Summary Document: Thoracic Radiology and Echocardiography

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These notes have been edited from an original document created by Dr Cathy Beck.

Here are some "rules" for assessing thoracic structures. However rather than being "rules" they are guidelines and must not be used in isolation – make sure you read the entire radiograph and interpret your findings in light of the history, physical examination and results of other tests. You will learn so much more about this in DVM3 and DVM4 so don't panic. The "rules" provided here cover the pulmonary and cardiovascular structures. The introduction to imaging the respiratory system lectures will be delivered in Sept and October.

Thoracic Radiology

The phase of respiration

Dog and cat:

- Inspiration: The leading edge of diaphragm crosses spine at T12 on the lateral radiograph and T10 on a VD/DV projection
- Expiration: The leading edge of the diaphragm crosses spine at T8 on lateral and VD/DV projections

The pulmonary vascular structures

- Veins are ventral and central

Lateral projection

The rules for the lateral projection are less helpful than the VD/DV projection

Dog:

- It is said that the ratio of the diameter of the artery or vein to the proximal fourth rib at the level of the 4th ICS is 0.73 (+/-0.24).
- The useful interpretation of that rules is that the vessels, at the 4th ICS, are considered enlarged when >1.2x the prox third of the 4th rib
- Another rule: vessels should not be larger than the diameter of the prox third rib at the fourth ICS

Cat:

- Right cranial lobar artery should be 0.5-1.0 times the prox third of the fourth rib when measured at the fourth rib.
- The cranial lobe veins should be 0.2cm in diameter at the same point as the above rule.

VD/DV

Dog and cat:

- The pulmonary artery and vein of each caudal lobe should be similar in size.
- The diameter of the artery or vein should be about the width of the 9th rib where they cross it, and no great than 1.2 x the width of the rib

Cat:

- A cut-off for pulmonary arterial enlargement of 1.6x the 9th rib has been suggested in an assessment of heartworm disease

<u>The Heart</u>

Canine cardiac size: rules of thumb

- On a lateral view the cardiac length (vertical line from carina to sternum) should be approximately 70% of the dorsal to ventral distance of the thoracic cavity
- On a lateral view the width (craniocaudal dimension) should be between 2.5 (deep chested breeds) and 3.5 (round chested breeds) intercostal spaces wide
- Cardiac width on a DV view is usually 60-65% of the thoracic width and no more than 66% of the thoracic width at the widest point of the cardiac silhouette on a VD view
- Sternal contact should be 2.5-3 sternebrae

Feline cardiac size: rules of thumb

- In cats the width of the cardiac silhouette should be no more than 2-2.5 intercostal spaces in width on the lateral view
- On the lateral view the maximal width should be approximately the same as the distance between the cranial border of the fifth rib and the caudal border of the seventh rib

Vertebral Heart Scale

Dog: Original normal range: 9.7 vertebrae +/- 1 vertebrae however Buchanan and Buchler (JAVMA 1995) state that up to 11 vertebrae may be normal for some breeds.

Cat: 6.9-8.1

Breed specific normal ranges have subsequently been published for many breeds. Use with caution and never use alone- make sure you read the radiograph using the rules above. The VHS has also been shown to be influenced by the phase of respiration and cardiac cycle. Be careful of the VHS!

Vertebral left atrial size

- Used in dogs with MMVD, and isn't exposed to as much error as VHS
- A VLAS >2.3 can be an indicator of left atrial enlargement

Summary of changes seen with cardiomegaly (dogs and cats unless indicated)

Lateral projection:

- Increased apicobasilar distance (>70% of dorsal to ventral distance of thoracic cavity) and reduction of distance between heart and spine
- Elevation of trachea, rather than deviating from the thoracic spine it runs parallel to the thoracic spine
- Ventral deflection of trachea at base of heart eliminated (dog)
- Compression of lumina of stem bronchi by left atrium (dog)
- Increased craniocaudal diameter of heart (width)
- Straightening of caudal heart border
- Expansion of left atrium into caudal lobar area (left atrial wedge)
- Cranial bulging of right heart border and increased sternal contact
- Change in direction of CVC

Ventrodorsal (dorsoventral projection)

- Increased transverse diameter (width) of heart
- Increased rounding and elongation of heart borders
- Bulging of left heart border due to increased size of left auricle (dog)
- Caudal and leftward displacement of cardiac apex
- "Valentine Shaped" heart (cat)
- Lateral displacement of the caudal lobar bronchi (cowboy legs) due to enlarged L atrium

<u>Mediastinum</u>

Dog:

- The maximum width of the cranial mediastinum on a VD/DV view should be less than twice the width of the vertebral column at this level

Cat:

- The cranial mediastinum should be no wider than the width of the superimposed thoracic spine on the VD/DV

Trachea

Dog:

Normal trachea diameter to thoracic inlet ratio:

- Meso- and longicephalic breeds: 0.21 (+/- 0.03)
- Bulldogs: 0.11 (+/- 0.03)
- Other brachycephalics: 0.16 (+/- 0.03)

CVC

- Variable size, but considered enlarged if consistently larger in diameter than the length of the 5th or 6th thoracic vertebral bodies on the lateral projection

OR

- If the diameter of the CVC is more than 1.5x the diameter of the descending aorta

Basic echocardiography

Please also refer to the practical session notes and the 'Introduction to Point of Care Ultrasound' booklet released in weeks 3 and 4.

When we use ultrasound to assess the heart, we can 'slice through' and see inside. This allows us to assess cardiac structure, chamber size, wall thickness, efficiency of contractility, turbulent blood flow (what we hear as murmurs) and overall function. With ultrasound, fluid (blood) is 'anechoic' or black, and tissue is described at levels of echogenicity (grey and white).

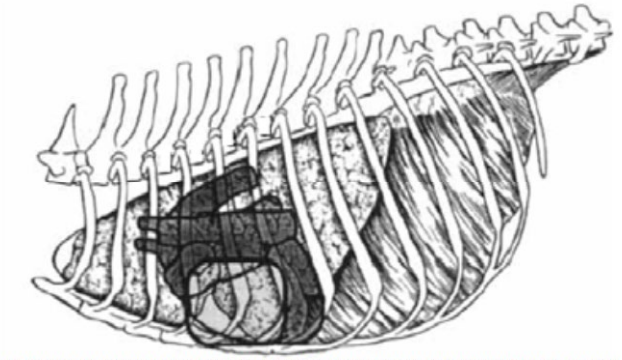
B mode: produces a 2D cross sectional image of the heart and demonstrates cardiac morphology

M mode: uses a single beam of ultrasound to display the echo as a distance-time graph. It is useful time dependent measurements such as chamber and wall dimensions.

Doppler: uses the Doppler principle to calculate the velocity of red blood cells (i.e. the flow of blood).

Right parasternal window

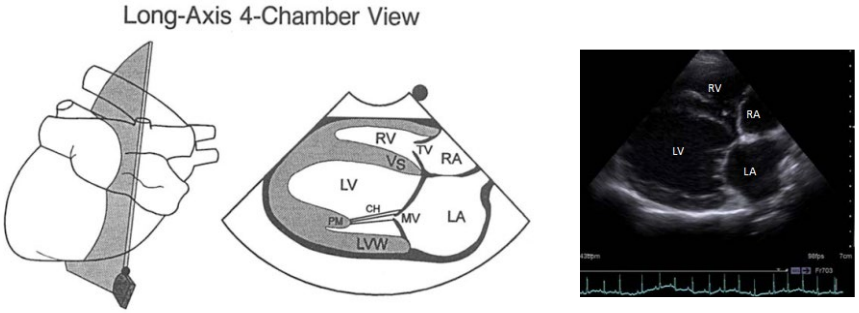
These images are easiest to obtain with the animal lying on their right side on a cardiac imaging table and by placing the probe on the right-hand side of the chest. However, sitting, standing, and lying in sternal are also options. The right parasternal window is between the 3rd and 6th intercostal spaces, between the sternum and costochondral junction.



This illustration shows how the heart is situated in the chest, and the location of the acoustic window. For the right parasternal planes, imaging will be performed from below. (**Adapted from Thomas WP et al. Re*commendations* for standards in transthoracic two-dimensional echocardiography in the dog and cat. Echocardiography Committee of the Specialty of Cardiology,** American College of Veterinary Internal Medicine. JVIM 1993;7:247-252.)

Right parasternal long axis 4 chamber view

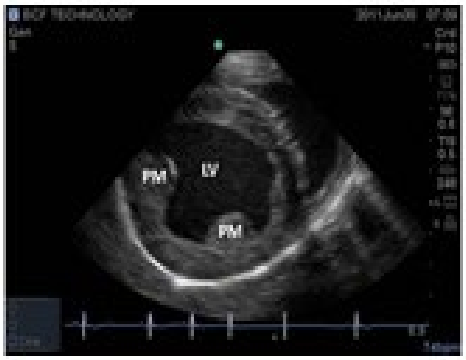
- Cross sectioning on the long axis of the heart
- Shows the left and right ventricles, left and right atria and the atrioventricular valves.
- Provides instant feedback on systolic function, cardiac size, atrial sizes, valve deformities and left and right pressure or volume overload conditions.

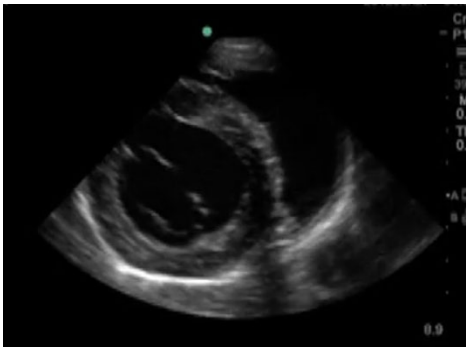


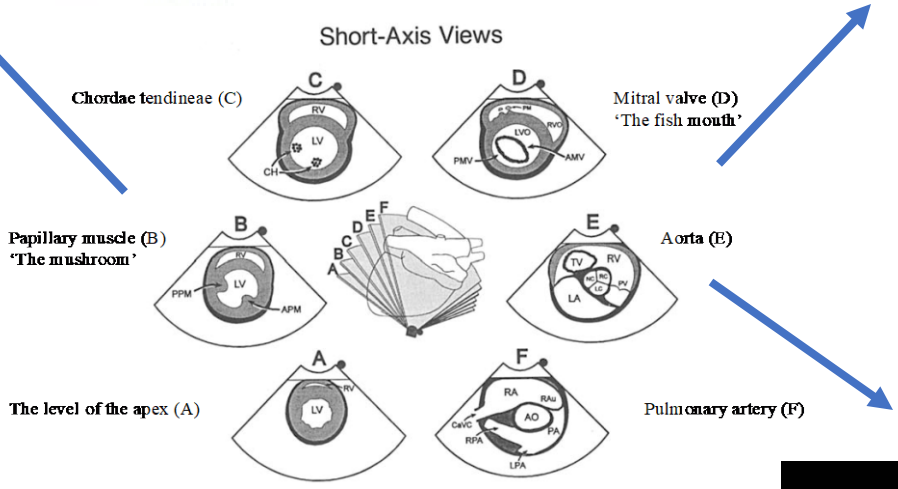
(Thomas et al, 1993)

Right parasternal short axis view

- Cross sectioning on the short axis of the heart
- By fanning through the short axis, the ventricular walls and septum, papillary muscles, mitral, aortic and pulmonary valves, left atrium and auricle and right ventricular outflow track.
- The most important measurement here is the left atrium to aortic ratio (LA:Ao). This image gives immediate information on the probability of cardiac failure and allow appropriate therapy to start. A line is drawn through the left atrium and aorta. Normal is < 1.6







Thomas W. P., et al. (1993) Recommendations for standards in transthoracic two-dimensional echocardiography in dogs and cats. J Vet Intern Med, 7, 247–252