

## CARDIOVASCULAR RADIOLOGY

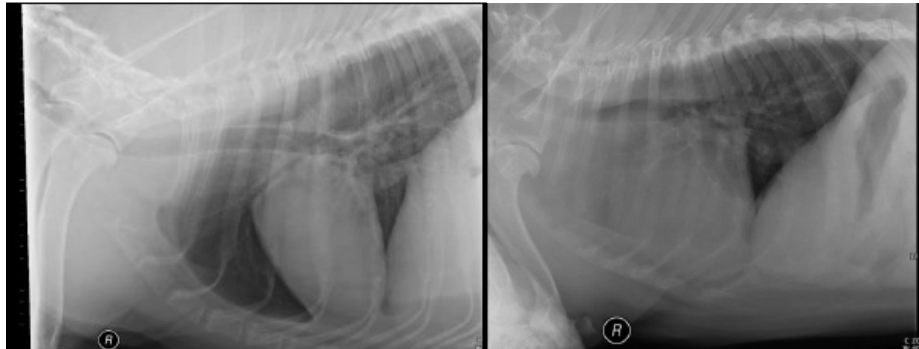
Revised by V20 Cardio Group modified from Dr. James Sutherland Smith BVSc, DACVR

### Introduction to Cardiovascular Radiology

Although radiology is not very commonly used as the primary means of diagnosis in cardiac disease when compared to echocardiography, it is readily available and can provide separate and valuable information to clinicians. When viewing radiographs, the term cardiac silhouette is used in place of “heart” to describe the myocardium, blood, and pericardium that cannot be radiographically distinguished from each other.

### NORMAL VARIATION IN CARDIAC SILHOUETTE

- **Cats:** Because domestic felines tend to be consistent in size and shape, the appearance of their cardiac silhouettes is also generally consistent.
  - Horizontal positioning of cardiac silhouette is recognized as an incidental age-related change in cats.
- **Dogs:** Breeds come in many shapes and sizes, and because of this, the cardiac silhouette seen on radiographs can have considerable variation.
  - Deep Chested Dog: tall and narrow heart (LEFT)



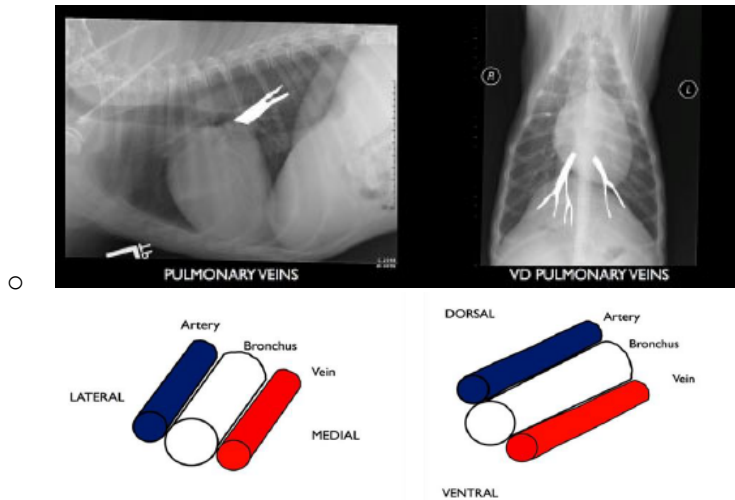
- Barrel Chested Dog: rounded with a cranial border that is not well defined due to mediastinal fat. (RIGHT)
- **Additional Factors**
  - Phase of the cardiac cycle during image acquisition (diastole versus systole)
  - Choice of radiographic view
    - Left Vs. Right Lateral: These are very similar, although the cardiac silhouette may be more rounded on the left lateral view due to dorsal displacement of the apex. The right lateral position is generally preferred, but the most important aspect of radiography is remaining consistent for evaluation purposes.
    - VD Vs. DV: The heart is more elongated, and central in a DV view. The caudal pulmonary vessels are also easier to identify in this view. The VD view shows a more rounded, left sided heart, and is not preferred. Differences in these views are more extreme in dogs than cats.



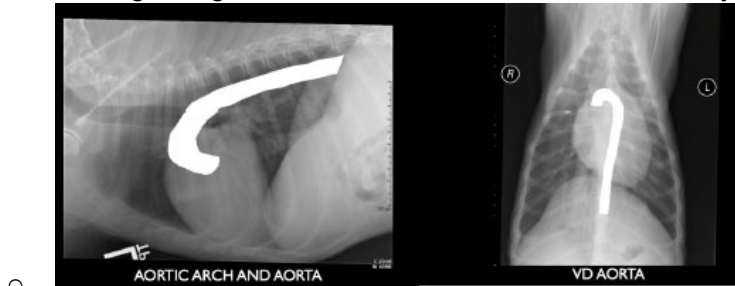
- The presence of increased pericardial fat
- Age related changes in position

### NORMAL PULMONARY AND THORACIC VASCULATURE

- Pulmonary Arteries: The main pulmonary artery is located at 1-2 o'clock on the DV view.
- Pulmonary Veins: These can be seen at the caudal aspect of the heart on the DV and lateral view.



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- The Aorta: The aortic arch is located at the 11-1 o'clock position. In older cats, this may look like a large bulge, due to incidental increased tortuosity of the aortic arch.



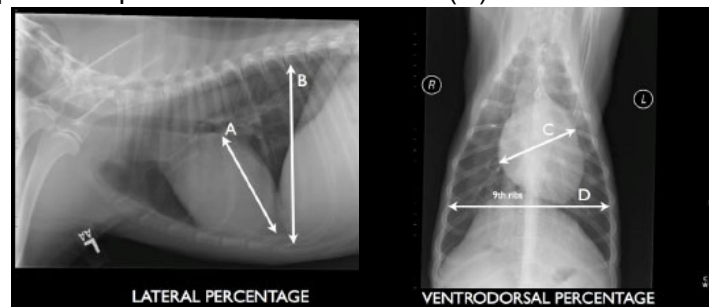
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- The Cranial and Caudal Vena Cava: The diameter of these vessels varies with the phase of the cardiac cycle and patient hydration. Given their collapsible nature their size and shape is sometimes not a reliable indicator of the circulating blood volume.

## ASSESSMENT OF PULMONARY VESSEL SIZE

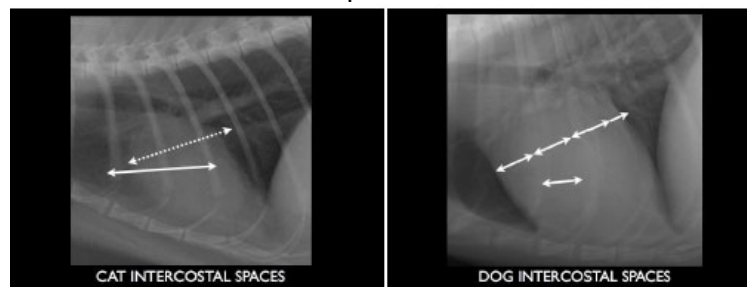
- Lateral Measurement: In lateral radiographs, the cranial lobar artery should have a diameter that does not exceed that of the narrowest part of rib 4 (located dorsal).
- DV Measurement: In a DV or VD view, the caudal lobar arteries and veins in the dog should not exceed the diameter of rib 9 at the point at which they intersect. In cats they can be up to 40% larger than the 9<sup>th</sup> rib.
- Artery to Vein Ratio: In the dog, the ratio should be about 1:1. An alteration in this ratio can give insight into the disease process occurring.

## ASSESSMENT OF CARDIAC SIZE

- **Subjective Assessment**: This can be difficult for beginners, but tends to be used by experienced radiologists and cardiologists. Keep in mind no quantitative measure of cardiac size is a perfect indicator of disease presence or absence.
- **Pleura to pleura measurements**:
  - Lateral view: The length of the heart from base to apex (A) should be less than 60% of the total thoracic cavity height from dorsal to ventral (B).
  - VD view: The length of the cardiac silhouette width (C) should be less than 50% of the pleura to pleura width at the 9<sup>th</sup> rib (D).



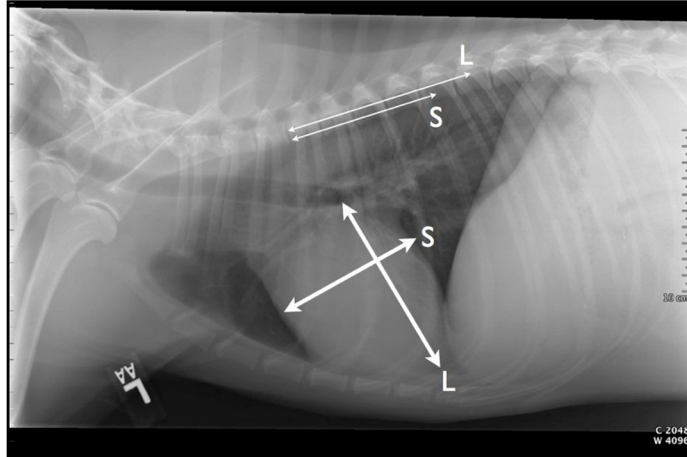
- **Intercostal Spaces**: An intercostal space can be used as a baseline to measure the length of the cardiac silhouette on the lateral view.
  - Dogs: 2.5 to 3.5 intercostal spaces
  - Cats: Cardiac width should be less than the distance from the cranial border of the 5<sup>th</sup> rib to the caudal aspect of the 7<sup>th</sup> rib.



- **Vertebral Heart Score**: This method has less variability than the intercostal space measurement, but it is the preferred measure by most veterinary cardiologists and has

been used repeatedly in cardiology studies. The long axis of the heart is measured (from the carina to the apex), and the short axis is measured perpendicular to the long axis in the middle of the cardiac silhouette. These lengths are then compared to their equivalent number of vertebral bodies beginning at the cranial aspect of T4.

- Dogs: Equal to or less than 10.5 vertebral lengths
- Cats: Less than 8 vertebral lengths



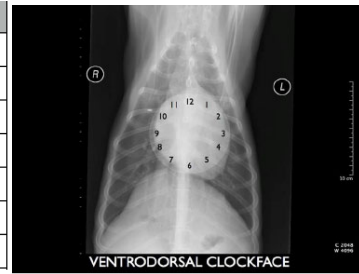
### ASSESSMENT OF LOCATION AND SHAPE

- **The Views**

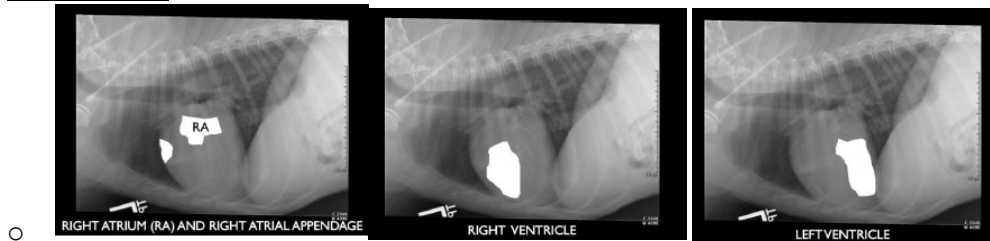
- Dorsoventral View

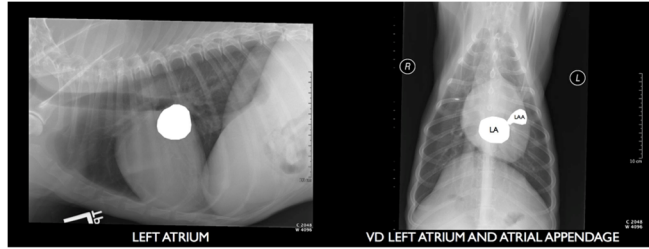
- The Clock Face Analogy: This analogy can be helpful for remembering the location of important cardiovascular structures on the dorsoventral (DV) view.

"Time" in VD or DV views	Structures
11 - 1 o'clock	Aorta
1 - 2 o'clock	Main pulmonary artery segment
2 - 3 o'clock	Left atrial appendage (dog), left atrium and appendage (cat)
2 - 5 o'clock	Left ventricle
5 o'clock	Apex (dog) or midline apex (cat)
5 - 9 o'clock	Right ventricle
9 - 11 o'clock	Right atrium



- Lateral View





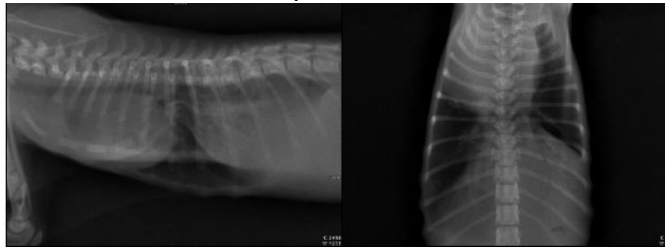
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- **Terminology**

- Cardiac Apex: The region where the interventricular septum and the left and right free walls intersect.
- Cardiac Waist: The junctions of the ventricle with the atrium.
  - Loss of the caudal aspect of the waist indicates LA enlargement.
- Globoid Silhouette: An enlarged heart may have a very rounded, or “globoid” silhouette. This should raise concern for pericardial effusion but can also occur with generalized cardiomegaly.

- **Abnormalities from Non-Cardiac Disease**

These non-cardiac processes can alter the appearance of the cardiac silhouette:

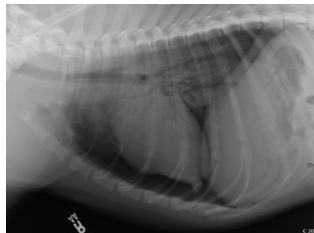
- Pectus Excavatum: A congenital defect in which the sternum points upwards and leads to cranial and dorsal displacement of the cardiac silhouette.



- Atelectasis: When a lung collapses, the heart and other mediastinal structures move in the direction of the collapsed lung. This is common in dogs that have been laterally recumbent for an extended period of time.



- Pneumothorax: Air around the lungs, leads to separation of the cardiac silhouette (apex) from the sternum in the lateral view. This is because the dependent lung is less inflated, and less able to support the heart in lateral recumbency.



- Peritoneopericardial diaphragmatic hernia (PPDH): A congenital defect where a hole in the diaphragm can allow abdominal organs to pass into the pericardial space. Many pets live with this defect and never demonstrate signs.

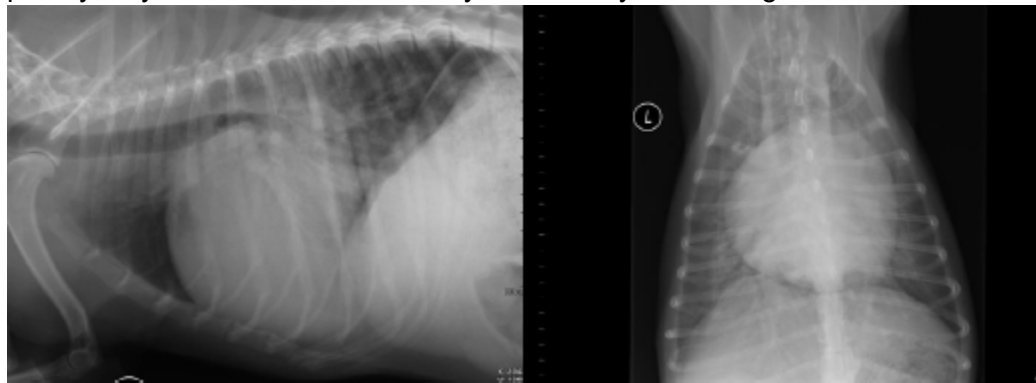


## **PULMONARY AND PLEURAL MANIFESTATIONS OF CARDIAC DISEASE**

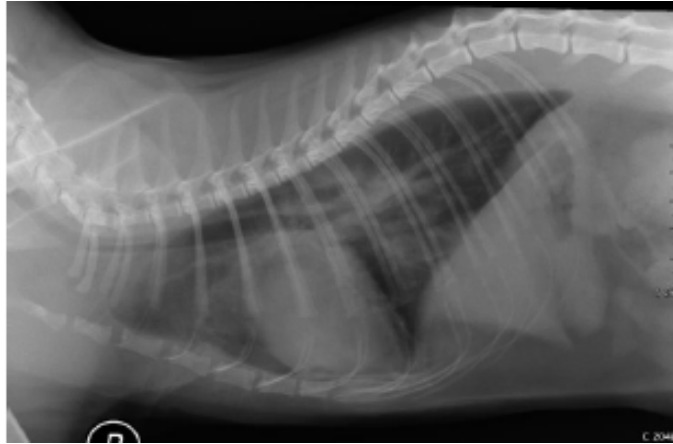
Cardiac disease can also result in abnormal radiographic findings elsewhere in the body:

- **Pulmonary Edema**

- Common Cause: Left-sided congestive heart failure
- Physiology: A transudate begins to leak from vessels and causes a moderate (interstitial) patchy pattern, or fills the alveoli leading to a severe increase in opacity (alveolar pattern).
- Location: Primarily around the heart (perihilar region) in dogs and sometimes in the caudodorsal lung fields. Cats can be similar to dogs or sometimes can have a patchy, asymmetric edema that may involve any of the lung lobes.



Dog



Cat

- **Pleural Effusion**

- Common Cause: Biventricular congestive heart failure (especially cats) or right-sided congestive heart failure
- Incidence: This is more common in cats than dogs
- Appearance: There is retraction of the lung lobes from the thoracic wall, and scalloped lung margins.

