilitate probe positioning at this site.

For the regional lung ultrasound protocol, the probe is typically oriented longitudinally (perpendicular to the ribs). The probe is moved 1-2 intercostal spaces cranially and caudally and 1cm-2cm dorsally and ventrally at each site to look for B-lines. If B-lines are present, the probe should be held motionless and the number of B-lines counted and recorded.

If no B-lines are present, the probe should be held motionless and the presence or absence of the glide sign is evaluated.

If a glide sign is present at the caudal dorsal region, presence or absence of a glide sign does not need to be assessed elsewhere in the thorax because air accumulates dorsally.

If a glide sign is present at the caudal dorsal region, presence or absence of a glide sign does not need to be assessed elsewhere in the thorax because air accumulates dorsally.

The presence of B-lines and/or the presence of a glide sign rule out pneumothorax. The presence or absence of pleural effusion should also be evaluated at the 3rd and 4th regional lung sites.

The sliding lung ultrasound protocol is more comprehensive than the regional protocol but can be equally rapid with sufficient practice. The sliding lung ultrasound protocol involving the following steps (see Figure 7).

The probe can be oriented longitudinally (perpendicular to the ribs) or transversely (parallel to the ribs).

Place the probe in the dorsal region of the last (12th) intercostal space, just below the paralumbar muscles. From the starting position, the probe is slowly moved ventrally between the 12th and 13th ribs until the diaphragm becomes visible.

If abdominal structures are visible, move the probe cranially one intercostal space at a time until the abdominal structures are no longer visible. If abdominal structures are visible, move the probe cranially one intercostal space at a time until the abdominal structures are no longer visible.

The probe is then advanced cranially one rib space and placed in the dorsal region of the 11th intercostal space, just below the paralumbar muscles. The probe is once again slowly moved ventrally until the diaphragm becomes visible or until the probe reaches the sternum.

The intercostal sliding process is repeated for all intercostal spaces until the entire hemithorax has been scanned.

The procedure is then repeated on the other side of the chest.

Throughout the sliding lung ultrasound protocol, the presence or absence of B-lines is assessed. If B-lines are present, the probe should be held motionless and the number of B-lines counted and recorded.

If no B-lines are present at a particular site, the probe should be held motionless and the presence or absence of the glide sign is evaluated. The presence of B-lines and/or the presence

of a glide sign rule out pneumothorax. If pneumothorax is suspected prior to beginning lung ultrasound, the probe should initially be held stationary at the caudal-dorsal sites to assess the presence or absence of the glide sign before starting the sliding technique. The presence or absence of pleural effusion should also be evaluated when the probe is sliding along the middle and ventral thoracic regions.

CONCLUSIONS

VPOCUS in small animal practice includes AFAST, TFAST, and lung ultrasound scans such as VetBLUE and the sliding lung ultrasound protocol. These scans are rapid and non-invasive and require minimal patient preparation. Scans be can be performed at the cageside during initial stabilisation, which is particularly valuable for animals not stable enough for radiographic positioning or CT scans.

Early detection of free fluid by sonography allows for fluid analysis following centesis, which can help guide the diagnostic and treatment approach.

Early detection of other pathology, such as B-lines or pneumothorax, can also influence initial interventions. Serial scans allow monitoring of response to treatment.

VPOCUS scans may be performed by general practitioners with minimal prior ultrasound experience, and these techniques can easily be incorporated into general and emergency practice.

READING LIST

Boysen SR, Lisciandro GR. The use of ultrasound for dogs and cats in the emergency room – AFAST and TFAST. Vet Clin Small Anim 2013; 43: 773-797

Boysen SR, Rozanski EA, Tidwell AS, Holm JL, Shaw SP, Rush JE. Evaluation of a focused assessment with sonography for trauma protocol to detect free abdominal fluid in dogs involved in motor vehicle accidents. J Am Vet Med Assoc 2004; 225(8): 1198-1204

Lisciandro GR. The use of the diaphragmatico-hepatic (DH) views of the abdominal and thoracic focused assessment with sonography for triage (AFAST/TFAST) examinations for the detection of pericardial effusion in 24 dogs (2011-2012). J Vet Emerg Crit Care 2016; 26(1): 125-131

Lisciandro GR, Lagutchik MS, Mann KA, Voges AK, Fosgate GT, Tiller EG, Cabano NR, Bauer LD, Book BP. Evaluation of a thoracic focused assessment with sonography for trauma (TFAST) protocol to detect pneumothorax and concurrent thoracic injury in 145 traumatized dogs. J Vet Emerg Crit Care 2008; 18(3): 258-269

McMurray J, Boysen S, Chalhoub S. Focused assessment with sonography in nontraumatized dogs and cats in emergency and critical care setting. J Vet Emerg Crit Care 2016; 26(1): 64-73

Vezzosi T, Mannucci T, Pistoresi A, et al. Assessment of lung ultrasound B lines in dogs with different stages of chronic valvular heart disease. J Vet Intern Med. 2017; 31(3): 700–704

Ward JL, Lisciandro GR, Tou SP, Keene BW, DeFrancesco TC. Evaluation of point-of-care lung ultrasound (Vet BLUE protocol) for the diagnosis of cardiogenic pulmonary edema in dogs and cats with acute dyspnea. J Am Vet Med Assoc. 2017; 250(6): 666-675

READER QUESTIONS AND ANSWERS

1: WHAT PATIENT POSITIONING SHOULD ALWAYS BE AVOIDED DURING POINT OF CARE ULTRASOUND SCANS DUE TO RISK OF DECOMPENSATION OR ARREST?

A Right lateral recumbency.
B Left lateral recumbency.
C Dorsal recumbency.
D Sternal recumbency.
E Standing.

2: WHAT IS THE PRIMARY OBJECTIVE OF ABDOMINAL FOCUSED ASSESSMENT WITH SONOGRAPHY FOR TRIAGE (AFAST)?

A To evaluate kidney function.
B To scan the liver for masses.
C To evaluate the gallbladder size.
D To estimate vascular volume status.
E To look for free abdominal fluid.

3: WHAT STRUCTURES CREATE THE 'BAT SIGN' OR 'GATOR SIGN' WHEN THE PROBE IS PLACED IN LONGITUDINAL ORIENTATION ON THE THORAX?

A Parietal-pleural interface stretching between adjacent ribs.
B Left ventricle, right ventricle, and ventricular septum.
C Diaphragm and abdominal organs sliding in and out of the field of view with respiration.
D Coalescing B-lines across multiple intercostal spaces.
E Concurrent pleural effusion and pericardial effusion.

4: WHAT CAUSES THE SHIMMERING APPEARANCE OF THE GLIDE SIGN?

A Pneumothorax.
B Artifact created by movement of the patient or of the clinician's hand holding the probe.
C Surface of the lung sliding against the inner chest wall during respiration.
D Respiratory fluctuations in caudal vena cava diameter.
E Excess fat in the subcutaneous tissues of the chest wall.

5: THE PRESENCE OF ≥3 B-LINES IN ONE FIELD OF VIEW ON THE THORAX INDICATES WHAT TYPE OF PULMONARY PATHOLOGY?

A Lung consolidation.
B Pulmonary nodules.
C Neoplasia.
D Interstitial-alveolar disease.
E Bronchitis.

ANSWERS: 1: C; 2: E; 3: A; 4: C; 5: D