2019 International Veterinary Point-of-Care Ultrasound Society Symposium

NOV 18-20, 2019

AUSTIN, TEXAS

IVPOCUS

Welcome to IVPOCUS 2019

Dear Attendee,

As President, and on behalf of our board of directors, welcome to the 2nd International Veterinary Point-of-Care Ultrasound Society's (IVPOCUS) Symposium and to vibrant and eclectic Austin, Texas!

This symposium is hosted by the International Veterinary Point-of-Care Ultrasound Society (IVPOCUS), a 501c3 non-profit organization founded in 2017 dedicated to the awareness, advancement and responsible use of veterinary point-of-care abdominal, thoracic, pulmonary, cardiovascular, musculoskeletal, ocular, neurological and FAST ultrasound.

Over the next 2.5 days, you will have the opportunity to meet, listen to and interact with outstanding speakers that represent thought leadership in veterinary FAST and point-of-care ultrasound (POCUS) including:

- **Dr. Diego Portela**, Dipl. ACVAA, Assistant Professor Anesthesiology and Pain Management, University of Florida
- **Dr. Marta Romano**, Dipl. ACVAA, Clinical Assistant Professor Anesthesiology and Pain Management, University of Florida
- **Dr. Terri DeFrancesco**, Dipl. ACVIM (cardiology), Dipl. ACVECC, Professor Cardiology and ICU Critical Care, North Carolina State University
- **Dr. Jennifer Gambino**, Dipl. ACVR, Staff Radiologist, Idexx Laboratories
- **Dr. Greg Lisciandro**, Dipl. ABVP, Dipl. ACVECC, Hill Country Veterinary Specialists, CEO of FASTVet.com, editor of the textbook Focused Ultrasound Techniques for the Small Animal Practitioner

We are also pleased to welcome Dr. Nilam J. Soni, MD, Associate Professor of Medicine, University of Texas Health Science Center in San Antonio, Texas who will be our Keynote Speaker on Tuesday. Dr. Soni's academic interests focus on the clinical applications of hand-carried ultrasound, including ultrasound-guided procedures and diagnostic bedside ultrasound. He is a visionary in the field, a leader in POCUS implementation within medical school curriculum, and chief editor of Point-of-Care Ultrasound, translated into several languages and recently released in its 2nd edition.

We look forward to spending time with you not only exploring the world of POCUS, but to have the chance to network and get to know each other as passionate colleagues exploring exciting, gamechanging POCUS and FAST ultrasound as the new frontier of veterinary medicine.

Speaking for myself and our board of directors, we have found POCUS and FAST ultrasound to be one of the greatest advancements in small animal veterinary medicine this decade. We are looking forward to sharing our experiences with you and hope you will join us on our journey as members of IVPOCUS for years to come.

Welcome to an outstanding clinical program!

Dr. Greg Lisciandro, Dipl. ABVP, Dipl. ACVECC
President, International Veterinary Point-of-Care Ultrasound Society

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Meet Our Speakers

Dr. Diego Portela, DACVAA, University of Florida

Dr. Portela received his veterinary degree from the School of Veterinary Sciences, University of Buenos Aires, Argentina, and a PhD from the University of Pisa, Italy. Dr. Portela completed his residency in anesthesiology at Cornell University College of Veterinary Medicine, and joined the faculty to work as a Clinical Instructor. He is a Diplomate from the ACVAA and is currently an Assistant Professor at the University of Florida (Gainesville, FL). More information can be found at the University of Florida website.

Dr. Marta Romano, DACVAA, University of Florida

Dr. Romano received her DVM degree from the University of Pisa, Italy. She holds a Masters in small and exotic animal anesthesia and pain management and a PhD with a focus on the stress response of dogs to surgery and anesthesia. Dr. Romano completed her residency in veterinary anesthesiology at Cornell University and is board-certified with the American College of Veterinary Anesthesia and Analgesia (ACVAA). Currently, she is a clinical assistant professor at the University of Florida. More information can be found at the University of Florida website.

Dr. Teresa DeFrancesco, DACVIM, DACVECC, North Carolina State

Dr. DeFrancesco received her DVM degree from Cornell University, an internship at Virginia Tech, and residency in Cardiology and Emergency & Critical Care at North Carolina State University. Dr. DeFrancesco has received numerous teaching and clinical awards and leads in training first line veterinarians in POC ultrasound for the cardiac/respiratory patient to better identify the cause, and better treat for survival to gold standard testing.

Dr. Jennifer Gambino, DACVR, Mississippi State

Dr. Jennifer Gambino received her DVM from Ross University School of Veterinary Medicine, completed a small animal internship at Fifth Avenue Veterinary Specialists, NYC, and a Diagnostic Imaging Residency and Clinical Instructorship at Mississippi State University and MRI fellowship. She currently works with Idexx Laboratories and as an adjunct Professor in Diagnostic Imaging, Lincoln Memorial University. Her interests include interventional ultrasound and CT-guided procedures, intraoperative ultrasound-guided brain tumor removal, MRI and CT imaging as well as imaging marine mammals and sea turtles.

Dr. Greg Lisciandro, DACVECC, Hill Country Veterinary Specialists

Dr. Lisciandro received his DVM degree from Cornell University, completed an internship at The Animal Medical Center, NYC, and a residency in Emergency & Critical Care at the Emergency Pet Center, San Antonio, Texas. He developed AFAST and it's abdominal fluid scoring system, TFAST and Vet BLUE lung ultrasound and has practiced half his 28-year career in general practice and half in emergency and critical care. He knows what he missed every day without ultrasound the first half of his career!

Dr. Nilam Soni, MD, MS, FHM, FACP

Dr. Soni received his degree from the University of Texas Health Science Center San Antonio. He is the lead author of the book, Point-of-Care Ultrasound, that was awarded the 2015 British Medical Association's President's Choice Award. He leads educational programs in point-of-care ultrasound locally, nationally, and internationally.

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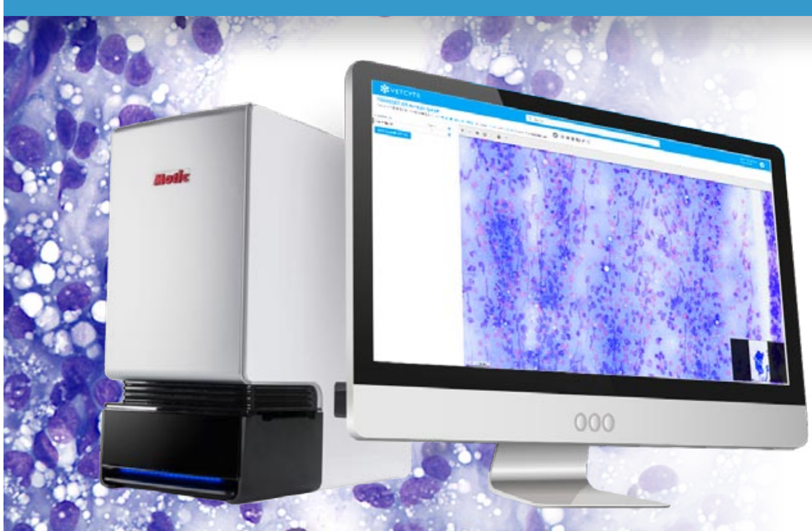

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"Think Global - Block Local!" - General concepts of Ultrasound-guided Regional Anesthesia

Diego A. Portela MV, PhD, Dipl. ACVAA
College of Veterinary Medicine
University of Florida, Gainesville, (FL), USA

Regional anesthesia (RA) has been used in veterinary medicine for many years, and in the last 10 years, the development of novel techniques involving objective methods to locate target nerves (i.e. nerve stimulation and ultrasound), has led to a resurgence of interest in this area. More than 100 veterinary studies have been published on this subject in the last five years alone (Campoy and Read, 2013; Lerche et al., 2016; Otero and Portela, 2018). In today's clinical veterinary practice, the use of epidural and peripheral RA is widespread, and most commonly employed for the treatment and prevention of acute perioperative pain (Wenger, 2004; Mosing et al., 2010; Campoy et al., 2012; Vettorato et al., 2012; Portela et al. 2014). However, the use of these techniques can also be applied to the management of several chronic pain conditions.

When local anesthetics are administered in relationship with peripheral nerves or plexuses, they selectively block the voltage-gated Na channel preventing axonal depolarization and thus the nerve transmission. The incorporation of regional anesthesia techniques to the analgesic plan in animals suffering from acute or chronic pain eliminates the need or reduces the amount of systemic drugs needed to control the pain, thus reducing the side effects associated with their use.

Regional anesthetic techniques are safe procedures, but severe complications can arise if not performed correctly. Knowledge of the pharmacology of the drugs used and of the anatomy of the blocked area is essential to reduce the risk of severe complications.

Patient management before the execution of a local block

Administration of regional anesthesia is a medical procedure with potential risks and complications, therefore the adequate management of a patient receiving a block is mandatory to try to reduce the complications associated with incorrect technique execution. Assessing the health status of an animal before performing a nerve block should be performed similarly to any pre-anesthetic evaluation and should include a physical examination, an evaluation of co-existing disease, and additional diagnostics as indicated on an individual case basis.

Most of the regional anesthesia techniques are performed with the animal sedated or under general anesthesia, therefore equipment and drugs that may be required to treat potential complications and adverse effects of the agents used should be readily available. Moreover, a trained person should be available to monitor the patient before, during, and after a block has been performed.

Patient management during the execution of a local block

Since most of the local anesthetic techniques are performed with animals heavily sedated or anesthetized, oxygen supplementation and monitoring of the cardiovascular and respiratory system are indicted. It is also essential to understand the nerve supply to the area intended to be blocked in order to perform the adequate technique for each patient. Proper aseptic technique through appropriate clipping, skin preparation and use of sterile materials should be observed when performing nerve blocks. Extravascular positioning of the tip of the needle should always be confirmed by the aspiration test prior to injecting a local anesthetic. High resistance (≥ 15 psi) or nociceptive reaction to injection could indicate that the needle tip is positioned intraneurally. If this occurs, the injection should be immediately discontinued and the needle repositioned. Patient monitoring should be continued after the block execution to promptly detect any signs of local anesthetic toxicity. If the block does not provide the expected analgesic effect, rescue analgesia should be administered to the patient.

Nerve localization techniques

Success and safety of RA depend on the accuracy of local anesthetic deposition in relationship with the target nerve, without damaging vital anatomical structures. Determining the exact location of a peripheral nerve represents one of the most significant challenges in regional anesthesia and for this reason several methods of nerve location have been developed.

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"Limiting Opioid Anesthesia" - Regional Anesthesia of the Abdominal Wall

Marta Romano DVM, MSc, PhD, Dipl. ACVAA
College of Veterinary Medicine
University of Florida

Contents

Multiple regional anesthesia techniques may be used to desensitize the abdomen, including neuraxial anesthesia, transversus abdominis plane (TAP) block, and quadratus lumborum block. The TAP block will be discussed in detail during this lecture.

Objectives

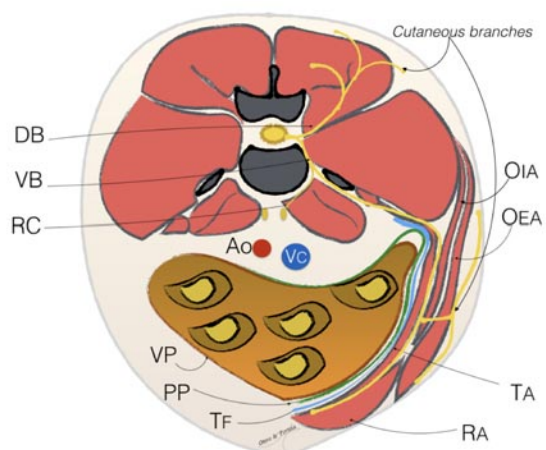
- Discuss the current evidence supporting the use of this technique
- Learn the relevant anatomy to perform the TAP block
- Become familiar with the ultrasound anatomy of the TAP
- Learn how the technique is performed
- Identify the possible complications and pitfalls of the TAP block and ways to avoid them

What's the evidence?

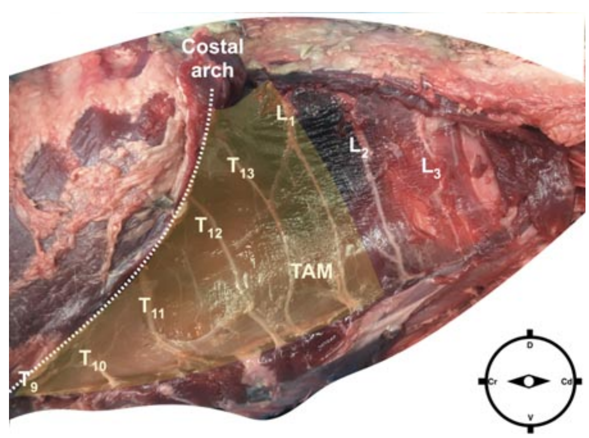
In humans, the TAP block is used to provide analgesia for a variety of abdominal surgery procedures (Børglum et al. 2011). Cadaveric studies in dogs describe multiple approaches for the TAP block (Schroeder et al. 2011, Drozdzynska et al. 2017, Zoff et al. 2017). Put together, the evidence suggests that the use of a subcostal TAP injection in combination with a lateral abdominal TAP injection is suitable to desensitize the entire abdominal wall and underlying parietal peritoneum. Clinical application of the TAP block in animals has been described for exploratory laparotomy (Schroeder et al. 2010), mastectomy (Portela et al. 2014) and ovariectomy (Skouropoulou et al. 2018). One recent study describes the use of TAP catheters to manage severe abdominal pain associated with pancreatitis and abdominal surgery (Freitag et al. 2018). Following a TAP injection of a long acting local anesthetic, such as bupivacaine, the analgesic effect is expected to last 24 to 36 hours (Skouropoulou et al. 2018, McDonnel et al. 2008).

Relevant anatomy

The abdominal wall is innervated by the ventral branches of T9-T13 and L1-L3 spinal nerves. The lateral aspect of the abdominal wall comprises of the external and internal oblique and the transversus abdominis muscle, while the ventral aspect of the abdominal wall comprises of the rectus abdominis and the transversus abdominis muscles. The nerves innervating the abdominal wall run between the transversus abdominis and the internal oblique muscles on the lateral aspect of the abdomen, and between the rectus and the transversus abdominis muscles on the ventral aspect of the abdomen. These fascial planes are therefore the target for TAP injections of local anesthetics.



Otero & Portela

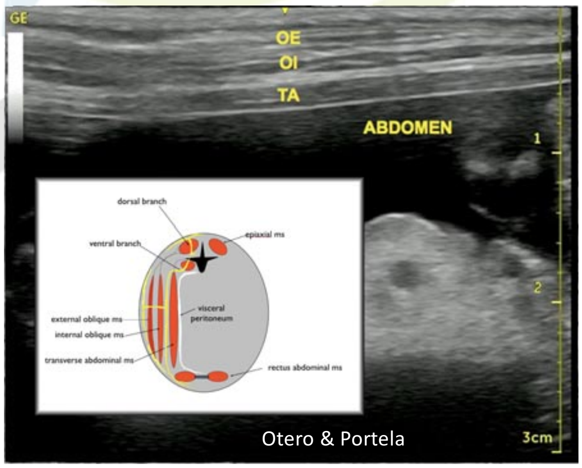


Ultrasound anatomy

The target nerves are not directly visualized with the ultrasound, but when a local anesthetic solution is injected in the TAP the nerves running within the plane will be soaked and desensitized. Therefore, the key to performing a successful TAP block is to correctly identify the target fascial plane. When performing a lateral TAP (i.e. a TAP injection performed on the lateral aspect of the abdomen), the parietal peritoneum is visible as a markedly hyperechoic line. Immediately superficial to the parietal peritoneum, lies the transversus abdominis muscle. The internal and external oblique muscles are located superficial to the transversus abdominal muscle. The fascial planes separating each muscular layer is visible as a slightly hyperechoic line. The needle should be inserted in plane and directed towards the target muscular layer under constant ultrasound visualization.

When performing a subcostal TAP (i.e. a TAP injection performed immediately caudal to the costal arch), the rectus abdominis muscle is visible immediately superficial to the transversus abdominis muscle. The injection target is the plane between those two muscles.

The injected local anesthetic is visible as a hyperechoic structure within the target fascial plane, and a net separation (hydrodissection) of the muscles forming the plane should be clearly visible after the injection.



Technique description
Position the ultrasound transducer with a parasagittal orientation caudal to the last rib, on the lateral aspect of the abdomen (lateral TAP) or immediately caudal to the costal arch (subcostal TAP). Insert the spinal needle in plane and, while constantly visualizing its tip, drive it to the target plane. After excluding the intravascular position of the tip of the needle, inject a small amount of solution to visualize hydrodissection of the muscles surrounding the target plane and confirm correct positioning of the TIP of the needle. If the injection is at target, inject the remaining calculated solution.

Necessary equipment

- Quincke spinal needle, (20 or 22 G, 3.5 inches for dogs larger than 8-10 kg; 22 G or 25 G 2.5 or 1.5 inches for cats or dogs smaller than 8-10 kg)
- Syringe containing local anesthetic
- Short T port
- High-frequency 50 mm linear transducer; 25 mm linear transducer for animals smaller than 5 kg
- Gloves
- Alcohol

This technique is best performed if one operator handles the ultrasound transducer and the needle and a second operator performs the injection. The needle should be connected to the T port and pre-filled with local anesthetic solution.

Local anesthetic and dose
This technique is typically performed using a long acting local anesthetic, such as bupivacaine. The author routinely uses 1 mL/ kg of 0.25 % bupivacaine divided in 4 points (two subcostal and two lateral) for both dogs and cats).

Potential complications

- Local anesthetic toxicity
- Intra-abdominal or organ puncture
- Intravascular injection of local anesthetic
- Intramuscular injection
- Difficult visualization of the target plane
- Tip of the needle larger than target fascial plane (very small patients)

Key points

- The TAP block is a safe and effective technique to provide analgesia for a variety of conditions associated with abdominal pain
- TAP blocks can only be performed under ultrasound guidance
- The use of adequate equipment and correct technique maximizes success while minimizing the occurrence of complications

References and Further Reading:

Børglum J, Maschmann C, Belhage B, Jensen K. Ultrasound‐guided bilateral dual transversus abdominis plane block: a new four‐point approach. *ACTA Anaesthesiol Scand* 2011; 55:658-663.

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Skouropoulou D, Lacitignola L, Centonze P, Simone A, Crovace AM, Staffieri F. Perioperative analgesic effects of an ultrasound-guided transversus abdominis plane block with a mixture of bupivacaine and lidocaine in cats undergoing ovariectomy. *Vet Anaesth Analg* 2018; 45:374-383.

Zoff A, Laborda-Vidal P, Mortier J, Amengual M, Rioja E. Comparison of the spread of two different volumes of contrast medium when performing ultrasound-guided transversus abdominis plane injection in dog cadavers. *Journ Sm An Pract* 2017; 58:269–275.

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"Put Me Back in Coach" - Regional Anesthesia of the Thoracic Wall & Trunk

Marta Romano DVM, MSc, PhD, Dipl. ACVAA
College of Veterinary Medicine
University of Florida

Contents

While multiple regional anesthesia techniques have been described to provide analgesia to the limbs in animals, only few published techniques focus on the trunk and thorax. In this lecture, we will explore a well-established regional anesthesia technique for the thoracic wall (intercostal nerve blocks) and a novel regional anesthesia technique for the trunk (erector spinae plane block).

Objectives

- Discuss the current evidence supporting the use of intercostal and erector spinae plane (ESP) blocks
- Learn the relevant surface and ultrasound anatomy to perform these techniques
- Learn how these techniques are performed
- Identify the possible complications and pitfalls associated with either technique

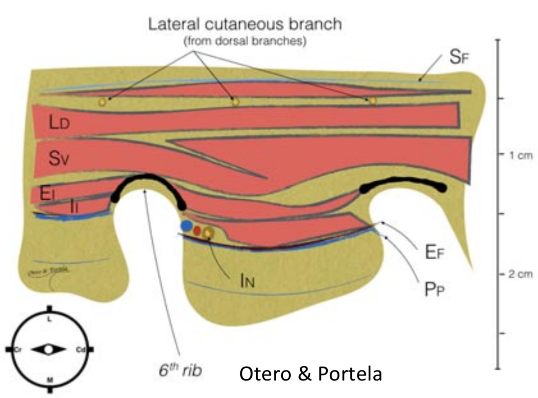
Intercostal Nerve Blocks

What's the evidence?

The intercostal nerve blocks may be performed blindly or under ultrasound guidance (Gulati et al. 2014), aiming to desensitize the ventrolateral aspect of the thoracic wall and parietal pleura, and can be used to provide analgesia for a variety of painful conditions and surgical procedures, such as sternotomy, lateral thoracotomy, mastectomy of the thoracic mammary glands, chest tube placement and pain management for rib fractures (Kirk et al. 1991). Ultrasound guidance has the potential to reduce the risk of complications including intrathoracic and pulmonary puncture.

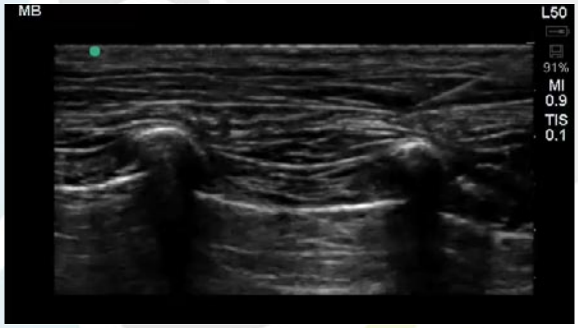
Relevant anatomy

Intercostal nerves run along the caudal aspect of the rib, superficial to the parietal pleura and deep to the intercostal muscles. The intercostal arteries and veins run alongside each intercostal nerve.



Ultrasound anatomy

Identify the target rib by positioning the transducer on the last rib and slowly moving the transducer cranially until the target intercostal space is identified. Identify the parietal pleura and the target injection point, which is located on the caudal aspect of the rib, immediately superficial to the parietal pleura.



Technique description
The needle should be connected to the T port and pre-filled with local anesthetic solution. A second operator should be in charge of performing the injection. The block should be performed on the proximal third of the rib. When the target intercostal space is identified, the needle should be introduced in plane. The tip of the needle should be visualized while moving it towards the target space, to avoid accidentally advancing it past the parietal pleura. Once the tip of the needle is in contact with the caudal aspect of the rib, it should be slowly positioned immediately superficial to the parietal pleura. After excluding intravascular positioning of the tip of the needle, inject the local anesthetic. Displacement of the parietal pleura as the injection is being performed is a sign that the injection was performed at target. Blocking the target intercostal nerve and the two intercostal nerves immediately cranial and caudal is recommended.

Necessary equipment
- Quincke spinal or Tuohy epidural needles (20 or 22 G, 3.5 inches for dogs larger than 8-10 kg; 22 G or 25 G 2.5 or 1.5 inches for cats or dogs smaller than 8-10 kg)
- Syringe containing local anesthetic
- Short T port
- High-frequency 50 mm linear transducer; 25 mm linear transducer for animals smaller than 5 kg
- Gloves
- Alcohol

Local anesthetic and dose
A dose of 0.03-0.05 mL/kg per intercostal nerve of either a long or short acting local anesthetic is recommended.

Potential complications

- Pneumothorax
- Intravascular injection of local anesthetics
- Local anesthetic toxicity

Key points
- Intercostal nerve blocks can be used to provide analgesia for a variety of procedures
- Ultrasound guidance and correct technique minimizes the risk of potential complications.

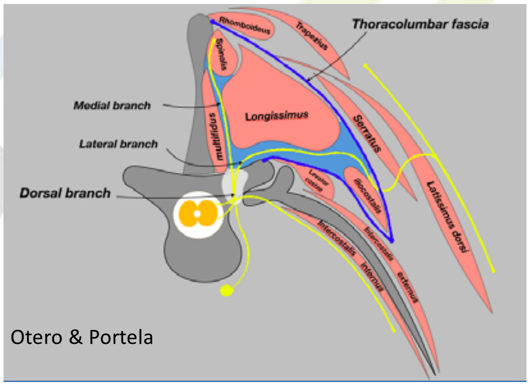
Erector Spinae Plane (ESP) Block

What's the evidence?

The erector spinae plane is a novel regional anesthesia technique consisting of the injection of local anesthetic in the fascial plane between the transverse process of the thoracolumbar vertebrae and the erector spinae muscular group (Kot et al. 2019). Limited studies are available at this time supporting the use of this technique (Ferreira et al. 2019). However, this technique is rapidly gaining popularity in clinical practice, and it is anecdotally effective to provide analgesia for a variety of painful conditions involving areas innervated by the dorsal branches of the spinal nerves, such as hemilaminectomies, vertebral fractures and facet joints osteoarthritis.

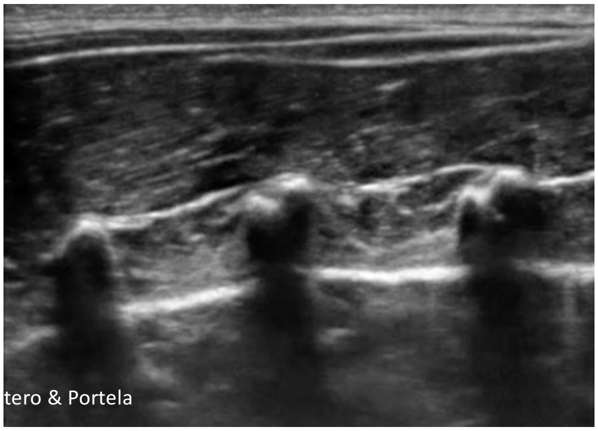
Relevant anatomy

The erector spinae muscular group comprises of the longissimus, spinalis and iliocostalis muscles and extends from the cervical region to the sacrum. The dorsal branches of the spinal nerves run in a plane between the erector spinae muscles and the transverse processes of the thoracolumbar vertebrae.



Ultrasound anatomy

The block should be performed one space cranial to the target space. The transverse process should be differentiated from the rib to ensure the injection is at target.



Technique description

The needle should be inserted in plane, cranial to the transducer, and its tip should be consistently visualized as it is advanced to the target plane. After confirming extravascular positioning of the tip of the needle, the calculated local anesthetic solution should be injected, and it can be observed distributing within the ESP.

Necessary equipment

- Quincke spinal or Tuohy epidural needles (20 or 22 G, 3.5 inches for dogs larger than 8-10 kg; 22 G or 25 G 2.5 or 1.5 inches for cats or dogs smaller than 8-10 kg)
- Syringe containing local anesthetic
- Short T port
- High-frequency 50 mm linear transducer; 25 mm linear transducer for animals smaller than 5 kg
- Gloves
- Alcohol

Local anesthetic and dose
0.4-0.5 m/kg of a long acting local anesthetic are recommended

Potential complications

- Local anesthetic toxicity
- Intravascular injection of local anesthetic
- Pneumothorax
- Retroperitoneal puncture

References and References:

Ferreira TH, St James M, Schroeder CA, et al. Description of an ultrasound-guided erector spinae plane block and the spread of dye in dog cadavers. *Vet Anaesth Analg* 2019; 46:516–522.

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Regional Anesthesia of the Thoracic Limb

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University of Florida, Gainesville, (FL), USA

Peripheral nerve blocks of the thoracic limb have been used for several years in veterinary medicine to provide perioperative analgesia and local anesthesia in several surgical condition of the forelimb. Nerves of the brachial plexus can be performed at different levels, from their intervertebral foramen to distal location in the brachium region. Peripheral nerve blocks of the thoracic limb are indicated to alleviate intra and postoperative pain during surgical procedures of the shoulder, brachium, antebrachium, carpus, metacarpus or phalanges. They can also be used as part of a multimodal analgesia approach in animals with chronic pain or undergoing palliative care.

To block these nerves, several methods have been published and they involve blind techniques, nerve stimulation and ultrasound guidance. Due to the complex anatomy of the brachial plexus and its branches, it is highly recommended to avoid using a blind techniques. Using ultrasound to have a direct visualization of the relevant anatomical structures can facilitate the execution of this technique and reduce the risks of complications. Detailed information regarding the currently available techniques to perform regional anesthesia of the forelimb can be found elsewhere (Portela et al. 2018).

Relevant anatomy of the thoracic limb

The thoracic limb receives its motor, sensory and autonomic innervation from the brachial plexus. This plexus is formed by the ventral branches of C6, C7, C8 and T1 spinal nerves, with a variable contribution from C5 and T2 (Fig. 1). Once these branches exit through their respective intervertebral foramina, they travel between the longus colli muscle and the scalenus muscle, wrapped by the prevertebral and deep fasciae of the neck. These nerves reach the axillary space where are grouped around the axillary artery and surrounded by the axillary fascia (continuation of the deep fascia of the neck). At this level, the nerves of the brachial plexus can be recognized as the subscapular, suprascapular, musculocutaneous (M), radial (R), ulnar (U) and median nerves (M). After leaving the axillary space, the RUMM nerves run in close proximity to the brachial artery, on the medial aspect of the proximal epiphysis of the humerus and caudal to the biceps brachii muscle.

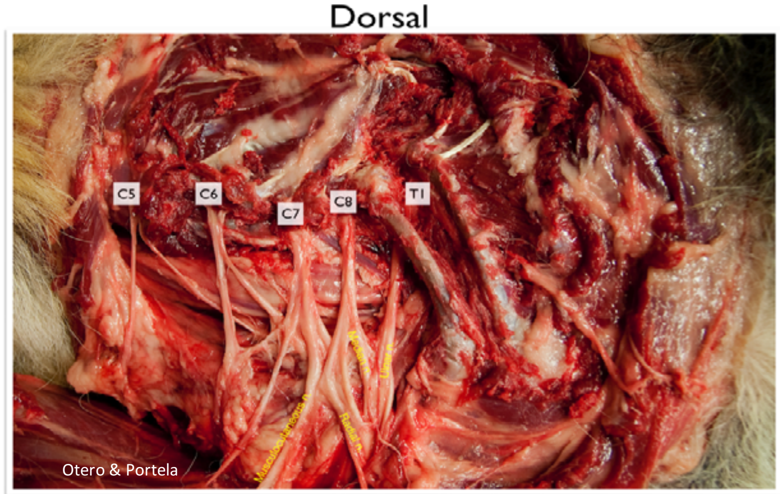

Figure 1: Anatomical dissection of the brachial plexus. The scapula and the scalenus muscles were removed to expose the brachial plexus. Copyright Otero & Portela.

Regional anesthesia for the proximal part of the thoracic limb (shoulder, humerus)

To achieve regional anesthesia of the proximal aspect of the thoracic limb, the nerves forming the brachial plexus have to be blocked before they reach the axillary space. These blocks are indicated for shoulder and humeral surgeries, and they also are suitable to be used in a multimodal analgesic strategy for forelimb amputations. Nerve roots forming the brachial plexus can be blocked using a paravertebral or a subscalene approach. Proximal nerve blocks of the thoracic limb are considered advanced techniques and they require skills and training in the use of ultrasound, regional anesthesia and patient monitoring. Proximal blocks are characterized by a large area of desensitization and significant motor blockade. Although complications associated with regional anesthesia have low incidence, a proximal nerve damage could have serious consequences, therefore it is highly recommended to perform these blocks using the appropriate technique and equipment, and to closely monitor the patient for potential complications. The use of ultrasound can help reducing complications by imaging other anatomical structures such as vessels and body cavities that should be avoided. The use of nerve stimulation in combination with ultrasound is recommended to improve the accuracy of nerve location. The scanned area and the injection site should always be clipped and surgically prepared.

Subscalene brachial plexus block: the ventral branches of spinal nerves of C6, C7, C8 and T1 run in the caudal aspect of the neck deeper to the scalene muscle and wrapped by the deep fascia of the neck and the prevertebral fascia. At this level, they can be seen by ultrasound aligned medially to the scalene muscle and cranially to the axillary artery and the first rib (Portela et al. 2018). To perform this block, the dog should be positioned in lateral recumbency with the limb to be block uppermost. A cushion or a rolled towel is positioned under the dependent shoulder to facilitate the procedure by allowing for caudal displacement of the limb and extension of the neck. The caudal cervical area is scanned by placing the probe parallel to the longitudinal-axis of the cervical spine, cranial to the first rib and above the costochondral joint. The insulated needle (7.5 – 10 cm) is advanced “in plane” cranio-caudally through the belly of the scalenus muscle and the deep fascia of the neck, aimed at the cranial aspect of C7 (Fig. 2). At this level, 0.1 mL of local anesthetic is injected. Subsequently, the needle is repositioned and placed caudally to C7 where additional 0.2 – 0.3 mL of local anesthetic is injected. It is recommended to use a long acting local anesthetic (bupivacaine, ropivacaine) at a concentration of 0.25 to 0.5%.

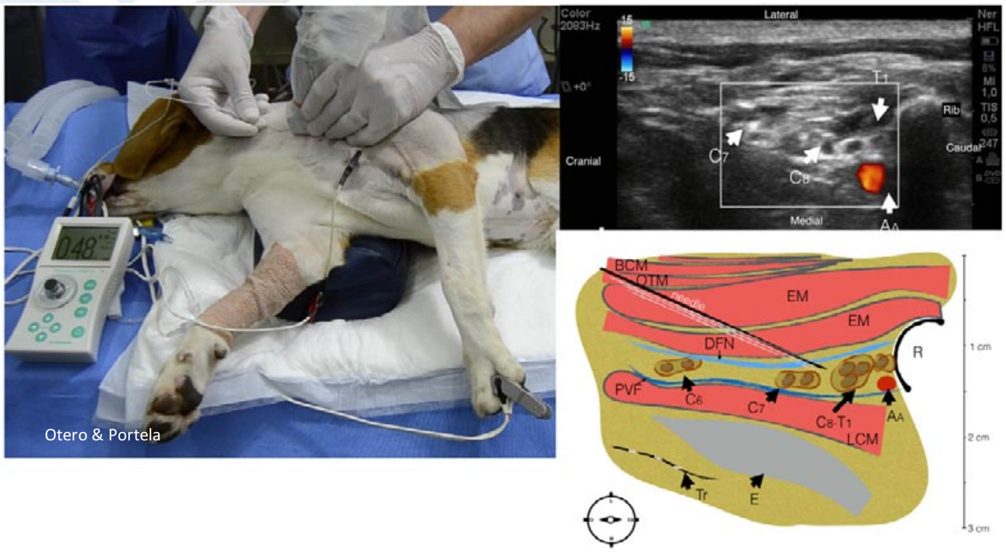

Figure 2: Ultrasound-guided subscalene brachial plexus block. AA: Axillary artery; EM: scalenus muscle; DFN: deep fascia of the neck; PVF: prevertebral fascia; R: first rib; E: esophagus; Tr: trachea. Copyright Otero & Portela.

The use of nerve stimulation allows to confirm the needle position by eliciting the motor response of the effector muscles. It is important to remember that this block is considered an advanced technique, and it requires a good anatomical knowledge and skills in ultrasound guided blocks. The needle should not be advanced further than the cranial border of the first rib to reduce the risk of pleural puncture. This block produces unilateral phrenic nerve paralysis, which is usually well tolerated in animals without respiratory compromise, however bilateral block is contraindicated because it will result in complete diaphragmatic paralysis. Also, spread of the local anesthetic can occur towards the laryngeal recurrent nerve resulting in laryngeal hemiparalysis with a potential increase in the risk of aspiration pneumonia.

Regional anesthesia for the distal part of the thoracic limb (elbow, radio/ulna, carpus)
The brachial plexus can also be blocked in the axillary space (Campoy et al. 2010), in the proximal (Tayari et al. 2019) or mid humeral area (Portela et al. 2013). Distal blocks of the brachial plexus aim at blocking the radial, ulnar, median and musculocutaneous nerves and are indicated for surgical procedures of the elbow, radius and ulna and carpus.

Proximal RUMM (radial, ulnar, median and musculocutaneous) nerve block: this technique has been recently introduced as an alternative to the classical axillary brachial plexus block (Tayari et al. 2019). In comparison to the axillary brachial plexus block, the proximal RUMM block does not produce phrenic nerve block, there is no risk of producing a pneumothorax and, the ultrasound images are very simple to obtain. The block is performed in the proximal epiphysis of the humerus on its medial aspect. The dog is positioned in lateral recumbency with the limb to be blocked lowermost. The elbow should be flexed with a 90º angle to allow visualization of the biceps brachii muscle. The linear transducer is placed perpendicular to the long axis of the limb, on the medial aspect of the arm at the level of the humeral proximal epiphysis close to the shoulder joint. The brachial artery and the biceps muscle are used as landmark for identification of the RUMM nerves. The musculocutaneous nerve can be visualized caudal to the biceps muscle and cranial to the brachial artery. The ulnar and median nerves are visualized between the brachial artery and vein. The radial nerve is visualized laterally (deeper) to the brachial artery. The same fascial layer generally wraps the radial, ulnar and median nerves. Introduce the insulated needle (5 – 7.5 cm) cranio-caudally "in plane" through the belly of the biceps muscle until the its tip is in relationship with the musculocutaneous nerve and inject 0.1 mL/kg of local anesthetic at this level (Fig. 3). The electrical nerve stimulation of this nerve will evoke contractions of the biceps muscle. After that, the needle should be repositioned, and directed towards the radial nerve where another 0.2 mL of local anesthetic is injected. It is important to confirm that the tip of the needle pierce the axillary fascia to obtain a homogeneous distribution of local anesthetic involving the radial, ulnar and musculocutaneous nerves. Electrical nerve stimulation of the radial nerve will result in triceps contractions.

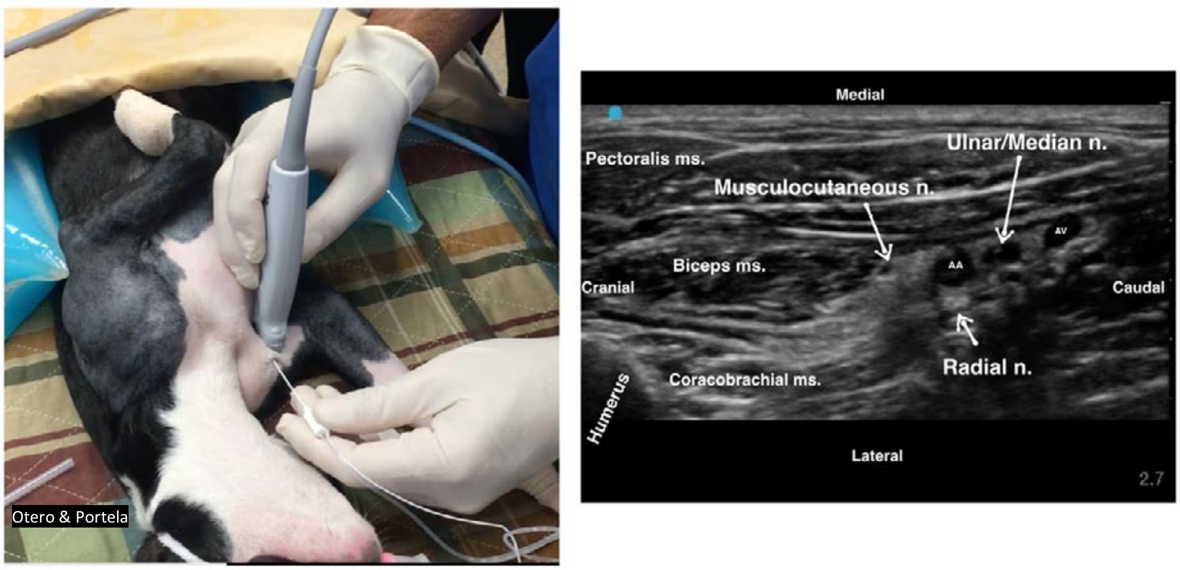

Figure 3: Ultrasound-guided proximal RUMM block.

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Regional Anesthesia of the Pelvic Limb

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Peripheral nerve blocks of the pelvic limb have gained considerable acceptance in veterinary medicine, and they are frequently used as an alternative to epidural anesthesia (Bartel et al. 2016). Detailed information regarding the currently available techniques to perform regional anesthesia of the pelvic limb can be found in the review articles published by Gurney and Leece (2014) and Portela et al. (2018).

The majority of the pelvic limb innervation is supplied by the femoral and the sciatic nerve. These nerves can be approached and blocked at different levels, from their emergence at the intervertebral foramen to their distal branches in the thigh region. As with any other regional anesthesia technique, the familiarity with the neuroanatomy of the nerves, the motor and sensory supply of the different areas of the limb is essential to perform successful and safe nerve blocks.

Relevant anatomy of the pelvic limb

The pelvic limb receives its motor, sensory and autonomic innervation from the lumbosacral plexus. This plexus is formed by the ventral branches of L4, L5, L6, L7, and S1 spinal nerves, with a variable contribution from L3 and S2 (Fig. 1). The lumbosacral plexus can also be classified as two separates plexuses: the lumbar and the sacral plexuses. The lumbar plexus (L4-L7) provides the roots for the lateral femoral cutaneous nerve, genitofemoral nerve, femoral/saphenous nerve and obturator nerve. The sacral plexus is formed by the lumbosacral trunk (L6 and L7) and S1, and provides the roots that originate the sciatic nerve, the cranial and caudal gluteal nerve and caudal cutaneous femoral nerve.

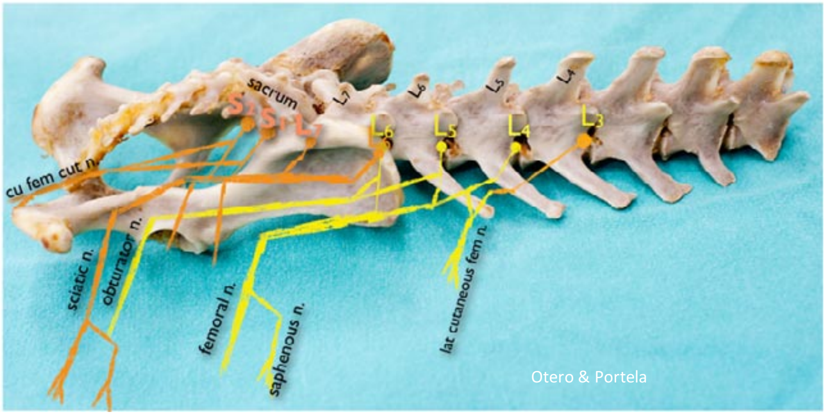

Figure 1: Representation of the lumbosacral plexus and its main nerves. Copyright Otero & Portela.

Regional anesthesia for the proximal part of the pelvic limb (hip, femur)

To achieve regional anesthesia of the proximal aspect of the pelvic limb using a peripheral nerve block, the lumbar and sacral plexuses need to be blocked. These blocks are valid alternatives to neuraxial blockades, having the advantage of sparing the contralateral limb. Peripheral nerve blocks of the proximal aspect of the pelvic limb are considered advanced technique and they require a good level of training in the execution of ultrasound guided techniques and patient monitoring.

Proximal blocks are characterized by a large area of desensitization and significant motor blockade. Although complications associated with regional anesthesia have low incidence, a proximal nerve damage could have serious consequences, therefore it is highly recommended to perform these blocks using the appropriate technique and equipment, and to perform a close patient monitoring. The use of ultrasound can help reducing complications by imaging other anatomical structures such as vessels and body cavities that should be avoided. The use of nerve stimulation in combination with ultrasound is recommended to improve the accuracy of nerve location. The scanned area and the injection site should always be clipped and surgically prepared.

Lumbar plexus block (psoas compartment block): the spinal nerves of L4, L5 and L6s run together into the psoas muscle to form the main components of the plexus (femoral and obturator nerve). To perform this block, the dog is poisoned in lateral recumbency with the limb to be block uppermost, abducted and extended caudally. The lumbar plexus is visualized positioning the linear transducer perpendicular (or slightly oblique) to the long-axis of the spine on the ventral aspect of the sublumbar muscles at the level of L7 (Tayari et al. 2017). The femoral nerve can be seen inside the belly of the psoas muscle, as a circular hyperechoic rim with a hypoechoic center (Fig. 2). The external iliac artery is an important landmark located in the ventromedial quadrant of the screen and it can help to locate the femoral nerve. An insulated needle (5-10 cm) is introduced "in plane" from the lateral aspect of the sublumbar muscles until its tip is close to the femoral nerve. Nerve stimulation with 0.5mA should produce a contraction of the quadriceps muscle. It is recommended to use a long acting local anesthetic (bupivacaine, ropivacaine) 0.25 to 0.5% at 0.15 to 0.2 mL/kg. This block is usually combined with a parasacral sciatic nerve block to achieve local anesthesia of the proximal aspect of the pelvic limb.

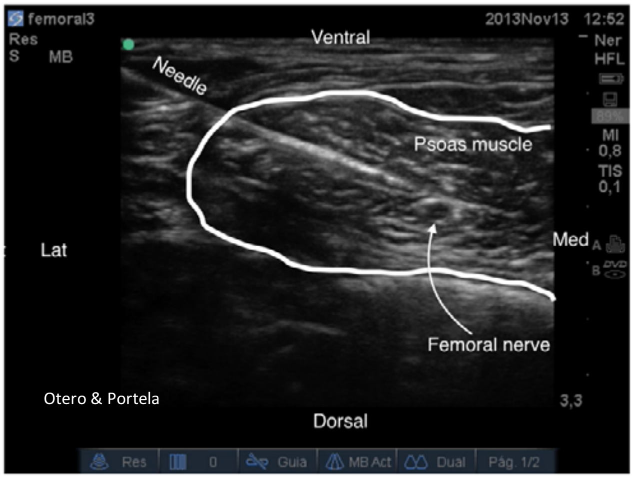

Figure 2: Ultrasound guided lumbar plexus block/femoral nerve (psoas compartment). Copyright Otero & Portela.

Parasacral lumbosacral trunk (sciatic nerve) block: this technique aims at blocking the origin of the sciatic nerve before it crosses the greater ischiatic notch, and it is used in combination with a psoas compartment block to provide anesthesia and analgesia to the proximal aspect of the pelvic limb including the hip. To perform this block, the dog is poisoned in lateral recumbency with the limb to be block uppermost and resting in neutral position. The lumbosacral trunk is located medially to the ilium and laterally to the gluteal vessels, ventrally to the superficial and medium gluteal muscles. For this technique a linear transducer is generally used, however in some dogs with large gluteal muscles a microconvex transducer may facilitate the execution of the block. The probe is positioned perpendicular or slightly oblique to the long-axis of the ilium over its greater ischiatic notch, adjusting the scan area until the gluteal vessels and the lumbosacral trunk are visualized (Portela et al. 2018; Marolf et al. 2019). Introduce the insulated needle "in-plane through" the gluteal muscles from medial-caudal to lateral-cranial, until the tip of the needle in in close relationship with the lumbosacral trunk (Fig. 3). Nerve stimulation with 0.5mA should result in dorsi flexion or extension of the tarsus. It is recommended to use a long acting local anesthetic (bupivacaine, ropivacaine) 0.25 to 0.5% at 0.15 to 0.2 mL/kg.

Figure 3: Ultrasound-guided lumbosacral trunk (LST)/sciatic nerve block. AGCd: caudal gluteal artery. Copyright Otero & Portela.

Regional anesthesia for the distal part of the pelvic limb (knee, tibia, tarsus)
To alleviate painful conditions of the knee or distally to it, the saphenous nerve (sensory terminal branch of the femoral nerve) and the sciatic nerve can be blocked. These blocks are also a valid alternative to neuraxial blocks and they produce a reduced area of desensitization compared to the proximal nerve blocks. These techniques are simpler to perform compared to the proximal blocks, however the use of the adequate equipment, the good knowledge of the anatomy and confidence with basic ultrasound guided techniques is highly recommended to reduce the chances of complications.

Saphenous nerve block: this technique aims at blocking only the saphenous nerve, which is the sensory component of the femoral nerve; therefore it results only in sensory block without affecting the motor function of the quadriceps muscle (Costa-Ferré 2011; Portela et al. 2018). To achieve a complete local anesthesia of the stifle, this block is combined with a sciatic nerve block. To perform this block, the dog is poisoned in lateral recumbency with the limb to be block uppermost, abducted and extended caudally. The linear transducer is positioned in the medial aspect of the middle third of the thigh to visualize the femoral artery. The saphenous nerve runs cranial to the femoral artery covered by the iliac fascia (Fig. 4). The insulated needle (5 - 7.5 cm) is introduce through the quadriceps muscle and directed towards the cranial aspect of the femoral artery using an "in-plane" approach. Particular attention should be payed to avoid piercing the femoral artery. Since this is a pure sensory nerve, the nerve stimulation is not used as a double confirmation of nerve location. It is recommended to use a long acting local anesthetic (bupivacaine, ropivacaine) 0.25 to 0.5% at 0.1 to 0.15 mL/kg.

Figure 4: Ultrasound-guided saphenous nerve (SN) block. FA: femoral artery, FV: femoral vein; P: pectinium muscle. Copyright Otero & Portela.

Sciatic nerve block (caudal approach): this block aims at blocking the sciatic nerve once it is located in the proximal and lateral aspect of the thigh, distally to the greater trochanter of the femur (Campoy et al. 2010;

Portela et al. 2018). This block will result in motor blockade of the muscle controlling the foot positioning, therefore the animal can have an absent proprioception for the duration of the motor blockade. To perform this block, the dog is poisoned in lateral recumbency with the limb to be block uppermost and resting in neutral position. The linear transducer is positioned over the lateral aspect of the proximal thigh, distally to the greater trochanter and perpendicular to the long-axis of the femur. The sciatic nerve can be visualized as a double rounded (tibial and peroneal nerves) hypogenic structure with a hyperechoic rim, located medially to the biceps femoris, laterally to the abductor muscle and cranially to the semimembranosus and semitendinosus muscles. The insulated needle (5 – 7.5 cm) is introduced in plane from the caudal aspect of the thigh and directed towards the sciatic nerve until its tip is in proximity to the nerve (Fig. 5). Nerve stimulation with 0.5mA should result in dorsi flexion or extension of the tarsus. It is recommended to use a long acting local anesthetic (bupivacaine, ropivacaine) 0.25 to 0.5% at 0.05 to 0.1 mL/kg.

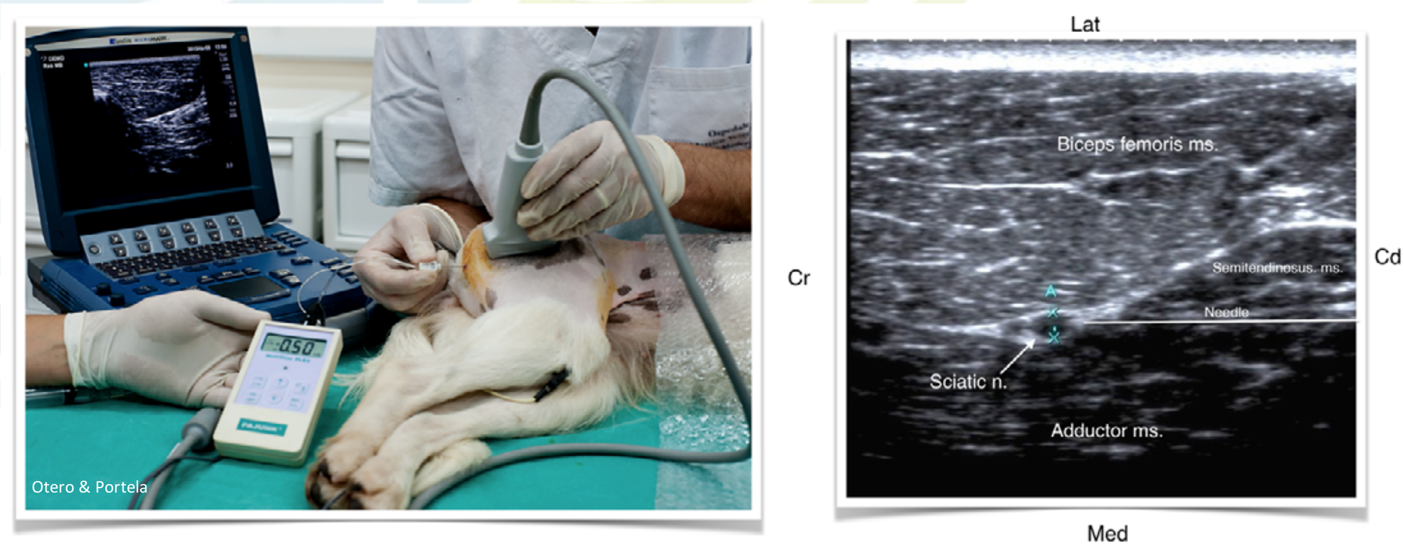

Figure 5: Ultrasound-guided sciatic nerve block. Copyright Otero & Portela.

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Ultrasound-Guided Procedures and Interventions

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Diagnostic ultrasound is a qualitative and quantitative standard of care test in veterinary patients. It is an integral tool in day-to-day case management. Numerous ultrasound-guided procedures are essential to therapeutic interventions and diagnostic testing for many presented veterinary emergency patients. Ultrasound-guided fine needle percutaneous peritoneal, pericardial and thoracentesis are generally safe, minimally invasive, quickly performed and relatively inexpensive with minimal risk of complication and great benefit while providing invaluable information in defining disease severity.

Percutaneous ultrasound-assisted fine needle aspiration (FNA) of subcutaneous mass lesion and arthrocentesis can allude to underlying disseminated and autoimmune systemic illness, respectively, and can directly and indirectly determine the cause of bi- or tri-cavitary effusion. As an example, it is necessary to remove the majority of the pleural effusion prior to performing thoracic radiography and computed tomography (CT) studies so as not to erroneously miss pulmonary metastatic neoplasia or other pathology. In the critical patient many ultrasound-guided techniques can be performed in the awake, lightly sedated or regionally-blocked patient. With practice, these techniques can be a frequently used tool to compliment the emergency patient evaluation and guide further therapeutics and diagnostic tests.

To the imaging critical care and internal medicine specialists, ultrasound-guided centeses, fine needle aspiration (FNA) and biopsy are used daily to drive appropriate care and are often used in combination with other modalities (radiography, computed tomography [CT] and magnetic resonance imagining [MRI]).

Indications

Ultrasound-guided diagnostic fluid and tissue sampling and therapeutic interventions are easily performed in patients with sonographically confirmed effusions (pericardial, peritoneal and pleural). Ultrasound-guided procedures should be considered if there is a moderate index of suspicion for effusion, or in any patient with respiratory distress, trauma (suspected pneumothorax or hemoperitoneum), muffled heart sounds or a fluid wave or thrill upon abdominal ballottement. These procedures can aid in stabilizing the critically compromised patient through resolving cardiac tamponade or severe pleural effusion induced atelectasis. Pleuro- and peritoneocentesis with ultrasound-guidance and can provide a great deal of respiratory comfort by improving pulmonary and diaphragmatic (respiratory) excursion by relieving pleural and/or peritoneal pressure while avoiding important vascular structures or vascularized pathology.

Percutaneous organ or tissue sampling is often reserved for the specialist and may include trans-bronchial sampling of pulmonary lesions, and fine needle aspiration (FNA) of various lymph nodes, glands, organs and mass lesions (pericardial, liver, splenic or vesicular mass lesions). These will be reviewed. In cases of subcutaneous or periorbital mass lesions, ultrasound-guided fine needle aspiration (FNA) can allude to the etiology of coexisting metastatic pulmonary or intraperitoneal lesions and can evaluate the regional extent of invasion for a given mass.

Ultrasound-assisted arthrocentesis can often be of value in cases where blind techniques result in little to no yield. In cases presenting with primary or metastatic bone tumors, ultrasound-guided fine needle aspiration (FNA) of the lesion via a disrupted region of cortex has the potential to be as diagnostic as bone biopsy. The diagnostic yield of a given sample is variable and greatly dependent on the organ sampled and the type pf disease present.

Probes and equipment and best practices

Variable frequency transducers are used for ultrasonographic procedures and interventions. As a general rule of thumb, a 3-5 MHz transducer is used for larger patients (>50 lbs.), a 5-7.5 MHz (25-50 lbs.) for medium-sized and a 7.5-12 MHz (<25 lbs) for smaller sized dogs and cats. A small to medium footprint is preferred; but a larger footprint can also be used. A baseline normal cine clip of the structure should be obtained immediately prior to any interventions. AFAST, TFAST and Vet BLUE examinations can precede the intervention.

The needle gauge size will depend on the fluid character (i.e. serous versus exudative) and tissue or lesion being sampled. For most procedures, a 22-gauge, 1-1.5” hypodermic needle attached to a 3-5 mL syringe is sufficient. There are some instances in which a larger (or smaller) gauge needles, larger syringes or syringe set-ups are indicated (e.g. 18-14 gauge for pericardiocentesis with extension and 3-way stop cock). These will be reviewed and discussed in detail. In procedures requiring larger gauge needle interventions, a hematocrit should be obtained prior to the intervention. A follow up hematocrit may then be obtained at the 1-, 6- and/or 12-hour post-procedural time points, especially if follow up scanning reveals hemorrhagic complication. Though, this is infrequently necessary you will learn how to recognize this complication.

For visceral and intracavitary interventions, a cine clip may be obtained during the procedure, but is not necessary. In my own practice, (other than for minor centeses) we obtain a cine clip 10-15 minutes following the ultrasound-guided procedure in the region where the procedure occurred. If the procedure was peritoneal, we will perform a brief AFAST examination with particular focus on the costophrenic recesses, dependent portion of the patient and cranial to the urinary bladder. This brief and worthy step screens for and documents the lack of associated complication (i.e. hemorrhage, pneumothorax, etc.).

If a complication of hemorrhage or pneumothorax associated with a fine-needle aspiration or biopsy is going to occur, it is the author's experience that such will occur within the first 15-minutes following the procedure. This is an easy enough time period during which FAST scanning can be used to closely monitor the patient. A cage-side TFAST or AFAST scan can quickly evaluate the most gravity-dependent regions (to evaluate for free fluid, i.e. hemorrhage) or non-gravity-dependent regions (to evaluate for free air, i.e. pneumothorax) easily for evidence of peri-procedural complication.

Patients are positioned variably for ideal access to the cavity, organ or lesion of interest. B-mode scanning and radiographs often precede a given ultrasound-guided intervention. Ideally, unless the patient is positive upon screening for cardiac tamponade, or the patient is in respiratory distress, a baseline platelet count is obtained.

Although the risk of complication is low, it's important to understand the hemodynamic and coagulation status of the patient going into any interventional procedure. There is an increased risk of peri-procedural hemorrhage in patients with suspected or known coagulopathy (petechiae, ecchymoses, or prolonged BMBT, PT/aPTT), decreased manual platelet count (<50,000), and those with recent NSAID therapy. These factors should be assessed on a case-to-case basis and if thrombocytopenia or coagulopathy are present, the procedure should briefly be postponed, or the risk of complication should be justified while attempts to mitigate complications (i.e. vitamin K supplementation, transfusion products) can be arranged.

The region of interest is clipped of hair and prepared aseptically. The focal zone is adjusted. For small parts, a shallow focal zone and variable gain settings are used throughout the procedure. Depth should be adjusted dynamically so that the organ or tissue of interest fills the screen in the near field while at the same time that organs to be avoided are easily visible in the far field. A high gain setting (>100 decibels) will obscure the needle. Thus, begin the needle-localizing scan with a medium to low gain setting (40-70 decibels) and adjust.

Detection of the needle by the sonographer is highly dependent on sonographer skill, requiring complex hand-eye coordination, spatial awareness and considerations for the density of the tissue being sampled. The more anechoic or hypoechoic the fluid or structure, the easier it is to detect the needle. There are various types of enhanced needles that are made specifically to increase detection by the sonographer. These typically have an irregular metal needle surface, which will increase the reflectivity of the needle. Placing the needle perpendicular the probe and its ultrasound beam can greatly increase detection of the needle especially in anechoic, superficial fluids. Deeper structures may present a greater challenge to orient the needle in perpendicular fashion to the beam. Generally, tissue sampling of deeper structures is reserved for the specialist.

Challenges

For the novice, skill acquisition and maintenance of hand-eye coordination while holding the ultrasound probe steady, ultrasound technical savvy, and sound general anatomic knowledge are the greatest hurdles in the learning curve and each required for successful ultrasound-guided procedures. Based on personal experience with resident trainees, there is a medium learning curve that is easily overcome with practice. A commonly encountered challenge is scanning with the dominant hand while maneuvering the needle and sampling with the undominant hand. Practice with phantoms and cadavers can easily overcome this challenge.

Limitations

In the emergency setting, the greatest benefit and reward of ultrasound-guided procedures is stabilizing a critically compromised patient and making a specific plan moving forward for that patient. Patient stabilization can often be achieved with ultrasound-guided fine needle centesis of the pericardial sac, or pleural or peritoneal spaces. Fine needle aspiration can be limited in its diagnostic capability depending on the disease state present and yield of the specific tissue or lesion type undergoing the procedure. For example, hemodilution (hemo-contamination) can artifactually alter the results of any sample; or the "shed" of cells may be low for a given fluid effusion, lesion type or organ such that the sample is deemed non-diagnostic. The presence of gas within normal lung (or abnormally within the pleural space) can pose a challenge in the detection (and for the radiologist, the accessibility) of pulmonary lesions.

Contraindications

Ultrasound-guided interventional procedures should be avoided in unstable coagulopathic or severely thrombocytopenic patients. Basic ultrasonography physics knowledge is essential to understanding spatial relationships between the needle, fluid or tissue in question and the probe. Confidence in performing blind pleural, pericardial and peritoneal centesis is essential before trying to juggle both probe and patient. A basic skill set may be acquired with practice in cadaveric specimens and with supervision by an experienced mentor in advance of attempting such procedures in the critically unstable patient. In patients with pyometra, unless there is already an index of suspicion for septic peritonitis, we generally recommend avoiding ultrasound-guided abdominal procedures to avoid inadvertent uterine puncture and peritonitis (including cystocentesis).

Summary

There are many circumstances in which the general practitioner, emergency veterinarian, and non-radiologist clinical specialist can use ultrasound-guided procedures for patient stabilization and lesion sampling. Supervision by an experienced mentor can greatly aid in facilitating familiarity and confidence with these specific techniques.

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"Don't Get Fooled" - The Accurate TFAST® Diagnosis of Pericardial & Pleural Effusion

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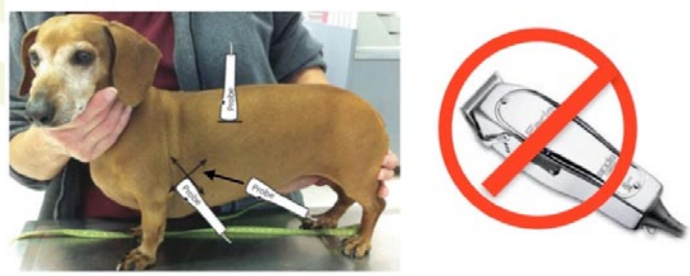
Knowledge of the TFAST® protocol, its views and their strengths including the TFAST® echo views are imperative for understanding how to accurately sonographically diagnose pleural and pericardial effusion. *This skill should not be underestimated because the only major structure in the thorax to be mistaken for free fluid (pleural and pericardial) is your patient's heart, which is an unforgiving organ on which to mistakenly perform centesis.*

The TFAST® Examination



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Strengths and Weaknesses of the TFAST® Views

Air rises and fluid falls into gravity-dependent pouches. The bilaterally-applied Chest Tube Site (CTS) view is best used to rule out pneumothorax (PTX) because air rises to least-gravity dependent regions. The CTS view also surveys for lung pathology, however, Vet BLUE is much more comprehensive surveying 24-intercostal spaces. The CTS view is considered the highest reasonable point over the pleural cavity where the cap of air would rise in the event that PTX (free air in the pleural cavity) was present and is position dependent being in different locations between lateral and standing/sternal recumbency. Thus, if lung is observed in direct opposition to the thoracic wall at the CTS view, then PTX is ruled out. In the event that PTX is suspected, then search for the “Lung Point" to determine the degree of PTX (Lisciandro 2011).

The bilaterally-applied PeriCardial Site (PCS) views are best used to screen for the presence of pleural or pericardial fluid being most gravity-dependent (fluid falls into gravity-dependent pouches) along with the Diaphragmatico-Hepatic (DH) View. The right PCS View is used for the TFAST® Echo Views that evaluate for the following: 1) volume status and contractility (fractional shortening, FS%) via the left ventricular short-axis "mushroom" view (LVSA) and 2) the “quick peek” short-axis left atrial to aortic ratio (LA:Ao) to screen for left-sided heart strain/failure/overload, and 3) the long-axis 4-chamber view for right-sided heart strain/failure/overload, (RV:LV); and the long-axis 4-chamber view with the left ventricular outflow tract (LVOT) for abnormalities within the LVOT and the aorta.

However, "Global FAST® Non-echo Fallback Views" may be used in place of the TFAST® Echo Views when the patient won't allow or restraint for echo views is too risky. The Vet BLUE® (lung) is used for left-sided *congestive* heart failure (L-CHF); and the FAST Diaphragmatico-Hepatic (DH) View (characterization of the caudal vena cava) is used for right-sided congestive heart failure (R-CHF). The AFAST®-TFAST® Diaphragmatico-Hepatic (DH) View is likely superior in most respiratory-distressed and hemodynamically-fragile patients for the detection of pericardial effusion over transthoracic TFAST®

views because of the acoustic window provided by the liver and gallbladder *with advantageously far less air interference* from the lung at the TFAST® PCS views (Lisciandro 2016). Moreover, the DH View generally is better tolerated requiring minimal patient restraint (Lisciandro 2016). Pleural effusion may likewise be detected via the DH View, however, because of its location(s) being more variable, the DH View may not be used as a sole view as with pericardial effusion.

The TFAST® Echo Views and Global FAST® Non-echo Fallback View Strategies

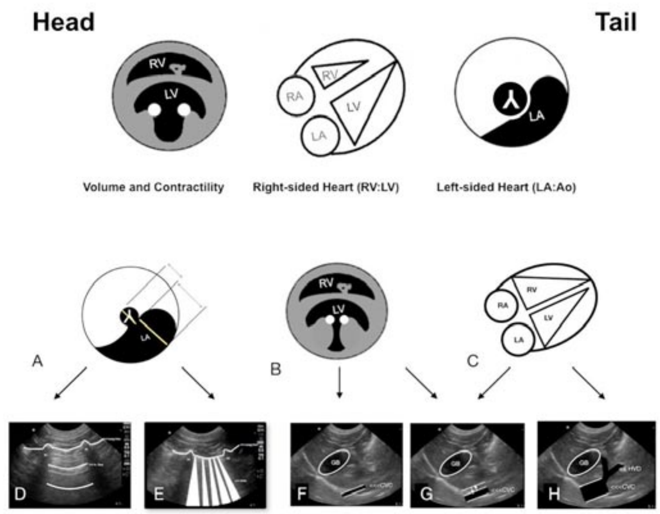

Figure. Note the imaging has head to the left and tail to the right referred to by the author as the "rogue but right orientation" - see TFAST® Echo Charts. The so called left ventricular short-axis (LVSA) "mushroom" view is shown in A) assesses for volume and contractility (fractional shortening, FS%) along with the "Global FAST® Non-echo Fallback Views." One of the "Global FAST® Non-echo Fallback Views" consists of the FAST Diaphragmatico-Hepatic (DH) View for characterization of the caudal vena cava and hepatic veins for the presence or absence of poor volume (flat CVC) or volume overload (FAT CVC and distended hepatic veins, Tree Trunk Sign). The long-axis 4-chamber view (LA4C) is used for right-sided strain/failure/overload by evaluating the right ventricular (RV) to left ventricular (LV) ratio (RV:LV) along with the FAST Diaphragmatico-Hepatic (DH) View for characterization of the caudal vena cava and hepatic veins for the presence or absence the FAST Diaphragmatico-Hepatic (DH) View for characterization of the caudal vena cava and hepatic veins for the presence or absence of right-sided *congestive* heart failure (FAT CVC and distended hepatic veins, Tree Trunk Sign). The short-axis left atrial (LA) to aortic (Ao) ratio (LA:Ao) is used for the presence or absence of left-sided strain/failure/overload along with the other "Global FAST® Non-echo Fallback View" of Vet BLUE® for the presence or absence of left-sided *congestive* heart failure. The "Global FAST® Non-echo Fallback View" are especially clinically helpful when it's too risky for the restraint, transport and time needed for either echocardiography or thoracic radiography. Moreover, Vet BLUE® has been shown to be an effective in *ruling in* and *ruling out* right- and left- sided *congestive* heart failure (CHF) (Lisciandro et al. JVECC 2016; Ward et al. JAVMA 2017). In other words, if the lungs are dry (absent B-lines all Vet BLUE® views) then L-CHF is unlikely with high sensitivity in both cats and dogs (~96%) (Lisciandro et al. JVECC 2016). Similarly, if the caudal vena cava has an expected "bounce" without its distension (FAT) or hepatic venous distension (Tree Trunk Sign), then right-sided *congestive* heart failure is unlikely. The left ventricular outflow tract may be viewed at the long-axis 4-chamber view - not shown. *Image provided by Dr. Gregory Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC, FASTVet.com and Hill Country Veterinary Specialists Copyright 2018, 2019.*

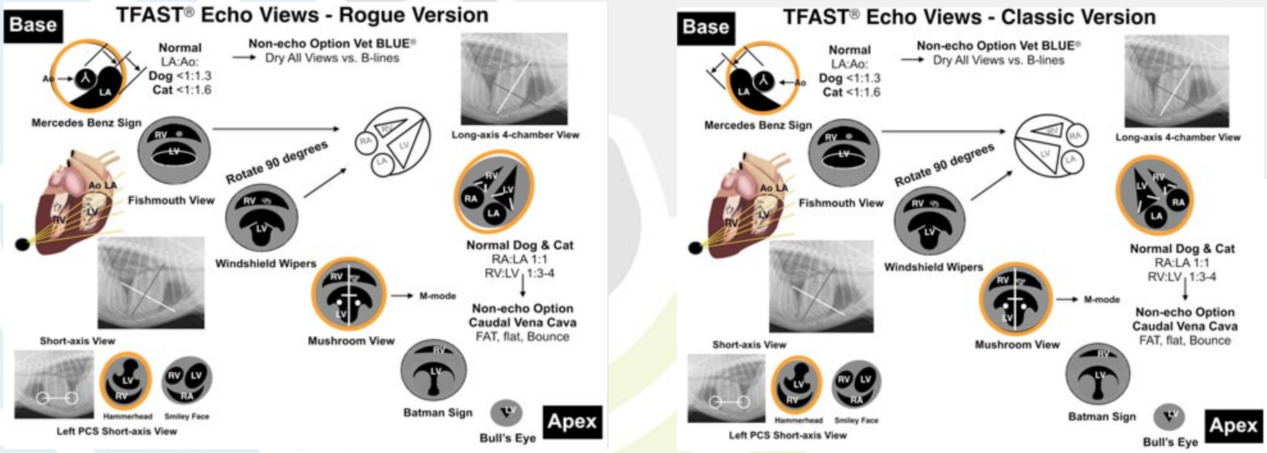

Figure. The TFAST® Echo Chart Rogue Version (head to the left of the screen as all other ultrasound is performed) and the Classic Version (head to the right of the screen as oddly the cardiologist have traditionally reversed the imaging) provide a means to learn what level of the heart you are imaging. The names for each level serve to better communicate and direct the probe to the level you want to get to for the cardiac information needed. The major views are circled in orange. Importantly, volume status at the "Batman" level will be mistaken for poor volume when in fact the sonographer is imaging at the incorrect level. Names for the short-axis levels along the "TFAST® Cardiac Ladder" have been created and are listed from the apex to the base as the Bull's Eye, Batman, Mushroom, Windshield Wipers, Fishmouth, and Mercedes Benz short-axis levels. The normal ratios, the "Global FAST® Non-echo Fallback Views", and when to rotate the probe for the long-axis views are also shown on our TFAST® Echo Charts. The "short-axis" and "long-axis" imaging lines are superimposed on a lateral radiograph. A clock face concept works well - direct the probe to 4 o'clock for short-axis and 1 o'clock for long-axis. At the left TFAST® Pericardial Site view the short-axis view has its unique "Hammerhead" and "Smiley Face" views that appear completely different than from the right TFAST® PCS view. *Image provided by Dr. Gregory Lisciandro, DVM, Dipl. ABVP, Dip. ACVECC, FASTVet.com and Hill Country Veterinary Specialists Copyright 2018, 2019.*

The TFAST® Diagnosis of Pericardial versus Pleural Effusion

When performing the TFAST® left and right PeriCardial Site (PCS) Views make it a habit to have enough depth to see the heart globally or in other words always imaging the heart in its entirety. You landmark is the hyperechoic (bright white) pericardium in the far-field. The sonographer should be aware that too shallow of depth easily leads to the possibility of mistaking heart chambers for pleural and/or pericardial effusion especially in distressed patients that provide only quick glimpses or flashes of the heart (short-lived acoustic windows) due to air interference from lung. The concept is illustrated in the images below.

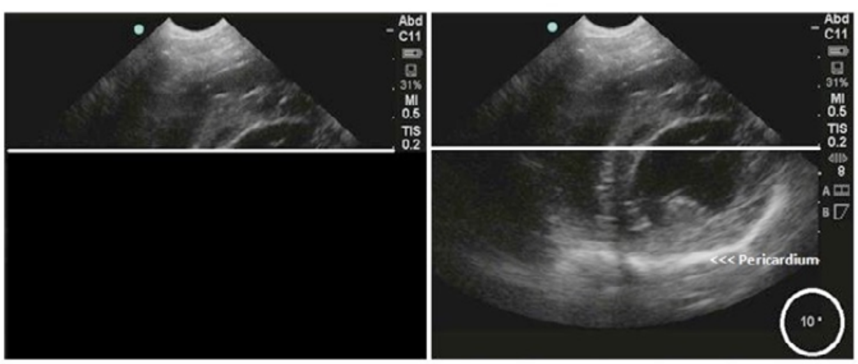

Figure. Serious Pitfall of Not Imaging the Heart in Its Entirety. Shows how having *too shallow depth* can lead to serious mistakes. To the left the image shows how it's difficult to tell if the near field is free fluid or a heart chamber (right ventricle). The right ventricle is crescent-shaped and in haste or in limited acoustic windows due to air interference can be mistaken for pleural or pericardial effusion and its papillary muscles for pathology (see the next figure). Similar mistakes may be made in long-axis or other orientations as well. For best practice, always insist on viewing the heart *in its entirety* using the hyperechoic (bright white) line of the pericardium in the far-field as your habitual landmark. *This material is reproduced with permission of*

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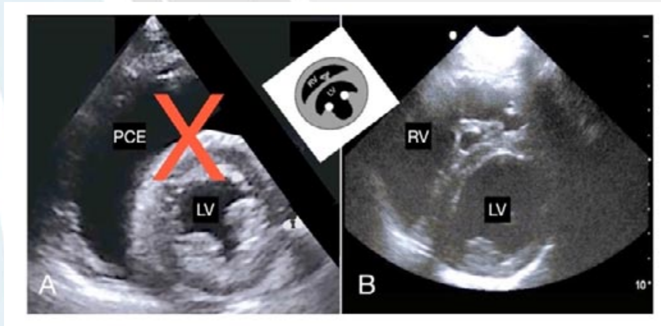

Figure. Serious Pitfall of the Left Ventricular Short-axis View. Shows how the left ventricular short-axis "mushroom" view is dangerous for the non-cardiologist. The image to the left shows pericardial effusion labeled as "PCE." Compare to the image to the right that shows how the normal cardiac anatomy of the right ventricle (RV) can mimic pericardial (or pleural effusion) leading to the potentially most catstrophic of interventions of performing centesis on a heart chamber (Lisciandro JVECC 2016). Do NOT use short-axis views for pleural and pericardial effusion unless combined with other views because the mistake is easy to make without this TFAST® mindset. *This material is reproduced and modified with permission of John Wiley & Sons, Inc, Focused Ultrasound Techniques for the Small Animal Practitioner, Wiley ©2014 and Dr. Gregory Lisciandro, DVM, Dip. ABVP, Dipl. ACVECC, FASTVet.com and Hill Country Veterinary Specialists Copyright 2018, 2019.*

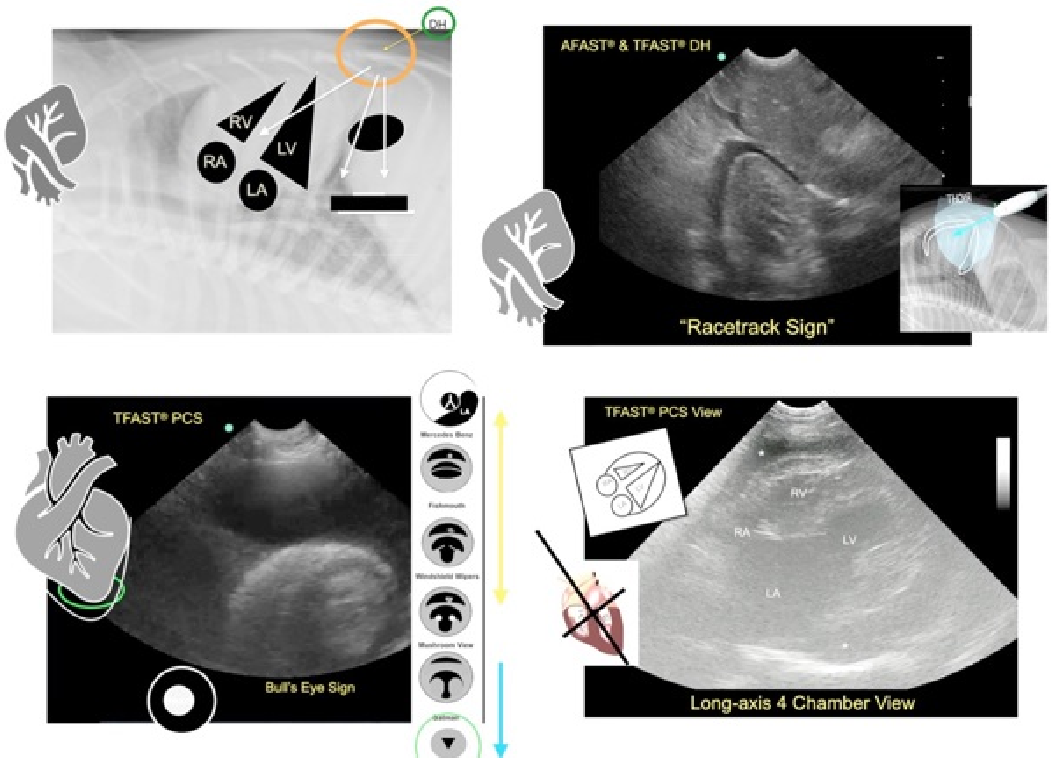

Figure. Strategy for Accurately Diagnosing Pericardial Effusion using TFAST®. The figure shows how imaging toward the muscular apex of the heart at the TFAST® DH View for its Racetrack Sign, the rounding of pericardial effusion (Lisciandro 2014, 2016), avoids mistaking a heart chamber for pericardial (and pleural) effusion. The other strategies utilize the right TFAST® Pericardial Site views by the following: 1) image toward the muscular apex of the heart for the Bull's Eye Sign (Lisciandro 2014, 2016) and 2) the use of the long-axis 4- chamber view, where clearly all 4 chambers are identified and fluid is observed outside the heart (Lisciandro 2014, 2016). The presence of non-hemoabdomen ascites supports a much more favorable prognosis (Stafford Johnson 2005) and argues for the Global FAST® Approach avoiding "satisfaction of search error." Integrating the Global FAST® Approach advantageously incorporates an unbiased set of standardized imaging data points (15- views) to improve the probability of being correct.

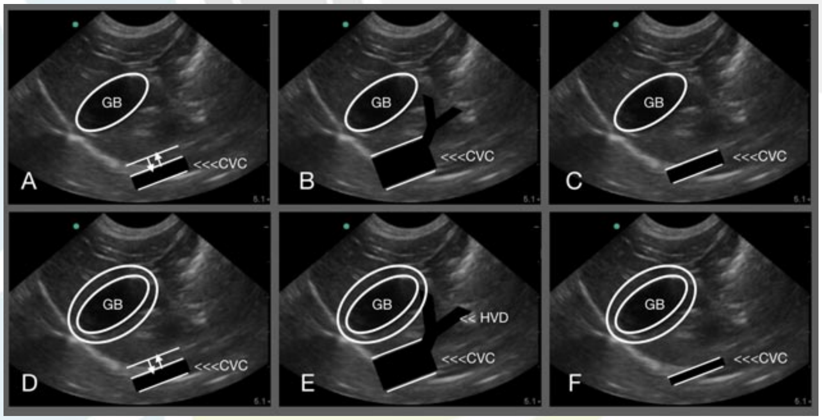

Figure. Integrating the Global FAST® Approach. Integrating the Global FAST® Approach advantageously incorporates an unbiased set of standardized imaging data points (15- views) to improve the probability of being correct. For example the finding of gallbladder wall edema may be due to either a "Canine Anaphylactic Gallbladder" or a "Cardiac Gallbladder." A FAT (distended) caudal vena cava and the finding of gallbladder wall edema (sonographic striation of its wall) supports pericardial effusion or other right-sided types of failure (obstruction of blood flow to the right heart that results in hepatic venous congestion (Tree Trunk Sign) and gallbladder wall edema) dubbed a "Cardiac Gallbladder" (Lisciandro 2014, 2019) Canine anaphylaxis also has gallbladder wall edema (massive histamine release results in hepatic venous congestion and gallbladder wall edema) dubbed a "Canine Anaphylactic Gallbladder", however, characterization of the caudal vena cava is the *opposite* having a flat (hypovolemic) appearance because of the life-threatening severe hypovolemic/distributive shock of anaphylaxis. *This material is reproduced and modified with permission JVECC 2011; 20(2): 104-122; and John Wiley & Sons, Inc., Focused Ultrasound Techniques for the Small Animal Practitioner, Wiley ©2014 and Dr. Gregory Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC, FASTVet.com and Hill Country Veterinary Specialists Copyright 2018, 2019.*

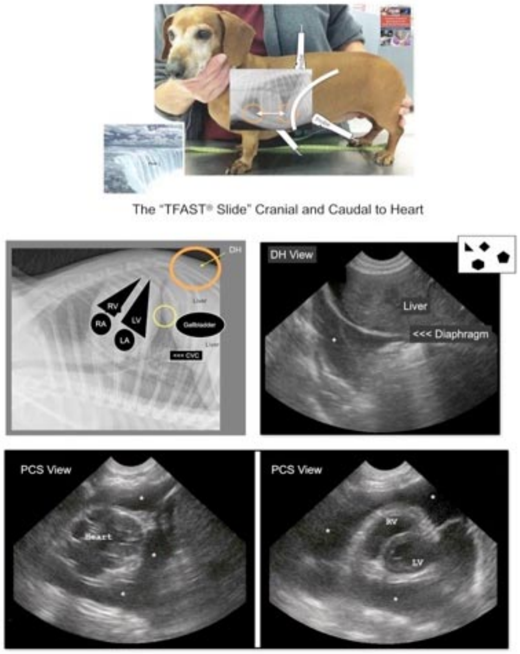

Figure. Strategy for Accurately Diagnosing Pleural Effusion using TFAST® . The figure shows how combining the AFAST® -TFAST® Diaphragmatico-Hepatic (DH) View and the left and right TFAST® Pericardial Site views including the principles of imaging the heart in its entirety and the "TFAST® Slide" caudal and cranial to the heart as well as excluding pericardial effusion. *This material is reproduced and modified with permission JVECC 2011; 20(2): 104-122; and John Wiley & Sons, Inc., Focused Ultrasound*

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Table. Summarizing Tenets for the Accurate TFAST® Diagnosis of Pericardial and Pleural Effusion.

TFAST® Diagnosis of Pericardial Effusion The Gold Standard for the Diagnosis of Pericardial Effusion is Ultrasound Radiography is Unreliable Pericardial Effusion is Contained in the Pericardial Sac that Attaches at One Atrium and Rounds the Muscular Apex of the Heart to Attach to the Other Atrium Pericardial Effusion is Easy to Recognize Using Our TFAST® Tenets		
Imaging Strategy	**FAST DH View**	**TFAST® PCS View**
*Image toward the muscular apex of the heart where no heart chambers can be mistaken for free fluid	*FAST DH View – Racetrack Sign	*TFAST® Right PCS View – Bull's Eye Sign
*Long-axis 4-chamber view where all 4 chambers are identified		*TFAST® Right PCS View
*Image the heart globally in its entirety using the bright white pericardium in the far-field as a landmark		
TFAST® Diagnosis of Pleural Effusion The Gold Standard for the Diagnosis of Pleural Effusion is Debatably Computerized Tomography and Ultrasound Could be Considered the Gold Standard Radiography is Generally Good Pleural Effusion is Uncontained and Unrestrained Unless Compartmentalized Exclude Pericardial Effusion - Which Is Generally Easier to Recognize and So Less Variable than Pleural Effusion		
Imaging Strategy	**FAST DH View**	**TFAST® PCS View**
*Image the heart globally in its entirety using the bright white pericardium in the far-field as a landmark		*TFAST® Right and Left PCS – Anechoic (Black) Triangulations
*Image toward the muscular apex of the heart where no heart chambers can be mistaken for free fluid	*FAST DH View – Anechoic (Black) Triangulations	
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GOAL-DIRECTED TEMPLATES FOR TFAST®

*Right and left sides are listed in templates for the CTS and PCS views

***Chest Tube Site (CTS) - Glide Sign?** **Present** (normal) -- no Pneumothorax **or** **Absent** – Pneumothorax **or Indeterminate** or **Not Assessed (NA)**

***Location of Lung Point?** **Upper 1/3** or **Middle 1/3** or **Lower 1/3** or **Indeterminate** or **NA**

***CTS - Lung Rockets (also called B-lines)**? **Present** (no PTX) – interstitial lung fluid (edema, hemorrhage) **or** **Absent** – no interstitial lung fluid **or Indeterminate or NA**

***CTS - Step Sign?** **Present** – concurrent thoracic wall trauma (rib fractures, hematoma, intercostal muscle tear) or pleural space disease is suspected **or Absent** - no concurrent thoracic wall trauma or pleural space disease is suspected **or Indeterminate or NA**

***PCS view - Pleural or Pericardial Eff.?** **Absent**- no pleural or pericardial fluid **or Present** - pleural or pericardial fluid **or** both (mild, moderate, or severe) **or** **Indeterminate** or **NA**

TFAST® Echo Views:

Left Ventricular Short-axis Mushroom View (LVSA):

Filling: **Adequate** suggesting normovolemia **or Inadequate** suggesting hypovolemia **or Indeterminate** or **NA**
Contractility: **Unremarkable** or **Decreased** or **Indeterminate** or **NA**

Left Atrial to Aortic Ratio (LA:Ao) Short-axis: **Unremarkable** or **Increased** or **Indeterminate** or **NA**

Right Ventricular to Left Ventricular Ratio (RV:LV) Long-axis: **Unremarkable** or **Increased** or **Indeterminate** or **NA**

DH View:
Pleural effusion: absent, present (mild, moderate, severe) or Indeterm or NA
Pericardial effusion: absent, present (mild, moderate, severe) or Indeterm or NA
$ **Hepatic Venous Distension:** present, absent or Indeterm or NA
& **Caudal Vena Cava Characterization:** FAT, flat or bounce or Indeterm or NA

Cardiac Tamponade: **Present or Absent or Indeterminate** or **NA**

Comments: ____

KEY: CTS = chest tube site; **PCS** = pericardial sac; **LV** = left ventricle, **PTX** = pneumothorax, **NA** = Not Assessed

Note: The TFAST® exam is a rapid ultrasound procedure used to help detect major chest wall, lung, and pleural and pericardial space problems as a screening test in order to better direct resuscitation efforts, help better direct diagnostics, and manage hospitalized critically ill patients. TFAST® exam is not intended to replace thoracic radiographs, or complete echocardiography.

$ The hepatic veins should not be apparent in both dogs and cats placed in lateral recumbency. When imaged the branching has been referred to by the author as the "Tree Trunk Sign."

& The caudal vena cava can be alternatively referred to as a bounce = fluid responsive cava (~35-50% diameter change); FAT= fluid intolerant cava (distended with increased maximum height < 1 cm in dogs < 9 kg, and > 1.5 cm in dogs > 9 kg with little maximum height change [< 10%]); flat = hypovolemic cava (small with decreased maximum height of < 0.3 cm in dogs < 9 kg and < 0.5 cm in dogs > 9 kg with little maximum height change [< 10%]).

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Template for TFAST®

Pneumothorax? Left CTS: absent ☐ present ☐ indeterminate ☐ not assessed ☐
Lung Point : upper 1/3 ☐ middle 1/3 ☐ lower 1/3 ☐ indeterminate ☐

Right CTS: absent ☐ present ☐ indeterminate ☐ not assessed ☐
Lung Point : upper 1/3 ☐ middle 1/3 ☐ lower 1/3 ☐ indeterminate ☐

Pleural Effusion? Left PCS: absent ☐ present ☐ indeterminate ☐ not assessed ☐
trivial < 5 mm ☐ mild < 1cm ☐ moderate >1 cm< 2 cm ☐ severe >2 cm ☐
Right PCS: absent ☐ present ☐ indeterminate ☐ not assessed ☐
trivial < 5 mm ☐ mild < 1cm ☐ moderate >1 cm< 2 cm ☐ severe >2 cm ☐

Pericardial Effusion? absent ☐ present ☐ indeterminate ☐ not assessed ☐
trivial < 5 mm ☐ mild < 1cm ☐ moderate >1 cm< 2 cm ☐ severe >2 cm ☐

TFAST Echo Views

Right PCS LVSA Volume - unremarkable☐ abnormal ☐
indeterminate ☐ not assessed ☐
LVSA Contractility (FS%) - unremarkable☐ abnormal ☐
indeterminate ☐ not assessed ☐
LA:Ao Ratio - unremarkable☐ abnormal ☐
indeterminate ☐ not assessed ☐
RV:LV Ratio - unremarkable☐ abnormal ☐
indeterminate ☐ not assessed ☐

Caudal Vena Cava unremarkable (BOUNCE) ☐ small (flat) ☐ distended (FAT) ☐
indeterminate ☐ not assessed ☐

Hepatic Venous Distension unremarkable☐ distended ☐
indeterminate ☐ not assessed ☐

Comments ______________________________

KEY: CTS = chest tube site; **PCS** = pericardial sac; **LV** = left ventricle, **PTX** = pneumothorax, **LVSA**: left ventricular short-axis view, **LA:AO** aortic to left atrial ratio on short-axis view, **RVLV**: right ventricular to left ventricular ratio on long-axis view.

Qualifier: The TFAST® exam is an ultrasound examination used to detect pleural and pericardial effusion, major thoracic wall, lung, and heart abnormalities as a screening test in order to better direct resuscitation efforts or manage hospitalized critically ill patients. TFAST exam is not intended to replace thoracic radiographs, or complete detailed echocardiography.

Created by Gregory Lisciandro, DVM, DABVP, DACVECC, CEO of FASTVet.com and President, International Veterinary Point-of-care Ultrasound Society, IVPOCUS.org

Figure. Another Example of a TFAST® Goal-directed Template.

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"Needle in the Chest": Performing Thoracocentesis and Pericardiocentesis

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Raleigh, North Carolina USA

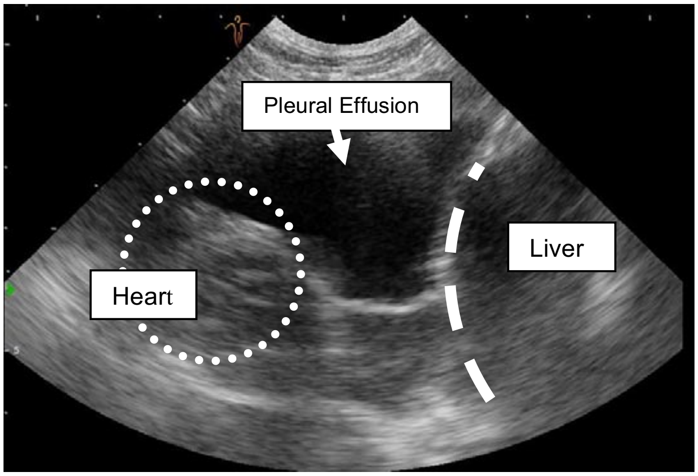
Ultrasound-Guided and Ultrasound-Assisted Thoracocentesis:
Most commonly, thoracocentesis is performed for therapeutic purposes to remove clinically significant (usually large volume) pleural effusion or air. The use of ultrasound (US) to either guide or assist the thoracocentesis has become standard of care in veterinary emergency and critical care as it increases the safety of these procedures. The complications associated with thoracocentesis are uncommon including pneumothorax, cardiac puncture, arrhythmias, hemorrhage or seroma at entry site.

The two most common methods to remove fluid or air is with either a needle attached to tubing + syringe or an over-the-needle IV catheter attached to tubing + syringe. For a therapeutic tap, my preference is to use an over-the-needle IV catheter with ultrasound (US)-assistance. Despite the increased learning curve for a successful fluid retrieval, the over-the-needle catheter increases the safety of the thoracocentesis as the needle stylet is taken out of the chest after entering the chest whilst leaving the soft catheter for fluid/air removal. US-guided is used by some clinicians, typically those proficient with ultrasound, for therapeutic centesis. My preference is to use US-guided thoracocentesis only for small volume diagnostic centeses.

> **Ultrasound-assisted thoracecentesis** indicates that US is being used to select the site of needle entry into the chest and to monitor intermittently the amount of fluid remaining during and after the thoracocentesis.
>
> **Ultrasound-guided thoracocentesis** is when the needle is observed real-time with US entering the chest and is monitored continuously during the centesis.

Site and skin preparation for thoracocentesis: The site of the needle entry for thoracocentesis is guided by US. Most animals can be tapped just on one side as most have an incomplete mediastinum. Occasionally bilateral taps will necessary. One chooses the site for needle entry as the area with the most amount of fluid or air based on imaging and where lung interference is minimal. Once the entry site is chose, you can mark the spot with a marker or cross hairs on the skin. In general, this area is usually ~ 7-8th Intercostal space. The needle is advanced into the pleural space in front of the rib as the artery, vein and nerve run along the caudal aspect of the rib. If one is removing air from the chest, your entry point is more dorsal than for fluid. If one divides the animal's lateral chest into thirds from ventral to dorsal, you would enter between the top third and middle third for remove air.

For fluid, the site of entry is lower, usually at or slightly above the costochondral junction. The highest yield site for to detection and removal of the pleural effusion is the just behind the heart and in front of the liver as seen on the US image.



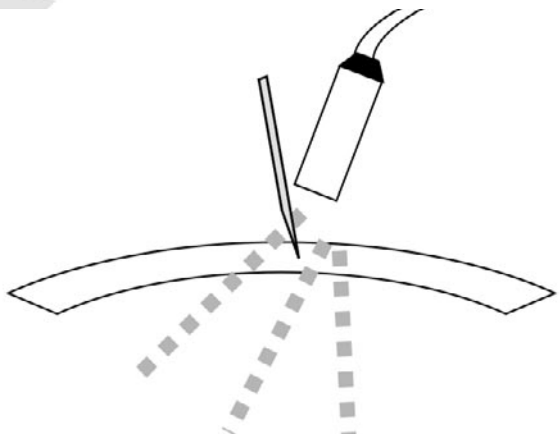
Once the exact site of the centesis has identified, the fur is clipped and skinned prepared aseptically. A local anesthetic block with lidocaine will decrease the patient discomfort associated with the procedure. The procedure is typically performed with the animal in sternal recumbency and typically with light to moderate sedation. My preference is typically an opioid mixed with a benzodiazepam or alfaxalone depending on the patient's demeanor.

Once the site has been selected and prepped, the patient position MUST not move or altered in any way as any slight change in position (such as shifting in the back legs) could change the optimal entry site.

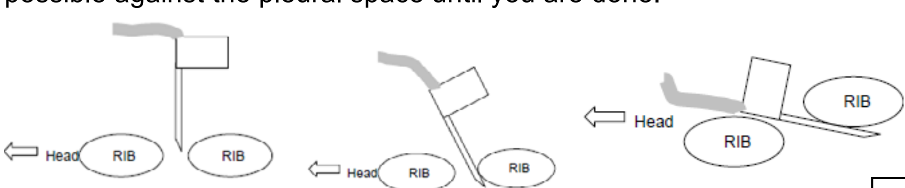
Needle or Butterfly Catheter Thoracocentesis: The advantage of this technique is that it is quicker than an over-the needle catheter. Oftentimes, local anesthesia with a lidocaine block is not needed. The main disadvantage is that you have a needle in the chest for a prolonged time period and may not be able to completely drain the chest especially if the pleural fluid is thick and chunky.

The butterfly needle catheter is often used for thoracocentesis in cats and small dogs but not in medium to large dogs as the length of the needle is short. One usually uses US assistance with the butterfly catheter. For a larger dog, a regular hypodermic needle can be attached to extension tubing + a 3-way stopcock (or special one way tubing) and syringe.

If using US-guidance, my preference is to hold the probe in my non-dominant hand with the long axis of the probe parallel with the ribs in the intercostal space. Using geometry, estimate the thickness of the chest wall to determine the angle of the needle entry and probe. Rock the probe along the long axis to visualize the tip of needle in the chest wall and watch the needle enter the chest as your assistant is applying suction so you know the second you are in the pleural space. If using US-guidance, hold the needle still just inside the chest wall as your assistant aspirates the fluid or air.



For US-assisted thoracocentesis with a butterfly, hold the needle and butterfly catheter in your dominant hand, and orient the catheter so that the opening of the bevel is oriented toward the head as the catheter enters the skin ("Mouth to Mouth") so the opening will be facing the pleural space and not the chest wall when in the chest. The needle should be advanced into the skin directly over the leading edge of the rib caudal to the interspace you've chosen. As soon as the needle enters the skin, your assistant must apply at least 1 ml of vacuum to the syringe and *hold the vacuum constantly*. As you advance the needle into the interspace, it is the responsibility of your assistant to notify you the instant the needle enters the pleural space. Once you've entered the pleural space, the most important 'finesse' step of the procedure is to *wrap* the needle around the rib as you advance it deeper, so the needle hugs the rib. Once inside the chest cavity with the needle, you hold still with the needle as flat as possible against the pleural space until you are done.



Sketches courtesy of Dr. Bernie Hansen

Over-the-needle Catheter Thoracocentesis: The primary advantage of the fenestrated catheter technique is that it permits a more complete removal air or fluid and with some minimal training is a safer procedure in the author's opinion. The catheter can also serve as a 'mini' chest tube that may be left in for up to several hours. This is a big advantage to patients that would otherwise have to endure the pain and risk of multiple needle sticks.

Fenestrated thoracoccentesis catheters are made however, one can create fenestrations with an #11 blade scalpel. Beginning 1 cm proximal to the tip of the catheter, with the needle in place inside the catheter, 'V'-

shaped cuts are made. The cuts or fenestrations should be small, no more than 20% of the catheter circumference. Any loose/ragged edges on the cut should be scraped off.

An #11 blade is also used to make a releasing skin incision at the site of the lidocaine block to minimize any burring of the catheter tip. Be sure to make this stab incision is completely through the dermis. The 3-ml syringe or tubing + syringe system is attached to the needle/catheter assembly, and the device is advanced throught the stab incision. Wearing sterile gloves, the dominant hand should rest on the body wall and the wrist and fingers are used to advance the catheter into the pleural space. Be sure your elbow or forearm is stabilized on the dog or table to allow the fine motor control of your hand to do the work. As soon as the needle has reached the subcutaneous tissue, 1 ml of vacuum is applied to the plunger, and is not released until the needle has entered the pleural cavity. Do not apply vacuum, release, advance and test again – you want the vacuum *continuously* applied. As soon as the needle penetrates the pleural space, the vacuum will be lost as air or fluid enters the needle. Advanced the needle and catheter about 2 mm more so that you are well seating in the chest and then stop advancing the needle any farther into the pleural space.

At this point, focus all of your attention on the needle hub and hold it absolutely stationary relative to the body wall until the catheter is partially advanced off it to cover the needle tip in the chest. Your primary focus during this step is on holding the needle stationary. Avoid the common mistake of pulling the needle back as you advance the catheter in.

Once the plastic catheter has covered the needle tip, one can angle the needle/catheter assembly to maximize removal of the fluid or air. If you are draining a pneumothorax, the catheter should be oriented parallel to the spine. If draining effusion, it should be aimed at the cranioventral thorax. The catheter is then advanced off the needle stylet and attached to the collection system.

Ultrasound-Assisted Pericardiocentesis

The main indication for pericardiocentesis is the urgent and life-saving removal of pericardial fluid in a patient with cardiac tamponade. If the patient condition allows, an attempt to identify a possible mass prior to pericardiocentesis is warranted as neoplasia is the most common cause of pericardial effusion and the mass may be difficult to visualize after centesis. The removal of the fluid is the only therapeutic maneuver that will allow the heart to fill normally and significantly improve cardiac output. Pericardial effusion without evidence of cardiac tamponade does not need to be urgently removed or removed at all. Small volume pericardial effusion is commonly a manifestation of heart failure in the cat and occasionally in the dog. When pericardial effusion without cardiac tamponade is thought to be a manifestation of heart failure, then conventional heart failure medical management is advised.

The complications associated with pericardiocentesis are uncommon but significant. Cardiac puncture, pneumothorax, arrhythmias and potential death should be discussed as potential complications. If a specialty center is close by and the dog's condition is reasonably stable, these cases are often referred to a center that commonly performs pericardiocentesis. However, if there is concern that the patient may not survive transport to a specialty center, then emergency pericardiocentesis is warranted. Pericardiocentesis is typically performed on the right hemithorax because it is considered safer due to the cardiac notch in the lungs (the space between the right cranial and middle lobes), and reduced chance of lacerating a coronary artery. It is of the utmost importance that the patient not move during the procedure. Sedation is sometimes needed however, some patients are so hemodynamically compromised that sedation is not necessary. The larger the volume of pericardial effusion, the safer the procedure because there is more distance between the needle and the heart.

In human medicine, ultrasound guidance has decreased the complication rate of pericardiocentesis. In veterinary medicine, ultrasound is most commonly used either to assist or to guide pericardiocentesis. US- guided pericardiocentesis is real time visualization of the needle draining the pericardial sac while US-assisted pericardiocentesis helps to find the optimal location for catheter insertion into the pericardium with intermittent US monitoring the fluid drainage. The author prefers the US-assisted because moderate to large volume pericardial effusion is most common and the preference to introduce and maintain a soft catheter in the pericardial sac for the duration of draining the fluid rather than needle that is often used for US-guide centesis. The author performs. US-guided pericardiocentesis for small volume pericardial effusion usually for diagnostic purposes under heavy sedation.

US-assisted Pericardiocentesis with an over-the-needle catheter

Pericardiocentesis with an over-the-needle catheter

- Place a short peripheral IV
  catheter for administration of drugs (sedation, antiarrhythmic drugs, or IV fluids).
- Sedated patient is positioned in sternal or left lateral recumbency depending on clinician preference.
- Shave fur on the right hemithorax over the heart (3rd to 8th intercostal space,just below CCJ to mid thorax)
- Prior to prepping the skin, the optimal entry site is chosen with the aid of the ultrasound. The optimal site should be at or above the costal chondral junction (to avoid the internal thoracic artery) and where there is a clear and central view of the pericardial effusion with minimal lung interference. Once the optimal puncture site is chosen, every effort should be made to keep the patient the same position.
- Local anesthesia with lidocaine is infiltrated in the subcutaneous, intercostal and pleura at the desired puncture site.
- Continuous ECG is monitored for any possible arrhythmias that may represent myocardial contact with the pericardiocentesis catheter.
- The size and length of the needle or catheter depends on the size of the patient, the volume and nature of the fluid. In most dogs, a 16g or 14g x 3.25 to 5 inch over-the-needle catheter (optional side-fenestrations) work well.
- The over-the-needle catheter is inserted through a releasing incision in the skin to minimize the drag or burring of the catheter through the skin. A luer slip 3-cc syringe is connected to the catheter. Once the catheter tip is through the skin, at least 1 cc of negative suction is applied to the syringe. The catheter is inserted perpendicular to the chest wall and advanced through the subcutaneous and intercostal muscles until dark red hemorrhagic fluid fills the syringe signaling that you have entered with pericardial space.
- Most pericardial effusions are hemorrhagic and can be similar in appearance to blood. If you are concerned about an accidental right ventricular puncture and frank blood, wait to see if the hemorrhagic fluid clots. Pericardial effusion should not clot while that of a cardiac puncture will clot after a couple of minutes. You many also feel the rhythmic pulsation of the heart on the catheter.
- Pleural effusion is often present together with pericardial effusion. Pleural fluid is typically serosanginous or pink in color. One should continue to advance the catheter until the dark red fluid fills the syringe. If there is any doubt the location of the catheter (pleural or pericardial space), one can injected a small amount of agitated saline and ensure that he catheter is located in the correct space and not in the pleural space or right heart.
- Once in the pericardial sac, the catheter is advanced over the needle stylet. The needle stylet then is removed. Extension tubing, a 3-way stopcock and a large syringe are attached quickly to the hub of the catheter and drainage of the fluid begins. The fluid should come easily with minimal negative suction.
- Even if one is unsuccessful in advancing the catheter into the pericardial sac, simply the puncture of the pericardium will likely relieve the cardiac tamponade. The pericardial effusion will often drain into pleural space.
- One should try to completely drain the PC effusion. Complete emptying of the fluid will be noted by the absence of more fluid with gentle negative suction. Arrhythmias will often be noted as the catheter tip will be touching the epicardium when little fluid is in the pericardial sac.
- Careful monitoring of the ECG during insertion of the needle and during the centesis is advised. If arrhythmias are noted, slight retraction of the needle/catheter should result in resolution of the arrhythmia.
- After the pericardiocentesis, the dog should be monitored with FCU for possibly re-effusion, especially if a right atrial mass is identified. Re-effusion within a few hours is not uncommon with right atrial hemangiosarcomas.

US-guided pericardiocentesis is very similar to US assisted with a few difference. With US-guided centesis, the sonographer will hold the probe with their non-dominant hand and a reasonably long centesis needle with dominant hand. The needle hub is connected to extension tubing, 3-way stopcock and syringe. An assistant with apply negative suction with the syringe as the needle is advanced into the skin and subcutaneous tissues. The sonographer will watch the insertion of the needle into the pericardial space that should coincide with fluid filling the collection system and syringe. The sonographer will continuously watch while the needle is in the pericardial sac while the fluid is drained using caution to keep the needle tip from touching the heart.

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2nd International Veterinary Point-of-Care Ultrasound Society Symposium (IVPOCUS)
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"See the Problem List & Find the Most Forgiving Target" Global FAST® for Staging the Patient

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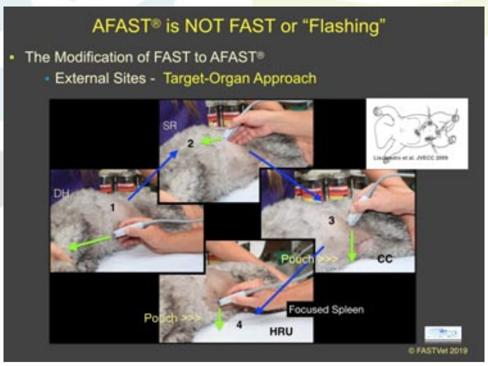
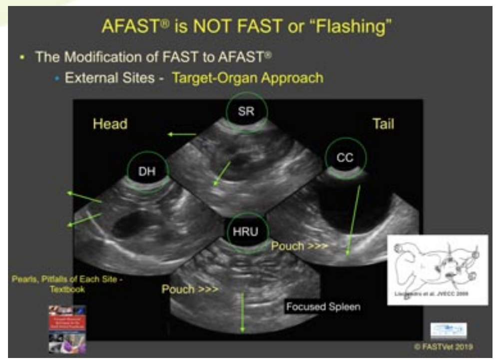
Review of Global FAST®

Global FAST**®** is a term we created nearly 10-years ago in 2010 when we developed Vet BLUE**®** as a more comprehensive lung ultrasound examination over the single bilaterally applied TFAST**®** Chest Tube Site (CTS) view. Prior to the development of Vet BLUE**®**, we have used the term "Combo (combination) FAST" since 2005 because we knew after just a few cases when we began this point-of-care ultrasound movement, that it was so important to image both cavities (Lisciandro 2012). At that same time circa 2005, we considered AFAST**®**-TFAST**®** - "Combo FAST" and now AFAST**®**-TFAST**®**-Vet BLUE**®** - "Global FAST**®** Approach" as an extension of the physical exam with everyday applications for nearly every patient.

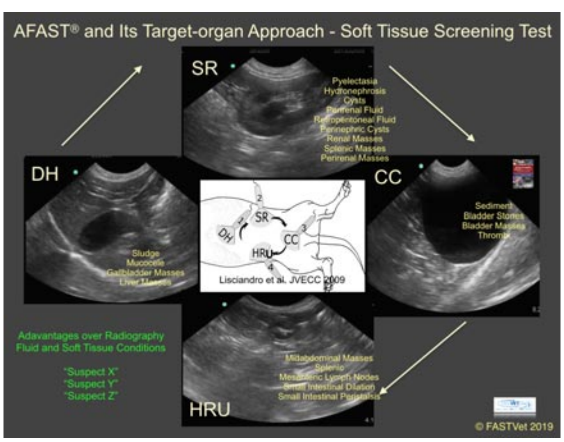


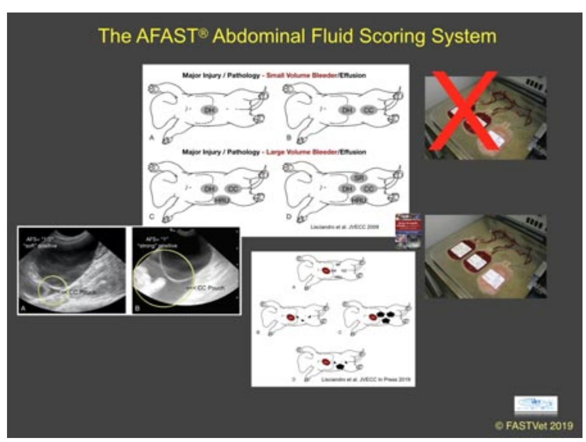


The AFAST® is not a Flash of the Abdomen, the TFAST® is not a Flash the Thorax, the Vet BLUE® is not a Flash the Lung. Shown here is the AFAST® and how the 4 acoustic windows making up the abdominal fluid scoring system are standardized and ordered 1-4 followed by a Focused Spleen. The TFAST**®** and Vet BLUE**®** methodologies are shown in the following figures. **Do not Flash!**

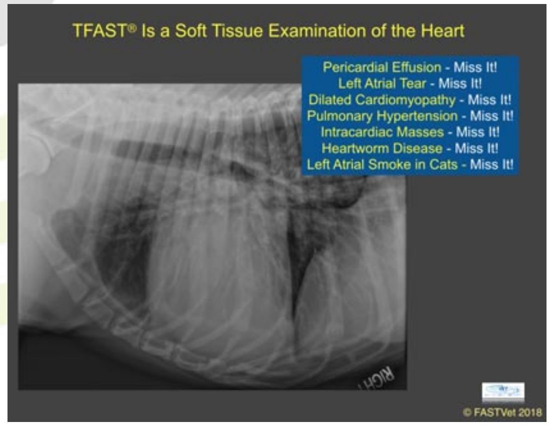
Advantages of AFAST®, TFAST® and Vet BLUE® Over Radiography

Let's be intellectually honest with one another. The Global FAST**®** Approach is a better first line-screening test over radiography for the great majority of our patients serving as a soft tissue screening test that outperforms radiography that suspects or all together misses conditions listed in the following figures.

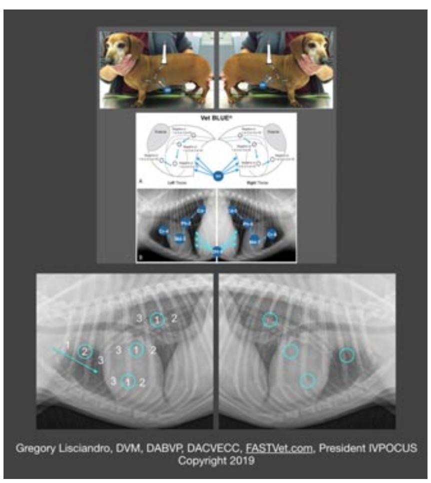


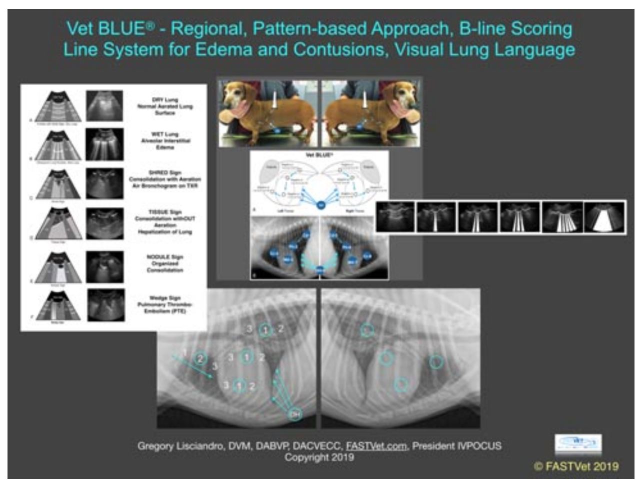


The AFAST®. The AFAST® Target-Organ Approach is a soft tissue-screening test for obvious abnormalities (examples listed on the figure) at each of its views. The Focused Spleen was added because of the possibility of medically-treated anaphylactic hemoabdomen in dogs. The AFAST®-applied abdominal fluid scoring system makes more clinical relevance of a positive examination. In bleeding patients, abdominal fluid scores (AFS) of 1 and 2 (<3) are considered "small volume bleeders/effusion" and AFS of 3 and 4 (≥ 3) considered "large volume bleeders/effusions." In other words, AFS <3 that are bleeding will not become anemic directly from their intra-abdominal bleed because there is not enough blood with the abdomen. On the other hand, AFS ≥ 3 potentially have enough blood in their abdominal cavity and predictably become anemic with some severely enough to warrant blood transfusion and exploratory surgery depending on the patient subset. In those with non-hemorrhagic effusions, the AFS is applied similarly as volume of loss that could contribute to hypovolemia as well as for deciding on performing therapeutic and diagnostic abdominocentesis, i.e. right-sided congestive heart failure.



The TFAST®. The TFAST® is not only used for its TFAST® Echo Views, pneumothorax (PTX), and pericardial (PCE) and pleural effusion (PE), but also serves with its TFAST® Target-Organ Approach as a soft tissue-screening test for obvious abnormalities (examples listed on the figure) of the heart that would only be suspected or outright missed radiographically.





The Vet BLUE®. Vet BLUE® is an extremely sensitive soft tissue-screening test for lung surface pathology and performs better than 3-view thoracic radiography and computed tomography in dogs and cats (Ward et al. JVECC 2018; Dicker et al. JVECC In Press 2019) and approximates the gold standard test of computed tomography (CT) in people. Its advantages are that it is rapid, radiation sparing (safer), readily available, cost-effective and point-of-care without the risk of patient transport and sedation. Every CT is considered 100 chest X-rays in people. The regional pattern-based approach allows for findings to be placed into clinical context. Flashing misses that opportunity and leads to false conclusions (as does flashing the abdomen and non-pulmonary thorax).

Don't Flash - Case Examples of How the Flash Examination is Detrimental to Patient Care - Some Common Clinical Examples

The Flash exam is problematic in that it leads to "satisfaction of search error" because of "selective imaging." You wouldn't due a selective physical exam because you are aware that you may miss important patient information. The failure to do a Global FAST**®** Approach is similar to not doing a complete physical exam, our mindset since 2005; and there is support on the human side to now use point-of-care similarly (Tavares et al. 2019). The author's mantra is the following: never let these cases leave your hospital without a Global FAST® Approach for staging localized versus disseminated disease because you may lose the opportunity to treat when the owner goes home to "think about it" regarding your recommended work-up. "Thinking about it" is generally code for not pursuing diagnostics - see Staging Cases section - this is a game-changer approach for your clients and for keeping clients.

Hemoabdomen
A recent well done clinical study out of the university setting that evaluated how many canine hemoabdomen cases were actually operated piqued my interest (Lux et al. JAVMA 2013). The authors found that out of 432 canine hemoabdomen cases, only 86 had surgical treatment. The total number was ultimately 83 because 3 had no histopathologic diagnosis (consider medically treated canine anaphylactic hemoabdomen, Lisciandro JVECC 2016, Hnatusko et al. JVECC In Press 2019).

Taking a hard look at these numbers, one has to wonder how many dogs with benign conditions were euthanized. In the author's experience, the "Flash mentality" is problematic and likely a contributing factor. When "Flashing" the abdomen, the clinician performs an ultrasound examination with no standardization willy-nilly or helter-skelter like, leading to "satisfaction of search error" through "selective imaging." Thus, the case typically goes as follows: the finding and sampling of the ascites and possibly a search for the offending mass, most commonly associated with the spleen. The clinician-client discussion is one of a bleed due to a malignant cancer, a process that can be overwhelming emotionally and financially to many clients. Moreover, the clinician has a reluctance to encourage surgery because they have been taught that ultimate diagnosis is in the range of 25-33% benign to 67-75% malignant.

The Global FAST® Approach provides a means to rapidly stage these patients prior to the initial client-clinician conversation because it can rapidly screen for obvious metastasis within the abdominal and thoracic cavity by looking for liver, heart and lung metastasis. The Global FAST® Approach thus carries the potential to change up the presentation to the owner as one of hope being a surgical candidate (or conversely not a surgical candidate in the event evidence of metastasis is present - liver masses, pleural and pericardial effusion, lung nodules). The author is asking the important clinical question - will the Global FAST® Approach applied to all splenic mass cases that stage negative for any signs of metastasis better predict benign from malignant tumors?

The Focused Spleen became routine part of AFAST because of medically treated canine anaphylactic hemoabdomen - see Anaphylactic Hemoabdomen section.

Gallbladder Wall Edema
Gallbladder wall edema (GBWE) in dogs in the acute setting is not pathognomonic for canine anaphylaxis. In the acute setting cardiac causes are possible, pericardial effusion (PCE) is the top non-anaphylactic cause followed by other causes of right-sided congestive heart failure including dilated cardiomyopathy (DCM). PCE should be staged using the Global FAST® Approach - see Pericardial Effusion section. When GBWE is caused by canine anaphylaxis it is referred to as an "Anaphylactic Gallbladder" and when caused by right-sided heart conditions the "Cardiac Gallbladder" by the author (Lisciandro JVECC 2016, JVECC 2019).

Anaphylactic Hemoabdomen
The author was the first to describe hemoabdomen as a complication of canine anaphylaxis in a case series of 11 dogs (Lisciandro JVECC 2016). The original study by Quantz et al. performed only Focused Gallbladder exams and not the AFAST® and its fluid scoring system nor the Global FAST® Approach. If they had, one has to wonder if they would have figured out within their case population of ~105 dogs, that they got a medically-treated hemoabdomen from an acquired coagulopathy; and with the Global FAST® Approach would have also discovered that GBWE was found in dogs with PCE and right-sided congestive heart failure (Lisciandro JVECC In Press 2019).

Urinary Bladder Mass
The Global FAST® Approach allows for you to stage these cases for obvious disseminated disease and complications as follows: the AFAST® Target-organ Approach allows for screening for hydronephrosis, over masses and ascites; the TFAST® allows screening for pleural and pericardial effusion and cardiac complications; and the Vet BLUE® for lung metastasis and complications. Use color flow Doppler to differentiate thrombus (clot) from mass.

Pericardial Effusion

The top differential in dogs with PCE is neoplasia followed by idiopathic; and for the cat the top differential is congestive heart failure (Ward et al. JVIM 2018; Hall et al. JVIM 2007). The Global FAST**®** Approach allows for you to stage these cases for obvious disseminated disease and complications as follows: the AFAST® Target-organ Approach allows for screening for splenic, hepatic, renal and mid-abdominal masses within the abdomen; the TFAST® allows screening for pleural effusion and cardiac complications; and the Vet BLUE® for lung metastasis and complications. Use color flow Doppler to differentiate thrombus (clot) from mass. Radiography is an unreliable test for pericardial effusion (Cote et al. JAVMA 2013; Gulglielmini et al. JAVMA 2012)

Pleural Effusion

The Global FAST**®** Approach allows for you to stage these cases for obvious disseminated disease and complications as follows: the AFAST® Target-organ Approach allows for screening for splenic, hepatic, renal and mid-abdominal masses within the abdomen; the TFAST® allows screening for pleural effusion and cardiac complications; and the Vet BLUE® for lung metastasis and complications. Use color flow Doppler to differentiate thrombus (clot) from mass. Radiography is a good test for pleural effusion. In one study of cats with and without pleural effusion, the presence of pericardial effusion was 100% specific for the ultimate diagnosis of congestive heart failure (Ward et al. JVIM 2018). The presence of pericardial effusion is important to look for in pleural effusion cats because cancer doesn't have to be mentioned as a first differential but rather treatable congestive heart failure.

Pulmonary Disease

The Vet BLUE® is a standardized repeatable approach to lung ultrasound examination and its findings defined by its regions, its B-line scoring system, and pathology along the lung surface via its easily understandable visual lung language. Vet BLUE® has been been shown to be clearly superior to 3-view thoracic radiography (TXR) for alveolar-interstitial syndrome (generally edema) (Ward et al. JVECC 2018); and for lung nodules (Kulhavy and Lisciandro JVECC 2015); and for lung contusions compared to 3-view TXR and computed tomography (CT) (Dicker et al. JVECC In Press 2019). The author is involved in additional comparative imaging of Vet BLUE® to 3-view TXR to CT.

Staging Oncology Patients and Suspects with Global FAST® Improves Care

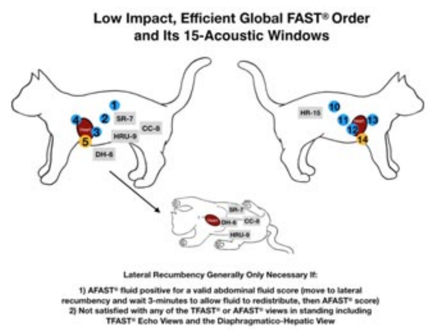
Lymphoma

Global FAST**®** shows how this case is not immunosuppressed with pneumonia post-CHOP protocol chemotherapy for lymphosarcoma (LSA) but rather out of remission evidenced by mid-abdominal masses, lung nodules and pleural effusion with lymphoblasts. Moreover, the heart on TFAST**®** Echo Views shows signs of right-sided congestive heart failure (dilated right ventricle and FAT, distended, caudal vena cava). The Global FAST**®** Approach was hugely impactful in case management by knowing the patient was out of remission rather than the thinking that the patient had pneumonia and thus sent home with antibiotics based on an evaluation lacking Global FAST**®**.

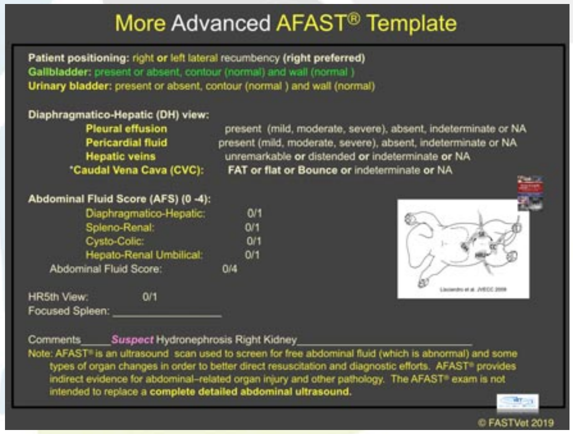
Other Oncological Cases or Suspects

We will also discuss as time allows cases of prostatic adenocarcinoma, malignant melanoma, fungal pneumonias and exotic companion mammals species.

How to Most Efficiently Perform Global FAST®



You MUST Record Your Findings - Goal-Directed Templates
Go to FASTVet.com, click on Premium Membership, click on Membership Resources, click on Free Resources, scroll down to Updated Goal-Directed Templates and click in to download them. There is AFAST®, TFAST® and Vet BLUE® and the Global FAST® Blend beginning in standing/sternal and the Global FAST® Blend beginning in right lateral recumbency.



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Global FAST® First Line Imaging for Traditionally Difficult Conditions

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Objective of the Lecture

The lecture will focus on the first line use of Global FAST® by a frontline emergency and critical care veterinarian for capturing cases for the appropriate clinical specialists, in this case the cardiologist, that would otherwise be missed without the use of point-of-care ultrasound.

We will cover the following 4 conditions:

1. Canine Left Atrial Tear (rupture)(LAT) in Mitral Valve Disease
2. Dilated Cardiomyopathy (DCM)
3. Pulmonary Hypertension (PHT)- Pulmonary Thromboembolism (PTE)
4. Pleural Effusion (PE)

First we will provide a brief overview of the Global FAST® Approach.

Global FAST® Approach

The Global FAST® Approach is the combined ultrasound application of AFAST®, TFAST® and Vet BLUE® as a single ultrasound examination serving as an extension of the physical exam.

The Global FAST® Approach has exact clarity to its 15-acoustic windows (views) and provides a baseline set of unbiased imaging data points that prevents the danger of "selective POCUS imaging" and "satisfaction of search error." The Global FAST® Approach is the most studied and validated in the veterinary literature with over 16 clinical studies in peer-reviewed journals; and moreover has led to several "firsts":

1. An AFAST®-applied Abdominal Fluid Scoring System that helps predict the degree of anemia for decision-making.
2. An AFAST®-applied Abdominal Fluid Scoring System that helps with tracking patients by assigning a score as well as its positive and negative locations - better system than trivial, mild, moderate and severe.
3. The standardization of its component formats using Goal-directed Templates.
4. The documentation and description of medically-treated canine anaphylactic hemoabdomen.
5. The use of the AFAST-TFAST® Diaphragmatico-Hepatic (DH) View for detection of pericardial effusion
6. The use of the Lung Point to characterize and track the degree of pneumothorax.
7. The first published proactive veterinary lung ultrasound examination named Vet BLUE®.
8. A visual Vet BLUE® lung language including dry lung, wet lung (B-lines also called lung rockets), Shred Sign, (air bronchogram), Tissue Sign (complete consolidation called hepatization), Nodule Sign, and Wedge Sign (pulmonary thromboembolism).
9. The Vet BLUE® B-line Scoring System for assessing and tracking pulmonary edema and lung contusions
10. The documentation of gallbladder wall edema being caused by right-sided heart failure including pericardial effusion, dilated cardiomyopathy and pulmonary hypertension.

The Global FAST® Examination

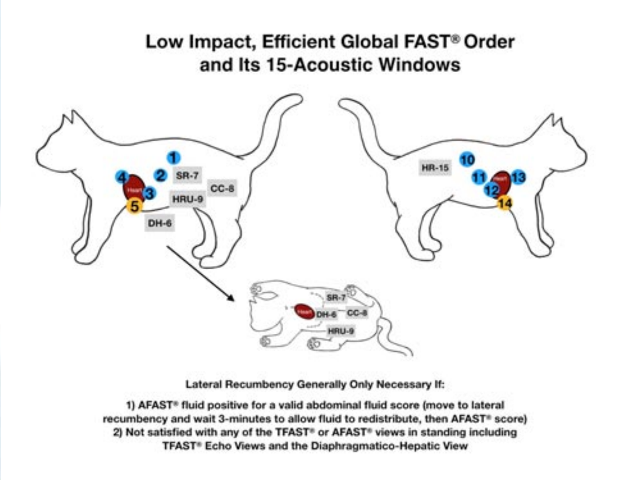
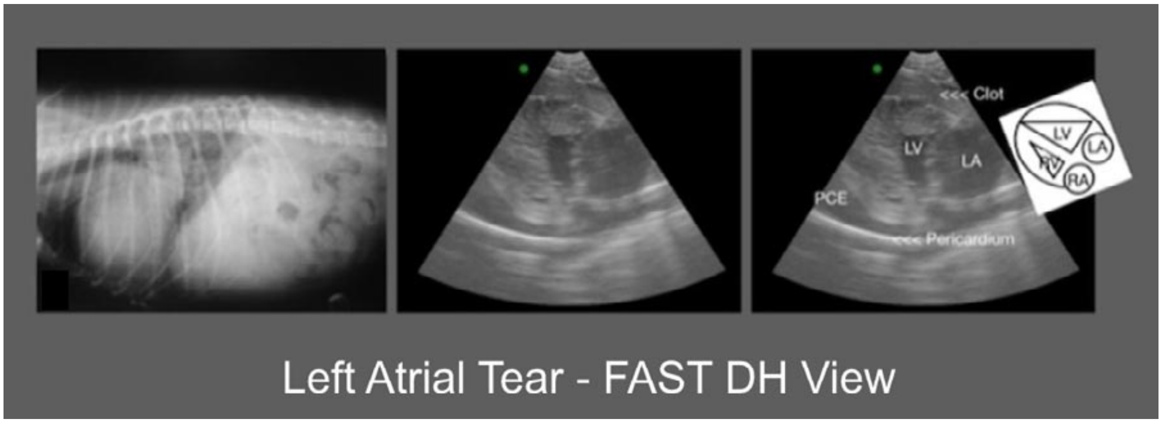


Figure. The Global FAST® Approach. Global FAST® Approach shown performed in a standing cat, which would be the same in a standing dog. The Order is listed and the *left* Vet BLUE® is followed by the *left* TFAST® PCS view and then the AFAST® with a Focused Spleen (*all* from the left side). The sonographer then moves to the *right* side of the patient and performs the *right* Vet BLUE® followed by the *right* TFAST® PCS views and its TFAST® Echo views ending with the AFAST® HR5th Bonus View of the right kidney and associated liver. If the patient is negative for ascites in standing then right lateral is unnecessary unless the sonographer needs the right lateral positioning for better image acquisition including the AFAST®-TFAST® DH View, and the TFAST® Echo views or re-scanning of certain AFAST® Target-Organs. *This material is reproduced with permission from Dr. Gregory Lisciandro, DVM, DABVP, DACVECC, FASTVet.com and Hill Country Veterinary Specialists Copyright 2018, 2019.*



Left Atrial Tear (LAT) (rupture) from Mitral Valve Disease (MVD)

*1st Line Screening: 1) Pericardial effusion (PCE) in dog with previous history of a murmur or known MVD

- Severe left atrial enlargement (100%)
- Clot in pericardial space - echogenic pericardial effusion - often seen encircling the left atrium and ventricle
- Most dogs will be in concurrent left-sided congestive heart failure (L-CHF) evidenced by the presence of diffuse B-lines
- Most dogs will have a recent history of collapse and respiratory distress

2) Pericardial effusion and left atrial enlargement often may be seen via the AFAST®-TFAST® Diaphragmatico-Hepatic (DH) View

- The DH View is low impact when restraint is risky
- The left heart lies against the diaphragm in dogs and cats (opposite of people in which its our right heart)

- Follow the tenets for an accurate TFAST® diagnosis of pericardial effusion in the TFAST® Proceedings

3) Evaluation for cardiac tamponade and increased right-sided filling pressures via the characterization of the caudal vena cava and its associated hepatic veins via the AFAST®-TFAST® Diaphragmatico-Hepatic (DH) View

4) Breed Predilection
- Any breed prone to mitral valve disease
- Anecdotally the Shetland Sheep Dog and Dachshund seem to be the most common breeds

* Radiography is a poor, unreliable test (see References)

Treatment:

1) AVOID pericardiocentesis because it is rarely needed unless imminent Cardio-Pulmonary Arrest (CPA)
- If performed, prevent tearing the pericardium because the pericardium is protective
- Only remove what is easily accessible, usually a small amount (< 30ml)
- Clot in the PCE reminds you to *avoid* pericardiocentesis

2) Judicious loop diuretic therapy - Guided by Vet BLUE® and its B-line Scoring System
3) Pimobendan and judicious vasodilator therapy indicated - AVOID ACE-inhibitors

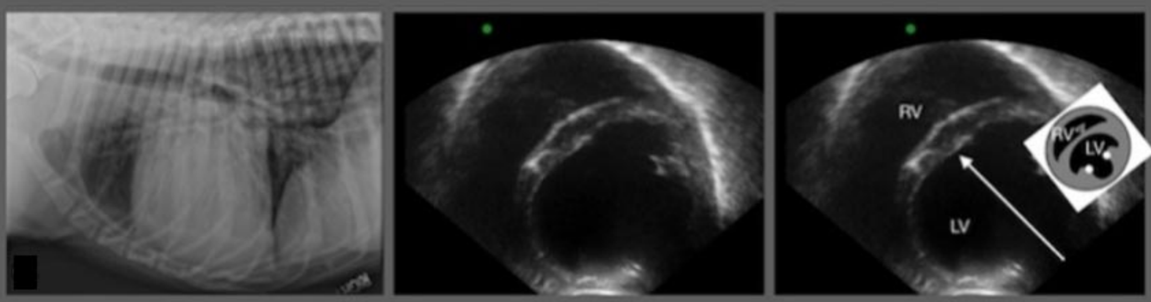
Prognosis:

1) Many survive to patient discharge
2) Long-term survival difficult to predict - could be 2-days, 2-weeks, 2-months or more, usually less than 1-year

Other Comments:

1) Complication is *missed* by thoracic radiography (TXR)
2) More common than you think for decompensated MVD

*Diagnosis: First line screening test findings are listed keeping in mind that the gold standard test is echocardiography by a cardiologist or similarly advanced trained sonographer.



Dilated Cardiomyopathy - Right TFAST PCS View

Dilated Cardiomyopathy (DCM)

*1st Line Screening:

1) Eyeball Method of poor contractility followed by gold standard imaging of Echocardiography
2) DeFrancesco Rule - the normal left ventricular internal diameter in diastole should never be greater than 5 cm
3) Increased spherocity or roundness to the LV lumen (normally shaped like a bullet) causing displacement of the interventricular septum (IVS) into the right ventricle
3) Increased End Point Septal Separation (EPSS) – of > 7 mm
4) Breed Predilection – Giant and large breed dogs, notably the Doberman Pincher, Boxer, Great Dane breeds.

Treatment:

1) Inotropic support - pimobendan administered orally - unavailable injectable form in USA - is indicated in clinical *and* preclinical DCM.

2) Diurectic therapy as most dogs with DCM present when symptomatic in heart failure, that is often biventricular failure - left *and* right sided heart failure.

3) Use Vet BLUE® for detecting cardiogenic pulmonary edema (and other lung complications) and its B-line scoring system to guide loop diuretic therapy.

4) Use the AFAST®- TFAST® Diaphragmatico-Hepatic (DH) view to assess for right-sided failure via the characterization of the caudal vena cava and its associated hepatic veins via the AFAST®-TFAST® Diaphragmatico-Hepatic (DH) view

5) Anti-arrhythmic therapy is used to manage arrhythmias that are often present. Atrial fibrillation and ventricular tachycardia are common arrhythmias seen in DCM.

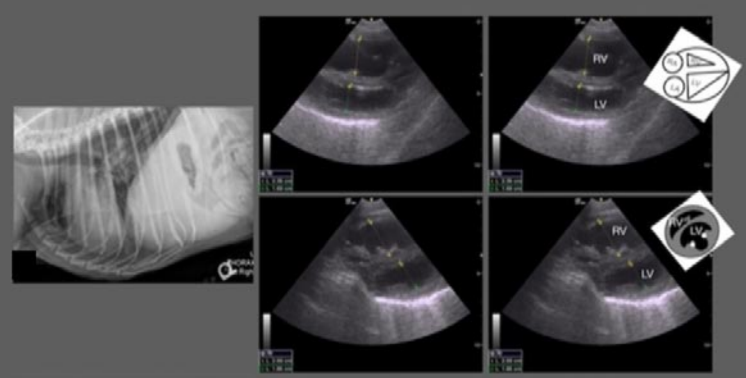
Prognosis:

1) If in heart failure, prognosis is typically a few months to 2-years
2) Prognosis is shorter in the presence of severe arrhythmias
3) Diagnosed prior to the development of heart heart failure, prognosis is typically years
4) Always consider the risk of sudden cardiac death

Other Comments:

1) Condition is only suspected or missed by thoracic radiography likely because the heart subjectively may not appear to be severely enlarged as compared to the size of the thorax
2) Certain boutique grain-free diets have been associated with DCM in atypical breeds Obtain diet history in all dogs with DCM
3) Cost of medications, i.e. pimobendan, is high in these large breed dogs

*Diagnosis: First line screening test findings are listed keeping in mind that the gold standard test is echocardiography by a cardiologist or similarly advanced trained sonographer.



Pulmonary Hypertension - Right TFAST PCS View - LAX, SAX

Pulmonary Hypertension (PHT)

1st Line Screening:

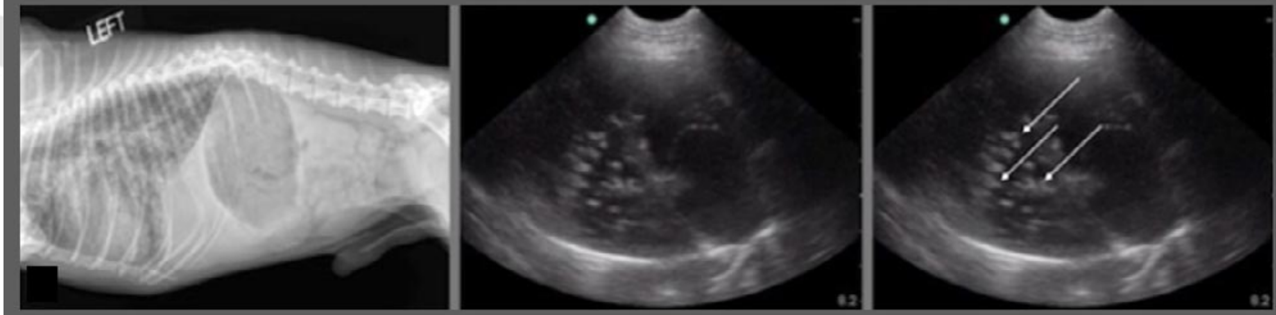
1) Enlarged right ventricle on long-axis 4-chamber view (RV:LV)
2) Compression (or flattening) of the interventricular septum (IVS) into the left ventricle observed at the short-axis "mushroom" view
3) Enlarged pulmonary artery, that is, larger in diameter than the aortic diameter
4) A FAT or distended caudal vena cava and its associated hepatic veins (Tree Trunk Sign) via the AFAST®-TFAST® Diaphragmatico-Hepatic (DH) View
5) History of chronic respiratory disease, heartworm disease (Dirofilariasis)
6) History of syncope or collapse is common
7) Breed Predilection – Small breed dogs (West Highland White Terrier have increased risk for pulmonary fibrosis)
8) If dog is in respiratory distress, B-lines may be present secondary to the PHT and can mislead the clinician into thinking that left-sided CHF is present thus an

integrative Global FAST® Approach including TFAST® and its heart and caudal vena cava and hepatic veins assessment is important

- B-lines represent pre-capillary pulmonary edema, which is non-responsive to diuretics
- Vet BLUE® and its B-line Scoring System may be used to dictate therapy and track response
- Vet BLUE® and its Visual Lung Language can help screen for aspiration pneumonia (Shred Sign in gravity-dependent regions)
- Vet BLUE® and its Visual Lung Language can help screen for PTE (Wedge Sign in upper non gravity-dependent regions)

Treatment:

1) Sildenafil (phosphodiesterase III Inhibitors, PDE III)
   - Get a pre-treatment Vet BLUE® profile recorded (B-line scoring System) to track response to treatment
2) Other Supportive Care, e.g. oxygen supplementation, sedation, antibiotics if concurrent aspiration pneumonia, anti-thrombolytics if pulmonary thromboembolism (PTE), bronchodilators, inotropes
3) If dog is in right heart failure, diuretics and pimobendan are indicated
4) If dog has severe heartworm disease or pulmonary fibrosis and pulmonary hypertension, corticosteroids are indicated



Heartworm Disease - Right TFAST PCS View

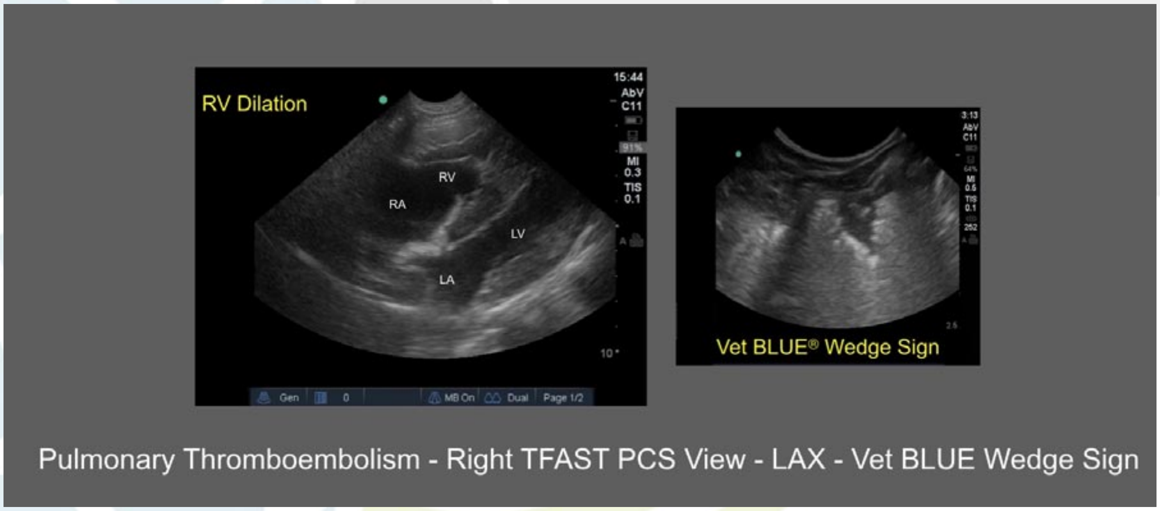
Prognosis:

1) Guarded and contingent on severity of concurrent lung disease
2) Some dogs will respond favorable and have a limited life span with treatment (months – 1-year)

Other Comments:

1) PHT dogs often have wet lung on Vet BLUE® that is mistaken for left-sided congestive heart failure
2) PHT-pulmonary edema is resistant to loop diuretic therapy
3) PHT dogs can have additional pulmonary complications including aspiration pneumonia and pulmonary thromboembolism (PTE)
4) In a recent study right-sided POCUS cardiac markers were *not* reliable for screening for PHT, thus if PHT is highly suspected or the clinician wants to rule out, a complete echocardiogram is necessary
5) The most reliable TFAST® echo view for non-cardiologists for right ventricular enlargement is the long-axis 4-chamber view - the short-axis is too unreliable unless the IVS is flattened.
6) Condition is only suspected or missed by thoracic radiography

*Diagnosis: First line screening test findings are listed keeping in mind that the gold standard test is echocardiography by a cardiologist or similarly advanced trained sonographer.



Pulmonary Thromboembolism - Right TFAST PCS View - LAX - Vet BLUE Wedge Sign

Pulmonary Thromboembolism (PTE):

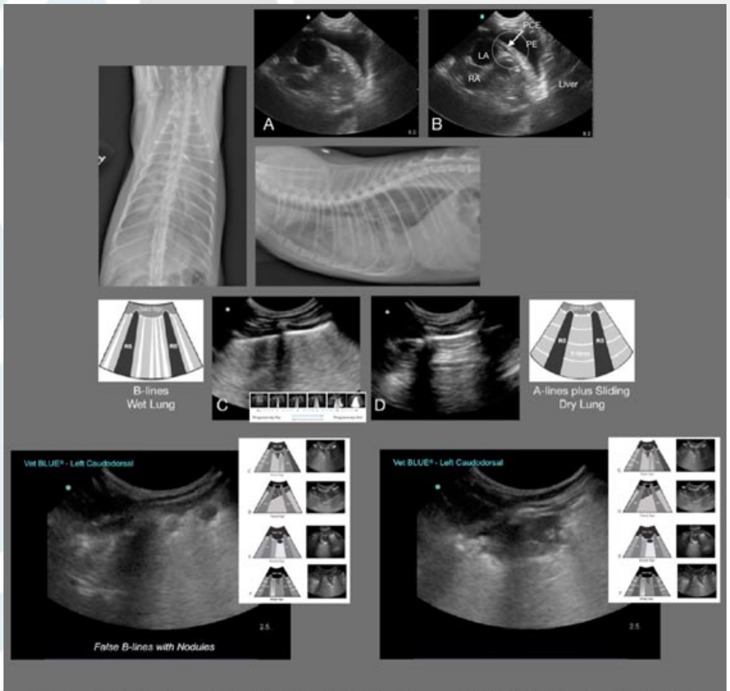
*1st Line Screening:
1) Enlarged right ventricle (RV), if acute RV dilatation *without* concentric hypertrophy supported by an increased RV:LV, defined as close to 1;1
2) Wedge Sign in upper Vet BLUE® lung regions
3) Possible sonographically-detected clot at bifurcation of the pulmonary arteries
4) Dogs in acute respiratory distress often associated with circulatory collapse
5) Suspected in dogs with increased risk factor for thromboembolism such as hemolytic anemias, protein-losing enteropathies or nephropathies, endocrine disease, neoplasia, polytrauma, pancreatitis, central venous catheters

Treatment:
1) Supportive and Symptomatic – oxygen supplementation
2) Anti-thrombolytics for acute, life threathing PTE
3) Thromboprophylaxis - Clopidogrel, Aspirin, Low Molecular Weight Heparin, Unfractionated Heparin, Anti-Xa Therapy (Rivaroxaban)

Prognosis:
1) Historically, grave to guarded as most dogs do not survive a symptomatic PTE event
2) Now, the use of Vet BLUE carries the potential for earlier detection of small PTE triggering thromboprophylaxis therapy and serving as a monitoring tool

Other Comments:
1) Other supportive findings
   Elevated D-dimers, Increased MA on thromboelastography
   Preexisting factors
2) Gold standard test - computed tomography pulmonary angiography (CTPA)
3) Most commonly affected canine and feline affected lung lobes are unknown
4) Condition is nearly always missed by thoracic radiography

*Diagnosis: First line screening test findings are listed keeping in mind that the gold standard test is Computed Tomography Pulmonary Angiography (CTPA); however, complete echocardiography by a cardiologist or similarly advanced trained sonographer may also make the diagnosis.



Pleural Effusion in a Cat - Pericardial Effusion and Vet BLUE Lung Evaluation

Pleural Effusion (PE) - Cats

*1st Line Screening:

1) Follow the tenets for an accurate TFAST® diagnosis of pleural effusion (PE) in the TFAST® Proceedings
2) See the heart in its entirety to avoid mistaking heart chambers for PE
3) Triangulations of free fluid within pleural space
4) Multiple views - one view is no view
5) Radiography is a good test (but may not be helpful in characterizing the etiology of the pleural effusion)
6) Most common causes of pleural effusion in cats are congestive heart failure and neoplasia. Other causes include pyothorax, FIP, idiopathic chylothorax
7) Look for pericardial effusion and an enlarged left atrium in cats as it makes CHF the top differential
8) Look for anterior mediastinal mass supportive of neoplasia
9) Look at lung surface doing Vet BLUE® for lung surface pathology
   - B-lines support CHF but also can be due to pressure atelectasis - do serial Vet BLUE® exams - and other less common causes
   - Nodules and other signs of consolidation support *non*-cardiac causes

Treatment:

1) Thoracocentesis as diagnostic and therapeutic dependent on the respective case
2) Fluid analysis is helpful to establish etiology of pleural effusion
2) If clinical Vet BLUE® - B-line Scoring System helps dictate loop diuretic usage - keeping in mind other causes of B-lines including pressure atelectasis
3) If Nodule Sign and other signs of consolidation then consider lung lobe aspirate or other imaging to find a source to sample or other clinical information dictating another diagnostic plan, i.e. fungal testing

Prognosis:

1) Prognosis varies, and is contingent on the underlying cause of the pleural effusion.

Other Comments:

1) Post-thoracocentesis imaging with ultrasound and radiography may be helpful in diagnosis
2) Point-of-care proBNP testing can also be helpful to either establish or refute a diagnosis of heart failure if uncertain based on imaging.

Global FAST® Goal-Directed Template

Sonographer ________ Patient Name_________ Date/Time________ Sedation? Y ☐ N ☐ If yes, type of_________________

Patient positioning: Sterestandin ☐ Lateral - Left ☐ or Right ☐ or Modified sternal ☐

Vet BLUE® LEFT

Lung Sliding Yes ☐ or No ☐ or Indeterminate ☐ or Not Assessed ☐

If PTX, **Lung Point** located - Upper 1/3 ☐ Middle 1/3 ☐ Lower 1/3 ☐

Indeterminate ☐ Not Assessed ☐

Cd - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterminate ☐ Not Assessed ☐

Shred ☐ size___ Tissue ☐ size___ Nodule ☐ size___ Wedge ☐ size___

Ph - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterminate ☐ Not Assessed ☐

Shred ☐ size___ Tissue ☐ size___ Nodule ☐ size___ Wedge ☐ size___

Md - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterminate ☐ Not Assessed ☐

Shred ☐ size___ Tissue ☐ size___ Nodule ☐ size___ Wedge ☐ size___

Cr - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterminate ☐ Not Assessed ☐

Shred ☐ size___ Tissue ☐ size___ Nodule ☐ size___ Wedge ☐ size___

TFAST® LEFT Pericardial Site: Pleural Effusion Absent ☐ Present ☐ Mild <1 cm ☐ Moderate >1 cm <3 cm ☐

Severe >3 cm ☐ Indetermimate ☐ Not Assessed ☐

*Pericardial Effusion - See Right TFAST Pericardial Site

FAST Diaphragmatico-Hepatic (DH) View

Caudal Vena Cava: Bounce (fluid responsive CVC) ☐ Flat (hypovolemic CVC) ☐

FAT (fluid intolerant CVC) ☐ Indeterminate ☐ Not Assessed ☐

Hepatic Venous Distension: Absent ☐ Present ☐ Indeterminate ☐ Not Assessed ☐

Pleural Effusion: Absent ☐ Present ☐ Mild <1 cm ☐ Moderate >1 cm <3 cm ☐

Severe >3 cm ☐ Indeterminate ☐ Not Assessed ☐

Pericardial Effusion: Absent ☐ Present ☐ Mild <1cm ☐ Moderate >1 cm <3 cm ☐

Severe >3 cm ☐ Indeterminate ☐ Not Assessed ☐

Vet BLUE®: B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterminate ☐ Not Assessed ☐

Shred ☐ size___ Tissue ☐ size___ Nodule ☐ size___ Wedge ☐ size___

AFAST® Sternal/standing ☐ Lateral - Left ☐ or Right ☐ or Modified sternal ☐

Diaphragmatico-Hepatic (DH) 0 ☐ *1/2 ☐ 1 ☐ Indeterminate ☐ Not Assessed ☐

Spleno-Renal (SR) 0 ☐ *1/2 ☐ 1 ☐ Indeterminate ☐ Not Assessed ☐

Cysto-Colic (CC) 0 ☐ *1/2 ☐ 1 ☐ Indeterminate ☐ Not Assessed ☐

Hepato-Renal Umbilical (HRU) 0 ☐ *1/2 ☐ 1 ☐ Indeterminate ☐ Not Assessed ☐

Total Abdominal Fluid Score (AFS) 0-4:** __________ *If positive as patient status allows, move to either lateral recumbency and WAIT 3-minutes to allow fluid to redistribute before ***repeating AFAST® and ***assigning*** the AFS.

Hepato-Renal 5th Bonus View:** *0 ☐ 1/2 ☐ 1 ☐ Indeterminate ☐ Not Assessed ☐ ****Not part of AFS

Focused Spleen: Unremarkable ☐ Abnormal ☐ Indeterminate ☐ Not Assessed ☐

Figure. Example of a Global FAST® Goal-directed Template.

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"Put the "I" in Ocular Ultrasound - It's Fluid-Filled, Image It!"
Ocular Ultrasound

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Patients with intra- and periorbital disease are often presented on an emergency basis. Ultrasonography of canine, feline and equine ocular structures is safe, quick, relatively well-tolerated, and inexpensive. Ocular ultrasound is an easy noninvasive way to evaluate the peri- and intra-ocular structures for the diagnosis of numerous emergency disorders of the globe and orbit. The procedure can be performed in the awake patient (typically), and uses non-ionizing, non-harmful electromagnetic radiation. With practice, it can become a frequently used tool in your practice to compliment the both the emergency and routine ophthalmologic evaluation in the clinical setting.

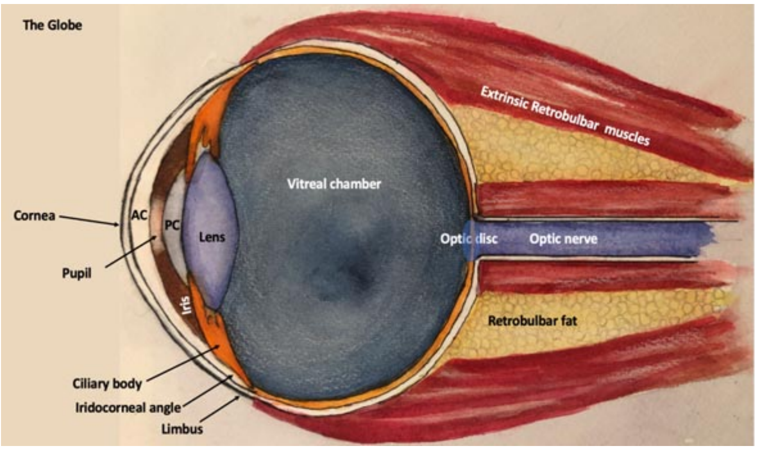
Ocular ultrasound is essential to ophthalmology and imaging specialists for exploring the globe and orbit (Gonzalez, 2001). Despite this, there is limited veterinary literature on the specific topic of veterinary point-of-care ocular ultrasound. A recent Pubmed key word search including the words "veterinary, ocular, emergency, ultrasound and ophthalmologic" revealed zero results. Regardless, point-of-care ophthalmologic ultrasonography is especially useful when the ocular examination is limited by imposing pathology such as blephoro- or conjunctival angioedema / chemosis, opaque corneal hyperpigmentation, cataracts or any other condition that obscures visual or fundoscopic inspection of the globe.

Ultrasound can be used when retrobulbar pathology is suspected; when access an imaging or ophthalmologic service is unavailable; or when advanced cross-sectional imaging modalities (CT or MRI of the head) are not possible. Color Flow and power Doppler interrogation can aid in evaluation of normal ocular and abnormal lesion blood flow. Familiarity with basic gross and fundoscopic ocular anatomy; and common ocular afflictions is required for a successful ultrasonographic diagnosis and prognosis. Real-time lesion sampling with ultrasound guided fine needle aspiration or biopsy can provide a definitive diagnosis.

Indications

Point-of-care ocular ultrasound (or a global look at the globe) can be performed in any patient with suspected ocular pathology. It is especially useful when a pathologic entity is obscuring all or a portion of the globe and intraocular soft tissues. Ultrasound can be used as a sensitive tool to screen for retinal detachment (e.g.in hypertensive or glaucoma patients). Additional specific indications for ocular ultrasound include: Corneal opacification (edema, scarring, hazing, hyperpigmentation, keratitis); anterior chamber hemorrhage, inflammation or exudate; corneal lacerations, erosions/ulcers; intra-orbital foreign body; trauma in general, disparate globe size; exophthalmia; cataracts; intra-ocular or intra-orbital neoplasia; uveitis, systemic illness and infectious disease; and vision loss.

Schematic of normal gross ocular anatomy



Normal gross and ultrasonographic ocular anatomy and terminology

Globe- consists of the outer fibrous (scleral and corneal), middle vascular (uveal) and inner nervous (retina) tunics

Limbus- sclero-corneal junction

Cornea- convex, thin, anterior most structure

Uveal tract- consists of the iris, ciliary body (muscle and process), and choroid (pigmented vascular structure).

Lens- biconvex, avascular structure with capsule round on the transverse plane, elliptical in in the sagittal place

3 intraocular chambers-

- ***Anterior***- bound anteriorly by the cornea, posteriorly by the iris, leads into the iridocorneal angle; contains aqueous humor
- ***Posterior***- bound anteriorly by the posterior aspect of the iris; anterior lens capsule and zonules posteriorly; contains aqueous humor
- ***Vitreal***- largest of the 3 chambers bound by the lens anteriorly, and retina posteriorly; contains the vitreal body

Optic disc and nerve- surrounded by the retrobulbar muscles and fat

3rd lid- deep to the ventromedial palpebra, may be seen as an iso- to hyperechoic structure

Retina/choroid- hyperechoic posterior boundary that in the normal state cannot be differentiated

Globe anatomy is described from anterior to posterior. The eye consists of the cornea, anterior chamber, uveal tract, lens, vitreal body (or vitreous), retina (within which the optic disc resides), and retrobulbar space (or periorbital cone). Structures in the posterior periorbital cone include the extrinsic ocular muscles, optic nerve, accompanying arteries and veins, and periorbital fat. Other structures that may come into view during the ultrasound exam include the dorso- temporolaterally located lacrimal gland and the ventromedially located nicitans and lacrimal sac. Posterioventral to the globe is the salivary gland which are often indistinct. *Courtesy of Suzanne Durand for anatomic illustrations, Philadelphia, PA.*

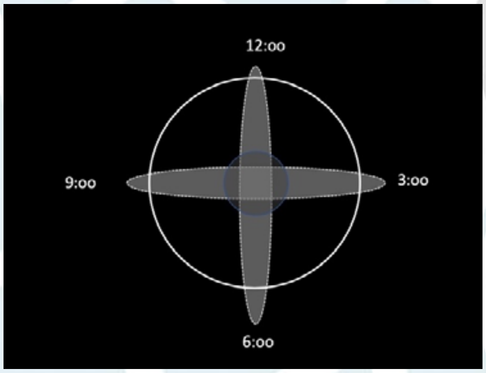
Probes

Higher frequency transducers (7.5-12 MHz) are used for ultrasonography of the eye. High frequency ultrasound transducers with beyond 12 MHz (25-50 MHz) or ultrahigh frequency probes are generally ocular specific and reserved for use and purchase by the ocular specialist. Linear transducers are best for near field structures whereas convex transducers provide good depth and are generally easier to manipulate upon the globe and along the periocular and periorbital bony and soft tissues. Both eyes are scanned for comparative evaluation.

Ocular ultrasound directional terms and probe placement

The eye is imaged in 3 main planes including transverse, sagittal and dorsal planes. Oblique planes are used when additional vantage points are required for interrogation of specific pathology. The entire globe is typically interrogated with an active, real-time, "fanning and scanning" motion. It is important to document which eye is being imaged at a specific time point and the directional position of the transducer’s marker.

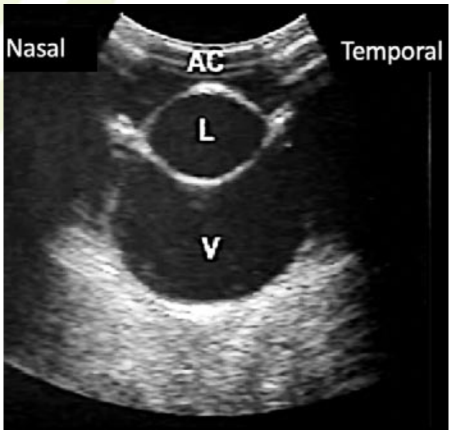
The globe is spherical. Because the orbit is incomplete in dogs and cats, the retrobulbar space is not totally surrounded by bone allowing for a nice sonographic window laterally. The transverse and sagittal planes are the equators and poles of the globe respectively. Although there is no set established convention in veterinary medicine for where to place the probe marker. I generally place the probe marker nasally in the transverse plane, and dorsally in the sagittal plane. A clock face analogy is helpful in documenting lesions and describing sonographer orientation. The dorsal plane is posterior to the limbus and the beam is aimed ventrally and fanned anterior to posterior with the transducer’s marker oriented medially. The sagittal plane (12:oo-6:oo) and parasagittal planes run dorsal to ventral.



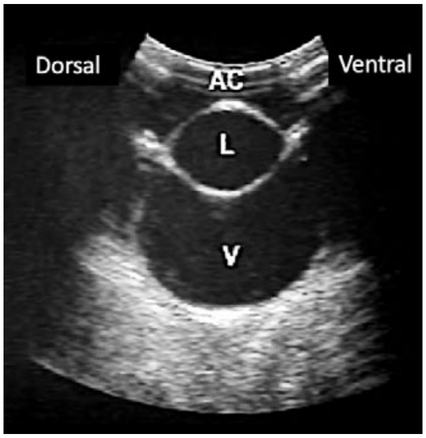
The transverse and sagittal planes are along the equator and poles of the globe, respectively. Using the clock face analogy, the transverse planes run from 9:oo-3:oo and the sagittal plane runs from 12:oo to 6:oo.

Transverse probe placement (nose is to the left the image).

Notice how the anterior-most portion of the eye is displayed to the top of the screen/image.



Sagittal probe placement (nose is to the left the image).



Dorsal probe placement (transpalpebral, nose is to the left of the screen).

Transcutaneous para-termporalretrobular probe placement (sagittal show).
Begin by orienting

The sonographic approach to the eye

The patient is seated in sternal recumbency with gentle restraint. Three B-mode methods are used to interrogate the eye. A direct trans-corneal or trans-scleral probe placement on the globe; a trans-palpebral approach through the lids and external periocular soft tissues; or by using a standoff pad or water bath over the globe wall. Either the trans-corneal or trans-palpebral are acceptable in the clinical emergency setting. The trans-corneal approach allows for assessment of the cornea and anterior chamber. A water bath or standoff pad can present some challenges and be cumbersome. Both eyes are always evaluated comparatively.

If only one eye is affected, the unaffected eye is a highly valuable "normal" baseline structure. The trans-palpebral approach may be achieved without the instillation of local anesthetic. The trans-corneal approach requires instillation of a regional local anesthetic through the palpebral commissure a few minutes prior to the exam. The transducer can then be gently applied to the corneal surface with a sterile water-soluble lubricating acoustic coupling gel. The trans-corneal approach offers the best means by which to evaluate the cornea and anterior chamber; whereas the trans-palpebral approach does not (even typically with the use of a water bath). For the transpalpebral approach, clipping a small area of fur (versus just parting the fur) can greatly improve visualization. Upon completion, the eyes are rinsed with sterile saline.

Three main planes of interrogation are used, as described. The transverse and sagittal (directed from anterior to posterior) and dorsal planes (directed from dorsal to ventral). The midline aspect of the globe is the equator. The sonographer can glide the probe gently along the surface of the cornea or blephora. A clock face analogy is used to denotate the location of pathology. Directing the beam through the sclera or limbus (trans-scleral / limbal approach in the dorsal plane) offers an excellent means by which to evaluate the globe's posterior; whereas a direct transcorneal or a near mid-line transpalpebral (transverse) approach with the lids closed can provide good visualization of the lens and vitreous, but can also offer a window for evaluation of the iris.

A shallow focal zone with variable gain settings are used. Depth should be adjusted so that the image of the eye fills the screen. An ideal gain setting is ~70 decibels. High gain settings (>100 decibels) allow for excellent evaluation of (intra) anterior-, posterior and vitreal mass lesions. Low gain settings (40 decibles) aid in evaluating retinal detachment (versus vitreal detachment, which disappears at low gain settings). High gain settings can lead to the artifactual impression of abnormalities in the fluid filled chambers. Begin with the gain on a high setting and actively make effort to adjust down and up throughout the scan as needed.

If the patient objects the examination, light sedation in addition to a topical anesthetic may be used. Heavy sedation and general anesthesia are avoided as the globe will have tendency to rotate ventrally hampering interpretation.

The point-of-care ocular emergency format

A standardized veterinary point-of-care ocular format is not previously described. A preliminary approach is as follows:

1) Transverse view- the probe is oriented transverse to the pupil along the equator (9:oo-3:oo). Fan and glide dorsal to ventral. Medial should always be to the left of the screen and the probe marker toward the nose.

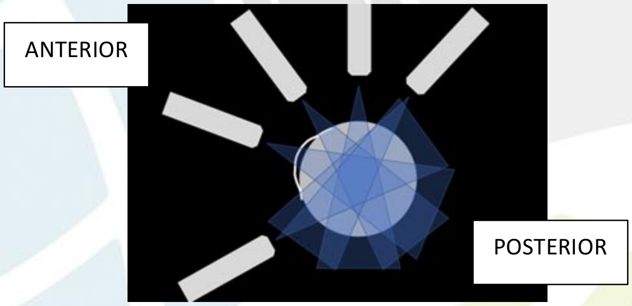
2) Sagittal view- the probe is oriented sagittal to the pupil on midline along the dorsal to ventral plane (12:oo-6:oo). Fan and glide nasal to temporolateral. Dorsal should always be to the left of the screen and the prober maker is "up" or dorsal.

3) Dorsal view- the probe is oriented horizontally, at the limbus aimed ventrally. Fan and glide toward the nose and retrobulbar space. Slide as posteriorly as possible. Repeat from the ventral margin of the globe. Medial should be to the left of the screen and the prober marker is toward the nose.

4) Retrobulbar paratemporal view- the probe is oriented transverse just temporocaudal to the globe, with the probe marker oriented toward the globe. Direct the beam into the retrobulbar space. Fan rostrally and caudally. Glide dorsally and ventrally as needed to cover the entire retrobulbar space. Repeat in the sagittal plane.

With trauma or suspected osteolyitc or proliferative disease, the bony orbit may be evaluated by tracing along the contour of the bones with the probe. Multiple 3 second cine clips can comprise the whole study (total 5-10 clips).

The entire scan for one eye can be achieved in under 5 minutes with attained skill. Still images can also be obtained as needed. The cine clips need to be labeled appropriately, and the findings recorded as you go.



Sonographic features and echogenicity of ocular landmarks

STRUCTURE	ECHOGENICITY
LIDS	**HYPERECHOIC**
CORNEA	**CENTRALLY HYPOECHOIC WITH 2 ECHOGENIC LINES**
Anterior chamber	**ANECHOIC**
Uveal tract	**HYPERECHOIC**
Posterior chamber	**ANECHOIC**
Lens	**HYPERECHOIC CAPSULE ANECHOIC CENTER**
Vitreal body	**ANECHOIC**
Sclera/retina	**HYPERECHOIC**
Optic cup	**HYPERECHOIC**
Optic nerve	**HYPOECHIC**
Retrobulbar space: Extrinsic muscles Retrobulbar fat	**HYPOECHOIC** **HYPERECHOIC**
Bony Orbit	**ECHOGENIC SHARP INTERPHASE THAT CASTS A CLEAN DISTAL ACOUSTIC SHADOW**

Eyelids- echoic, become indistinct with applied pressure

Cornea- curvilinear hyperechoic structure in near field, parallel to the lids. Appears as two think hyperechoic centrally anechoic- band (especially at higher frequency); or hyperechoic band. Requires a trans-corneal approach, stand-off pad or water bath

Anterior chamber- anechoic region deep to the cornea, fluid-filled chamber (aqueous humor)

Uveal tract- iris and ciliary body (anterior); choroid plexus (posterior). Hyperechoic structures at periphery of the pupil, separates the anterior and posterior chamber.

Posterior chamber- anechoic region deep to the iris, aqueous humor fluid-filled chamber

Lens- deep to the posterior chamber, normally anechoic (sans cataract)

Vitreous- deep to the posterior lens capsule, normally anechoic (sans asteroid hyalosis)

Sclera/retina- indistinguishable layers, hyperechoic posterior-most curvilinear border of eye

Optic cup- variable in appearance, slightly more hyperechoic than the confluent posterior wall. May have a slight depression, be flush or be a small (1-2 mm, <3 mm) bump in posterior wall

Optic nerve- hypoechoic linear structure coursing posteriorly, surrounded by hyperechoic fat

Extrinsic muscles- hypoechoic, +/- slightly striated, course in the retrobulbar fat in a triangular cone shape

Challenges in ocular ultrasonography

Skill acquisition and maintenance; ultrasound technical savvy, sound anatomic knowledge of ocular structures and function; and an optimal image are required for a successful ocular ultrasound study, accurate interpretation and diagnosis. Anything less can lead to misdiagnosis and mis-management. The approach should be performed the in the same way every time. Based on personal experience with resident trainees, there is a steep, but short learning curve that is easily overcome with practice and studying. A common challenge is mental conversion of the indirect fundic exam image to what is seen on the ultrasound screen. It can be challenging for the novice to understand the 3-D to 2-D localization of intraocular lesions.

Limitations of ocular ultrasound

Ocular ultrasound has its limitations. It's not possible to evaluate the entire orbit and retrobulbar/periocular bony and soft tissues. An ideal and concise point-of-care ocular ultrasound training protocol does not exist. The learning curve for use of veterinary ocular point-of-care ultrasound in the emergency setting by the general practitioner veterinarian is not well established or documented. A standardized scan point-of-care protocol or submission protocol is also not yet established and would aid in seamless tele-radiographic interpretation.

Ultrasound guided interventional procedures (fine needle aspiration or biopsy)

Yikes! A needle in the eye….? Generally, intraocular or deep retrobulbar tissue sampling procedures are reserved for the ophthalmologist or imaging specialist. **HOWEVER**, there are many circumstances in which the general practitioner can use ultrasound guidance for periorbital lesion sampling (as with periorbital neoplasia). Intimate knowledge of ocular anatomy and confidence with basic ultrasound guided techniques is required to avoid complications (laceration, globe rupture, peri-orbital hemorrhage or optic nerve damage).

Contraindications

Point-of-care ocular ultrasound should not be performed in cases of descemetocele and should be discontinued in cases in which globe rupture is discovered. Little else should preclude sonographic interrogation of the globe save lack of a basic knowledge of basic ultrasonography physics and ocular anatomy. A basic skill set should be acquired with normal healthy animals in advance of application to the emergency ocular patient.

Medical record keeping and getting your images to the radiologist or ophthalmologist – See and be seen!

The orientation of the probe upon the eye, the sonographers spacial awareness and mental conversion of a 3-D to a 2-D image are critical to properly documenting the location of lesions. Proper documentation and labeling of sonographic findings is an imperative best practice for an accurate interpretation and diagnosis. If a lesion(s) is noted, it must be described by its size, shape, location, margination and number (focal versus multifocal). DICOM or jpg ultrasound images can easily be sent to a teleradiology service or ophthalmologist for referral review. Ultrasound images generally have a low bit depth quality such that sending jpg images is fast and sufficient in quality for review with regard to resolution. A standard submission protocol for seamless tele-radiographic or referral interpretation is not established. Using the above discussed protocols, we can work toward establishing an accurate and repeatable method of evaluating the eye with a point-of-care approach. In summary, ocular ultrasound is a valuable diagnostic modality that can readily be performed in the emergency setting when a standard ultrasound machine is available.

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2nd International Veterinary Point-of-Care Ultrasound Society Symposium (IVPOCUS)
November 18-20, 2019, Austin, Texas, USA

"Expecting the Unexpected in Ultrasound Technology and Ultrasound-Guided Procedures"

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Contents
Point-of-care ultrasonography (POCUS) allows clinicians to perform focused bedside diagnostic evaluations and can guide periprocedural decision-making when an invasive procedure is indicated. Use of POCUS to guide site selection or visualize needle insertion during performance of invasive bedside procedures has been shown to reduce procedure-related complication rates and improve procedural success rates. New technologies are emerging that will improve the safety and ease of performing ultrasound-guided bedside procedures.

Objectives

- Review the current evidence supporting the use of ultrasound to guide the most common bedside procedures in medicine.
- Provide clinical pearls for the use of ultrasound for common bedside procedures performed by veterinarians.
- Present new and emerging technologies that will improve use of diagnostic and procedural POCUS applications in the future.

Key points

- Use of ultrasound guidance improves overall procedure success rate for all 4 procedures listed below and additional benefits include:
    - Vascular access – reduction in arterial punctures, hematomas, needle passes and attempts,
    - Thoracentesis – reduction in pneumothorax, hemothorax, and liver/spleen lacerations
    - Paracentesis – reduction in procedure-related bleeding and attempts in patients with insufficient peritoneal free fluid to drain
    - Lumbar puncture – reduction in the number of attempts, needle passes, and needle redirections.
- Real-time ultrasound guided needle insertion can be performed using a transverse (out-of-plane or short-axis), longitudinal (in-plane or long-axis), or oblique approach. Key characteristics of each approach include:
    - Transverse approach – easier to learn, preferred for deep procedures, operator must maintain needle tip visualization
    - Longitudinal approach – preferred for superficial procedures, entire needle tip and shaft visualized, requires more practice than transverse approach, needle visualization software available
    - Oblique approach – hybrid of transverse and longitudinal approaches, beneficial when vessel course and ultrasound beam cannot be aligned
- Several new ultrasound software applications are emerging that will improve the safety and ease of performing ultrasound-guided bedside procedures
    - Needle visualization software – longitudinal >> transverse approach
    - Artificial intelligence – improving diagnostic accuracy of ultrasound and other imaging modalities.

References & Further Reading

Evidence-based recommendations on the use of ultrasound guidance for bedside procedures were published in 2018-2019 series in the *Journal of Hospital Medicine*. Open access PDFs can be downloaded using these links:
1. Thoracentesis (click here)

2. Credentialing (click here)
3. Point-of-care Ultrasound for Hospitalists (click here) – Appendix has an excellent reference list (click here)
4. Paracentesis (click here)
5. Lumbar Puncture (click here)
6. Central and peripheral venous access (click here)

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