Practical Echocardiography:
ECHOES in the “REAL WORLD”

Know When to Hold ‘Em and When to Fold ‘Em

Introduction

The use of ultrasound in private veterinary practice is continuing to grow. The popularity of ultrasound as a diagnostic tool lies in its ability to image internal structures including abdomen, thorax (heart), eye, and appendages in a non-invasive manner. Information about the many uses of ultrasound are being disseminated to the practice community not only by university faculty and specialists, but also by recent veterinary school graduates who are now routinely trained in ultrasound.

One of the concerns of practitioners learning about ultrasound is that, particularly with echocardiograms, the US machines routinely used in practice do not have Doppler capabilities; they want to know if they can perform echocardiograms on their patients without Doppler, or without cardiac measurement software on their US machines.

The answer is “YES! – you can examine hearts with your US machine” even without Doppler or a cardiac measurement package. There is much information to be gained, and our goal today is to examine that information, learn the uses and limitations of cardiac ultrasound in a general practice, and put referral echocardiograms (complete cardiac exams performed by a specialist) in perspective:

• What you can realistically do for your patients with 2-dimensional grey-scale and M-mode US?
  • What can you reliably diagnose?
  • Can you do echocardiograms without Doppler?
  • When to refer to specialist for advanced workup?

Parts of the Echo Exam

• 2-dimensional imaging or real-time imaging
• M-mode: “ice pick” view of the heart
  – location of the cursor determines the portion of the walls and heart chambers measured
  – Can see movement of structures over cardiac cycle (systole/diastole)
• Doppler: color, pulsed wave, and continuous wave

Indications for echocardiography

• Indications based on
  • History/signalment
  • Physical examination
  • Good quality lateral and ventrodorsal thoracic radiographs
  • Auscultation of murmur, arrhythmias
Including gallop rhythm in cats
- Evidence of heart failure
- Suspected cardiac neoplasia, bacterial endocarditis, or pericardial effusion
- Suspected congenital heart disease

**Practical Echocardiography**
- What you can realistically and reliably do for your patients with 2-dimensional grey-scale and M-mode US?
  - What can I reliably diagnose?
  - Can I do a good job on echocardiograms without Doppler?
- When do I refer to specialist for advanced workup?

Using 2-dimensional grey-scale US & M-mode you can:
- Evaluate cardiac chamber size
- Evaluate wall thickness and motion
- Evaluate valve conformation and motion
- Evaluate for pericardial and pleural fluid
- +/- identify mass lesions associated with the heart

**Echo basics**
- Acoustic window: air in lung interposed between body wall and heart interferes with image quality.
- Need “window” where heart and body wall are in contact.
- Clip hair over the right cardiac apex; window over left cardiac apex optional as needed.

**Echocardiographic Exam technique**
- Apply US gel
- Sedation not typically needed
  - If sedation needed, alteration in chamber dimensions, ventricular wall motion and heart rate may arise
- Patient positioning
  - “Down” leg well forward to maximize cardiac window
  - Head should be recumbent and still; head movement changes heart position and increases difficulty.
- Use the highest MHz transducer available, and then switch to the next highest MHz transducer only when needed for additional penetration to deeper body structures on larger patients
- Adjust depth of field on US machine such that heart occupies 75% of the screen
- Image angle should be 50-70 degrees to improve resolution

Right parasternal window
• Feel apex beat
• Approximately 3=6 IC spaces
• B/t sternum and costochondral junction
  – Slightly more dorsal than CC junction in some dogs
  – Probe perpendicular to the body instead of at an angle

Transducer location – right intercostal

  • Long axis view
    • all 4 chambers
    • mitral, aortic, tricuspid, and pulmonic valves
    • Aortic root/left ventricular outflow view
  • Short axis view
    • Rotate 90° counter clockwise from long-axis
    • standard site of M-mode measurements (can also be performed from long axis view
    • Doppler evaluation of the pulmonic valve
    • Should be able to see:
      • Left ventricle
      • Chordae tendinea
      • Mitral valve
      • Heart base with aorta
      • Heart base with pulmonary artery

Left apical/parasternal window:

  • Feel apex beat; apex will be closer to sternum
  • Left intercostal- view of all 4 chambers, all 4 valves by rotation of probe
  • Used to better visualize the right heart
  • Parallel to flow- ideal location for Doppler evaluation of the valves
  • 4 chamber view
    • Good for assessing movement of mitral and tricuspid valves

  **Real time imaging of the heart**
  • provide anatomic view of the heart
• relative chamber size
• wall motion
• valve motion and appearance
• Advantages include ability to detect right heart changes, masses, and pericardial effusions

M-mode imaging
• Cursor placement from standard 2-dimensional image determines placement for M-mode
• Quantitative measurement of chamber dimensions, wall thickness, and valvular motion
• Multiple cardiac cycles are viewed simultaneously
• Disadvantages:
  – anatomic relationships may be difficult to define
  – Discrete lesions may not be visualized due to small sample size
• Sampled along cursor line and plotted over time; allows separate examination of structures in systole/diastole
• Why M-mode? Because measurements and motion throughout the cardiac cycle are more accurately obtained from the tracings than two-dimensional images
  – Careful placement of the cursor cannot be overemphasized
  – Incorrect placement results in spurious measurements of cardiac structures

Left ventricular measurements:
• Measurement of the left ventricular chamber dimensions should be performed at the level of the chordae tendinae (just distal to mitral valve leaflets)
• Diastolic and systolic measurements of LVFW and IVS, and LV chamber
  – Diastolic measurements are made at the onset of the QRS complex, or the widest point in the LV cycle prior to contraction
  – Systolic measurements are made from the point of peak downward motion of the IVS
• Calipers should be placed at the leading edge (edge closest to the transducer) for each parameter
• Functional indices-shortening fraction can be calculated
  – Shortening fraction-% change in left ventricular chamber size
    – %FS = LVIDd-LVIDs/LVIDd x100
  – Indirect measure of contractility
  – Some US machines will calculate %Ejection Fraction (EF)
• Can also measure from 2-D image if M-mode is difficult to obtain

Left atrium to aortic root ratio
The left atrium changes with a variety of disease states, most commonly mitral insufficiency. The aortic root doesn’t often change size in the presence of acquired cardiopulmonary disease, therefore the aortic root is used as each individual’s “normal” to compare to the left atrium.

- If LA measured through the aortic valve in the same plane, the LA size may be underestimated; move cursor for maximum left atrial size.
- Ratio less than 1.7 is normal in dogs and cats.

- Can be obtained in 2-D short or long axis.

**Mitral valve:**

- Mitral valve-septal (anterior) leaflet has biphasic kick or motion.
- D to E represents rapid ventricular filling.
- F point represents partial closure of the valve.
- A point atrial contraction at end diastole (just after the p wave of the ECG).
- C point coincides with valve closure (first heart sound), QRS on the ECG.
- EPSS-e point septal separation clinically an important parameter.
  - Represents distance of the mitral valve to septum.
  - Increase in EPSS with increase in left ventricular chamber size due to decrease in stroke volume (e.g. DCM) and valvular diseases (e.g. mitral regurgitation).
- EPSS: increased when:
  - reduced LV systolic function (poor pumping ability).
  - left ventricular dilation.

**Doppler ultrasound**

Left-sided views mostly are used for Doppler studies, however useful for visualization of prolapsing valves.

- Basilar view
  - Imaging from apex to base of heart.
Mitraal valve insufficiency
• Signalment/history
• Auscultate systolic murmur, left side
• Radiographs may show enlarged LA/Lau
• +/- cough due to mechanical pressure on carina of LA
• Pulmonary edema
• Measure LV/RV using M-mode
  • Calculate FS%
  • Assess right ventricle
• LA:Ao ratio
• View mitral/tricuspid valve
  • Size
  • Echogenicity
  • Movement
    • Prolapse?
• Right parasternal short axis view at level of aortic valve
  • Enlarged LA:Ao ratio
  • This may be monitored using grey-scale US for continued enlargement or regression
• Right parasternal short axis view at level of chordae tendinae
  • %FS is indirect measure of contractility
  Normal %FS means everything is OK, right????
• How do we interpret contractility with mitral insufficiency?
  – Elevated %FS: normal myocardial function
  – Normal %FS: decreased myocardial function
  – Decreased %FS: decreased myocardial function
• Myocardium pumps harder/faster to maintain forward flow in the presence of an insufficiency
• Left apical or parasternal 4 chamber view
  • Valve conformation
  • Valve movement
  • +/- prolapse
  • +/- chordae rupture
• Doppler (if available) to visualize regurgitant jet and quantify
• Assess pulmonary veins
• Assess response to treatment

Dilated cardiomyopathy (DCM) in dogs
• Breed predispositions
  • Dobermans
  • Boxers
  • Dalmatians
  • Cocker spaniels
  • Large breeds in general
• Rare in cats with addition of taurine to commercial diets
• LV dilation
• Atrial dilation
• Normal to thin IVS & LVFW
• Reduced FS
• Increased EPSS
• +/- RV dilation
• Stretching of the annulus may lead to
  • insufficient mitral and tricuspid valves
  • Left and right atrial enlargement

Hypertrophic cardiomyopathy (HCM) in cats
• Rare in other species
• Left ventricular hypertrophy
  – Small to normal LV diameter
  – Symmetrical most common
    • IVS and LVFW affected
  – Asymmetrical
    • IVS or LVFW affected
  – Restrictive
    • Looks normal on radiographs

Hypertrophic Cardiomyopathy in cats
• Fractional shortening increases and heart is visibly hyperdynamic
• LV is visibly smaller
  • Sometimes difficult to get accurate M-mode measurements due to cursor placement
• Myocardial ischemia may be sequela to severe, long-standing disease
• Pericardial effusion seen occasionally
• IVS hypertrophy may cause functional obstruction of LV outflow
  – May be seen on 2-D echo view
• LVFW thickening may displace MV into outflow tract
  – Mitral insufficiency
  – Left atrium may not be dilated
    • worse prognosis if present

Heartworm disease
• Echo is not sensitive tool for diagnosis of this disease
• Secondary changes may be seen:
  • Right ventricular enlargement and hypertrophy
  • dilation of the main pulmonary artery
  • Septal flattening due to right ventricular pressure overload
  • Visualization of worms as “=” in MPA or RV
• Cats – fewer worms make visualization even more difficult

Miscellaneous conditions where US is helpful
• Pericardial disease
  • Pericardial effusion is anechoic (black) space between the free wall of the heart and the epicardium
    – Best seen at the apex rather than the base
  • Tissue density mass may be identified in the pericardial sac in heart base tumors
    – 80% of all heart base tumors are accompanied by pericardial effusion
• Valvular endocarditis
  • Vegetative lesions on valves
  • Most commonly seen on mitral valve in small animals
  • Hyperechoic leaflets, rounded club-shaped leaflets or protrusions
  • Assess for prolapse
  • Blood cultures for positive ID and treatment
• Pleural effusion
• Heartbase masses

(More) Real-world cardiac conditions
• Congenital anomalies – most congenital anomalies need intensive Doppler exams for definitive diagnosis. These can be technically challenging for an experienced ultrasonographer – consider referral to a board-certified cardiologist or radiologist
• PDA
• Pulmonic stenosis
• Aortic stenosis
• VSD
• Tetralogy of Fallot

References
• Veterinary Diagnostic Ultrasound, 1st edition, Nyland & Mattoon ed., 1995
Sample Echocardiogram Report Form

Date:
Case number:
Client name:
Patient name:
Patient weight: ________

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Valves:

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Comments:
Pericardial effusion? Yes ____ No _____

Impression:
1.
2.
3.