



Cardiology Case Challenges 2017 Mini Series

Session 1: Canine cardiology case
challenges

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Canine Cardiology Case Challenges

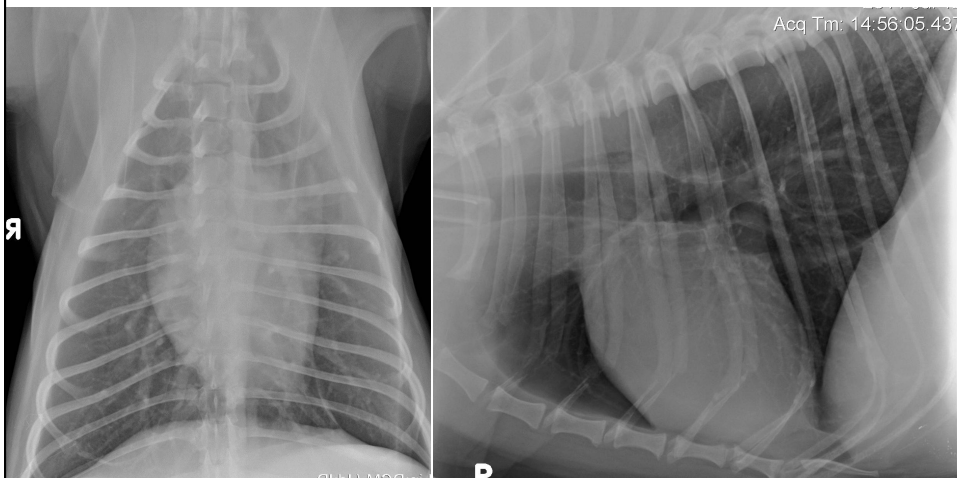
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Case 1

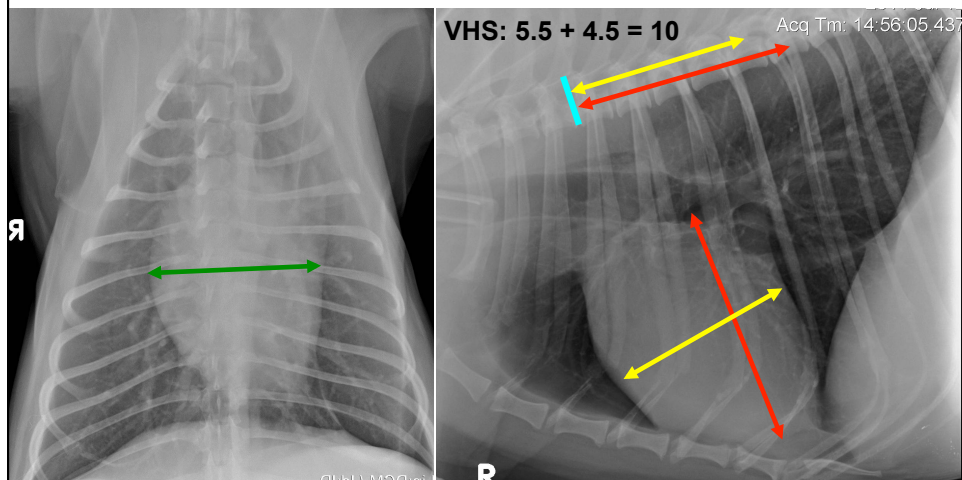
- 5 yr, FN, Mixbreed 7 kg
- Annual vaccination
- Asymptomatic
- Physical examination:
 - Grade 2/6 left apical systolic murmur
 - HR 90 bpm, regular rhythm
 - Pink mucus membranes with good femoral pulses
 - RR 20/min



Thoracic radiography is a good initial diagnostic tool to assess heart size



Thoracic radiographs confirm normal heart size



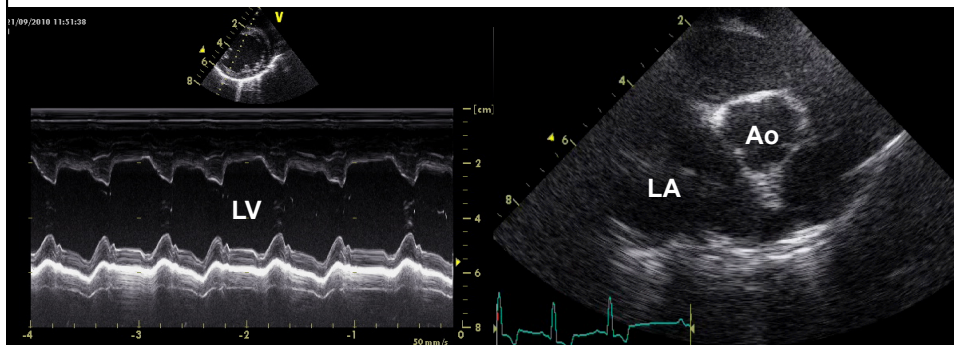
Question

- Which diagnostic test should be done next to confirm the cause of the heart murmur (i.e. to diagnose and stage the disease)?
1. Biomarkers (cTnI and NT-proBNP)
 2. Doppler echocardiography – **CORRECT ANSWER**
 3. ECG
 4. Holter monitoring

Echocardiography is the gold standard test to confirm diagnosis and stage the disease

LV M-mode

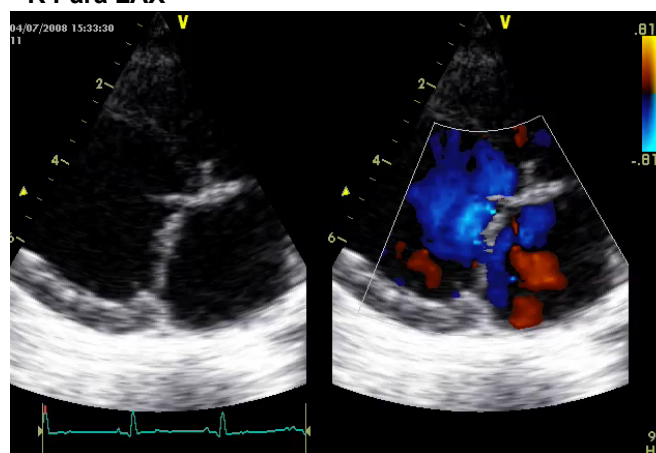
R Para SAX



- LV M-mode shows preserved systolic function
- LA:Ao ratio is < 1.5 therefore left atrial size is normal

Echocardiography is the gold standard test to confirm diagnosis and stage the disease

R Para LAX



- Thickened mitral valve with small jet of MR

Staging of heart failure in dogs with MVD (ACVIM Guidelines, JVIM 2009)

- **Stage A** - at risk (predisposed breed, family history)
- **Stage B1** - asymptomatic with no heart enlargement
- **Stage B2** - asymptomatic with heart enlargement
- **Stage C1** - acute HF (requiring hospitalisation)
- **Stage C2** - past or present HF (managed at home)
- **Stage D1** - refractory HF (requiring hospitalisation)
- **Stage D2** - refractory HF (managed at home)

Question

How would you stage this dogs' MVD (according to ACVIM Guidelines)?

1. Stage A
2. Stage B1 – **CORRECT ANSWER**
3. Stage B2
4. Stage C

Question

Would you start treatment for this dog's MVD?

1. No drug or dietary changes are necessary –
CORRECT ANSWER
2. I would start furosemide
3. I would start an ACE inhibitor
4. I would start pimobendan

Case 2

- 4 yr, MN, Irish Wolfhound 68 kg
- Broken tooth so needs anaesthetic for dental
- Asymptomatic
- Physical examination
 - No detectable heart murmur
 - Normal heart rate 100 bpm
 - Possible irregular rhythm and occasional pulse deficits



ECG



- ECG seems logical next test as non-invasive and easy to perform
- ECG is gold-standard test to diagnose possible arrhythmia detected on physical examination

Question

What is your ECG diagnosis?



Lead II 25 mm/sec 10 mm/mV

1. Sinus arrhythmia
2. Sinus bradycardia
3. Atrial fibrillation – **CORRECT ANSWER**
4. 3rd degree AV block

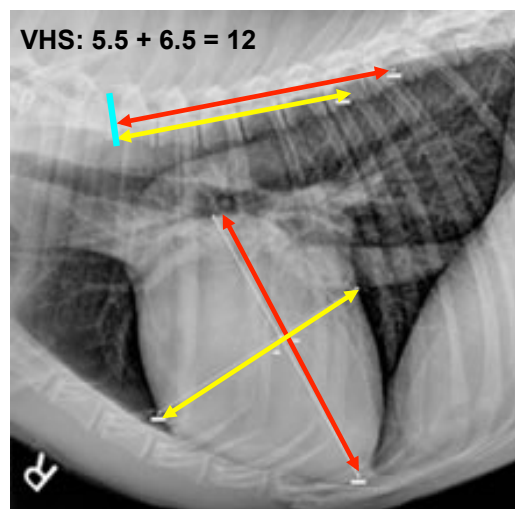
Atrial fibrillation



Lead II 25 mm/sec 10 mm/mV

- Irregularly irregular rhythm
- Fibrillation waves (f waves)
- No P waves
- Narrow, positive QRS complexes

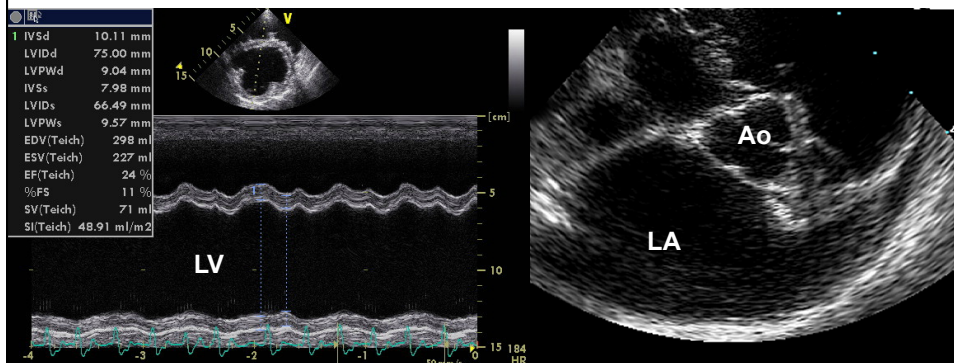
Thoracic radiography reveals cardiomegaly and left atrial enlargement



Echocardiography is the gold standard test to confirm diagnosis and stage the disease

LV M-mode

R Para SAX

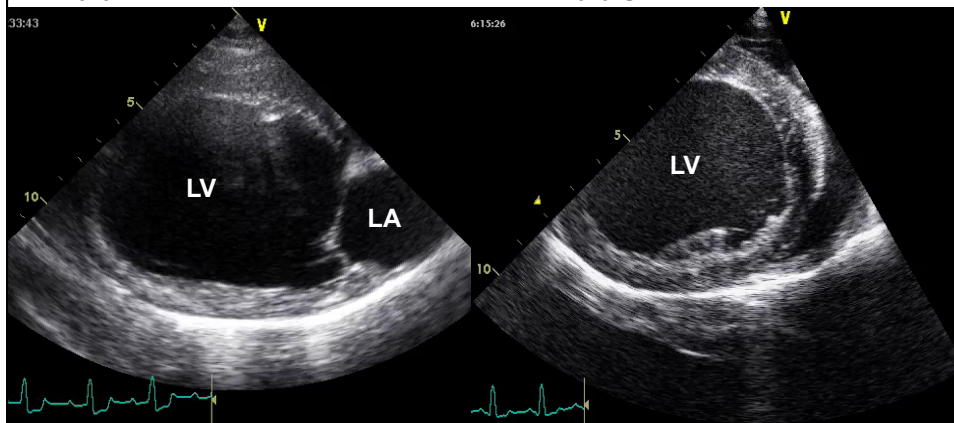


- LV M-mode shows decreased systolic function
- There is left atrial and left ventricular chamber dilation

Echocardiography findings are consistent with preclinical dilated cardiomyopathy (DCM)

R Para LAX

R Para SAX



- These images show decreased LV systolic function and left ventricular chamber dilation

Question

Would you start treatment for this dog's preclinical DCM?

1. I would start digoxin
2. I would start pimobendan – **CORRECT ANSWER**
3. I would start an ACE inhibitor
4. I would not start any therapy yet

Are PROTECT results applicable to breeds other than Dobermanns with preclinical DCM?

- In **Irish Wolfhounds** with preclinical DCM, AF or both, pimobendan monotherapy significantly prolonged time to onset of CHF or sudden death vs. monotherapy with benazepril or digoxin (Vollmar and Fox JVIM 2016)
- **N.B. In breeds other than the Doberman, use of Vetmedin in preclinical phase of DCM is currently off-label use**

PROTECT Study published in JVIM 2012



Case 3



- 9 year old FN Mix-breed 10 kg
- Intermittent non-productive cough (“throat clearing”) for the past 4 weeks
 - both at rest and on exercise
- Good exercise tolerance and normal energy levels

Clinical exam findings

- Grade 4/6 systolic murmur
 - Loudest over the left heart apex (mitral valve area)
- Resting HR = 100 bpm
- Femoral pulse strength normal
- Mucous membrane colour pink
- Prompt CRT
- Non-invasive systolic BP = 140 mmHg

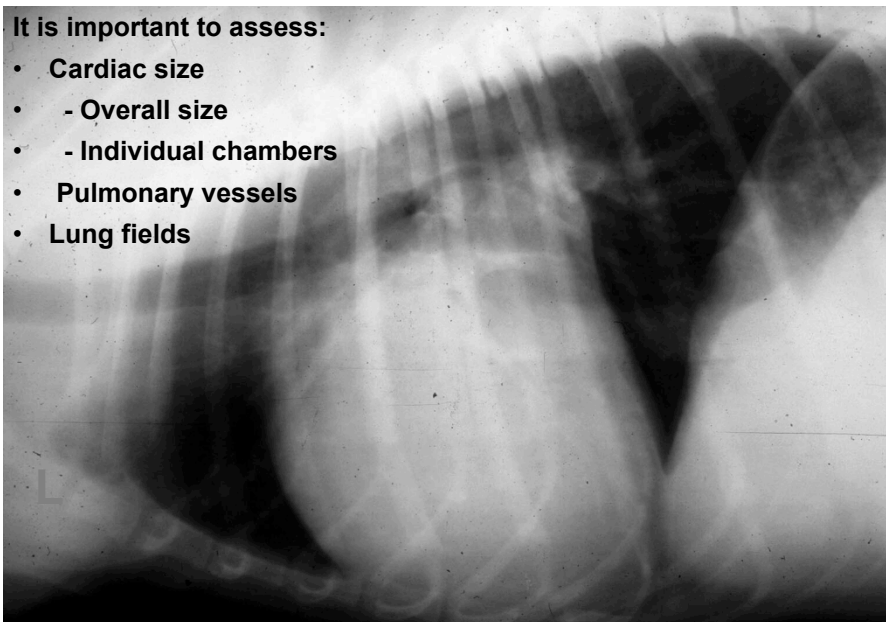
Clinical exam findings

- Resting RR 28/min, normal RE
- Pulmonary auscultation unremarkable
- No jugular distension
- No abnormalities on abdominal palpation
- Good body condition
- Normal rectal temperature
- **Problem list: cough and heart murmur**

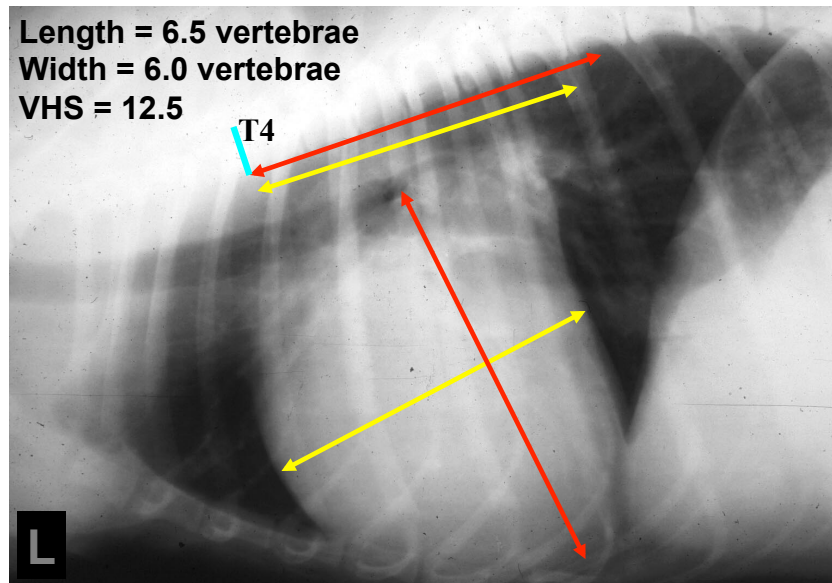
Looking for clues from the radiographs...

It is important to assess:

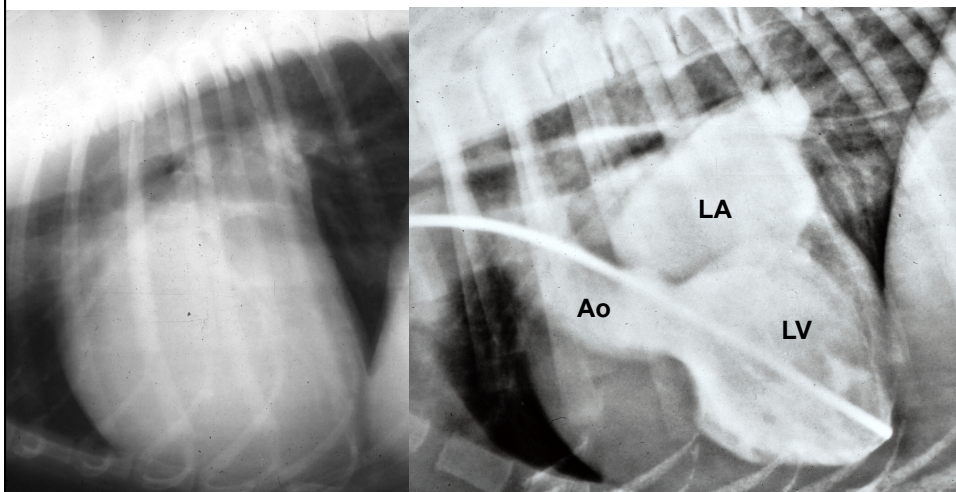
- Cardiac size
 - - Overall size
 - - Individual chambers
- Pulmonary vessels
- Lung fields



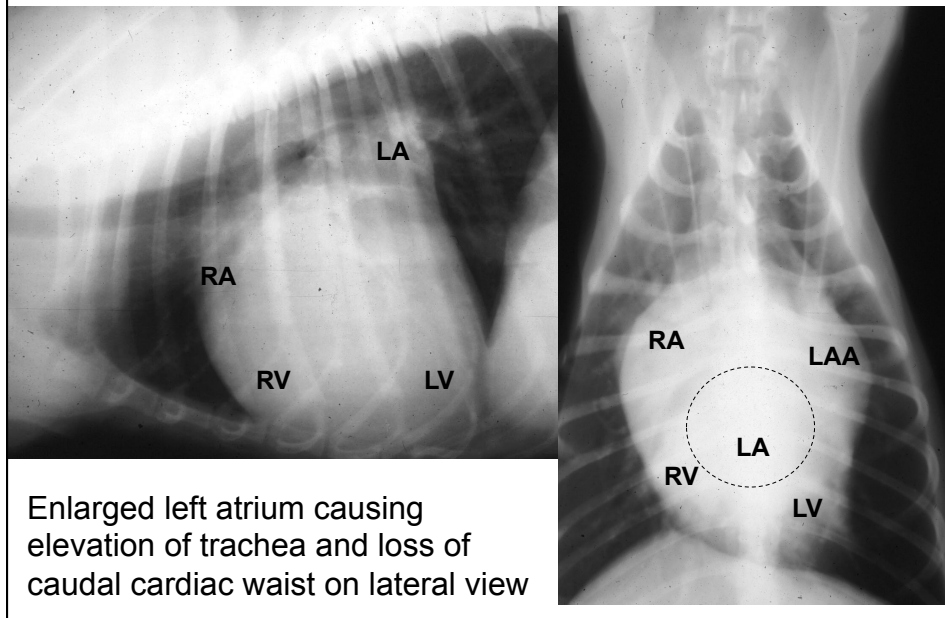
Vertebral heart size (VHS)



Locations of the left-sided cardiac chambers and aorta on a lateral radiograph, as shown by selective left heart angiography

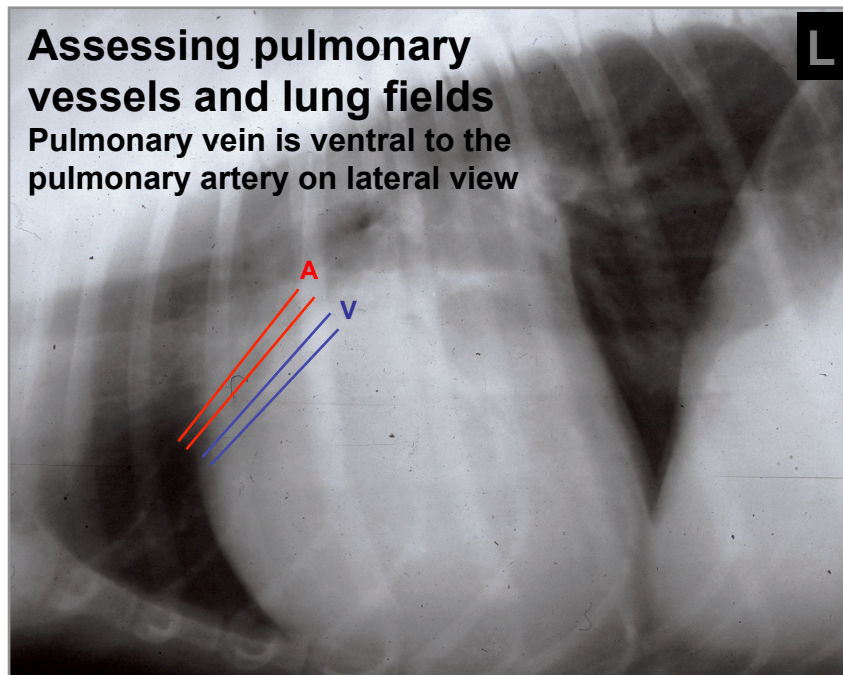


Assessing individual cardiac chamber sizes

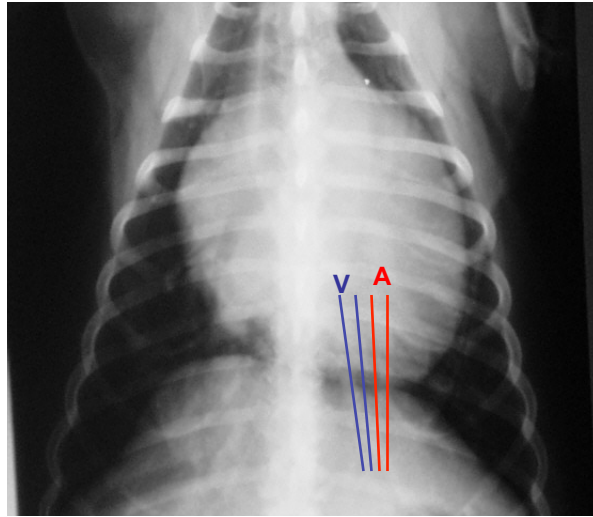


Assessing pulmonary vessels and lung fields

Pulmonary vein is ventral to the pulmonary artery on lateral view



Pulmonary vein is medial to the pulmonary artery on DV / VD view

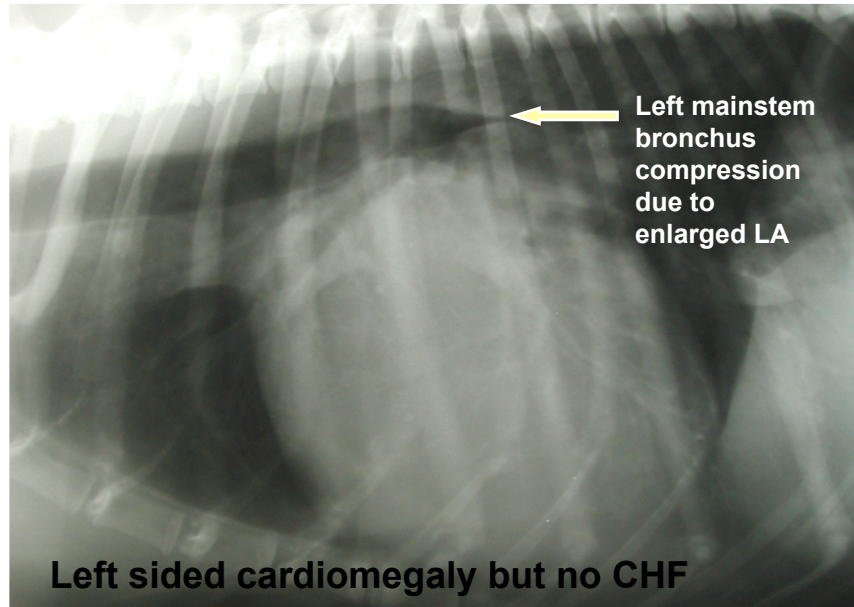


Question

Based on these radiographs, the history and physical examination findings, what is the most likely cause for the cough in this dog?

1. Inflammatory small airway disease
2. Left sided CHF / pulmonary oedema
3. Left mainstem bronchus (LMSB) compression by enlarged LA – **CORRECT ANSWER**
4. Combination of LMSB compression and CHF

Coughing is not always due to CHF



Echocardiography is the gold standard test to confirm diagnosis and stage the disease

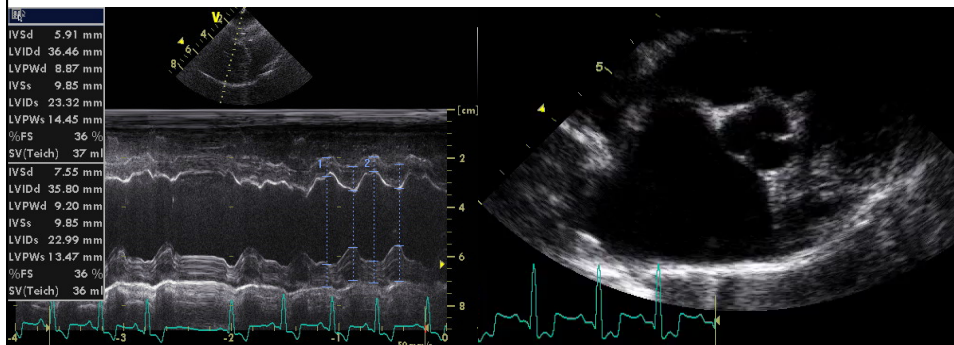
Echo findings in this dog with MVD:

- Thickened mitral valve with moderate volume mitral regurgitation
- Maintained systolic function
- Left sided cardiomegaly (volume overload)

Echocardiography is the gold standard test to confirm diagnosis and stage the disease

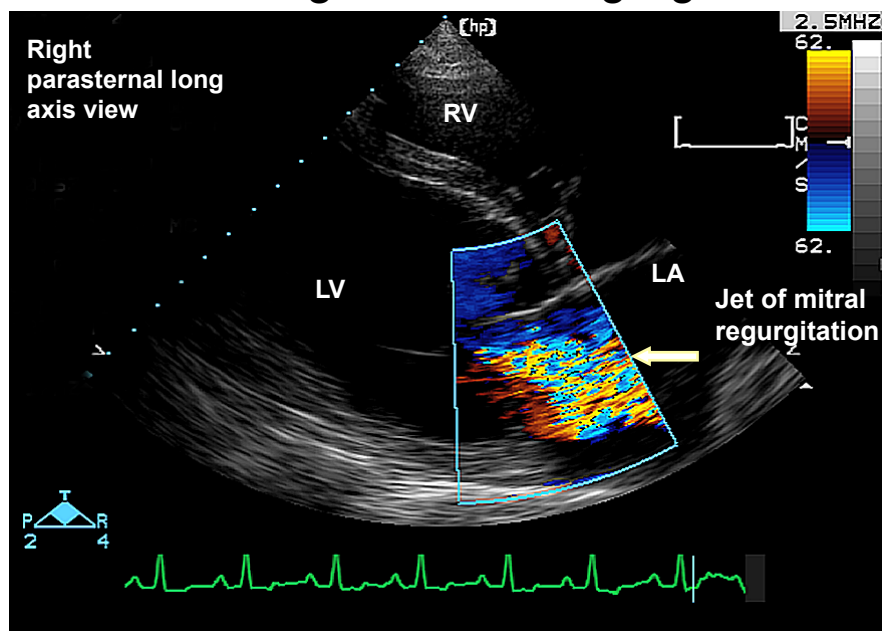
LV M-mode

R Para SAX

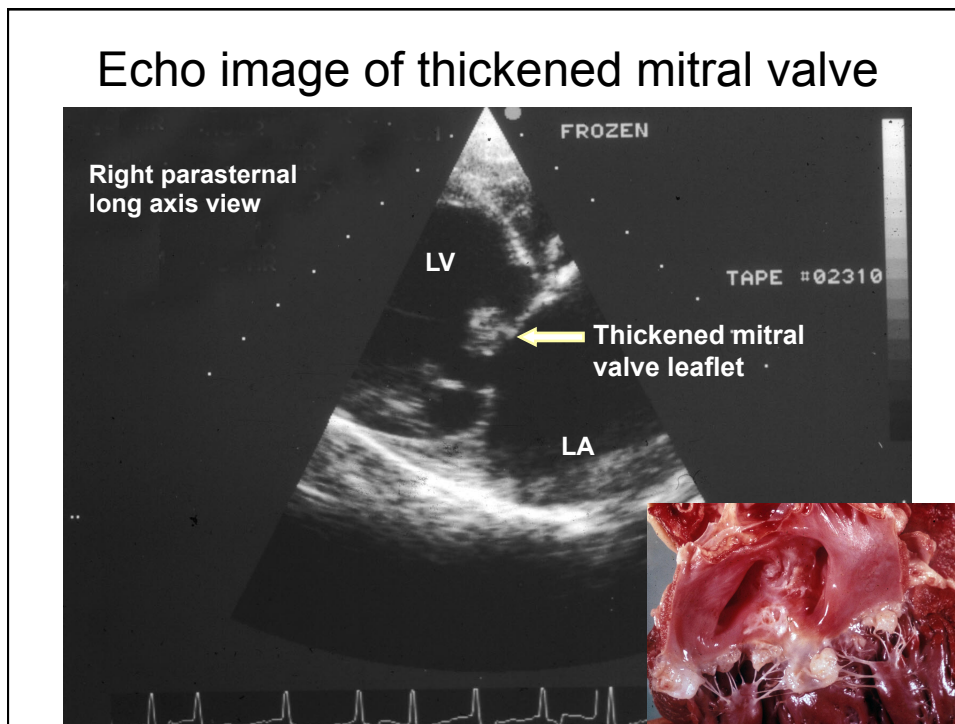


- Left atrial and left ventricular chamber enlargement
- Maintained systolic function

Echo image of mitral regurgitation



Echo image of thickened mitral valve



Question

How would you stage this dog's MVD (according to ACVIM 2009 guidelines)?

1. Stage B1
2. Stage B2 – **CORRECT ANSWER**
3. Stage C
4. Stage D

Question

Would you start treatment for this dog's preclinical MVD?

1. No drug or dietary changes are necessary
2. I would start furosemide
3. I would start an ACE inhibitor
4. I would start pimobendan – **CORRECT**

ANSWER

EPIC study

- **Results:** Administration of pimobendan to dogs with MVD and echocardiographic and radiographic evidence of cardiomegaly (stage B2) results in **prolongation of preclinical period by approximately 15 months**
- **N.B. Until Vetmedin receives license for this new indication (Stage B2 MVD), this constitutes off-label use**

EPIC study published in JVIM 2016

Same dog, 6 months later



- Less keen to go for daily walks during past 2-3 weeks and sleeping more at home
- Owner has noticed increased panting during and after walks (taking longer to recover)
- Heavy breathing at rest for past 24 hours
- Refused to eat breakfast this morning

Physical examination

- Grade 5/6 left apical (mitral valve) systolic murmur
- Rapid heart rate (160bpm)
- Regular heart rhythm
- Femoral pulse quality is decreased
- Pale oral mucus membranes
- Respiratory distress (respiratory rate > 60 / min)
- Harsh lung sounds bilaterally

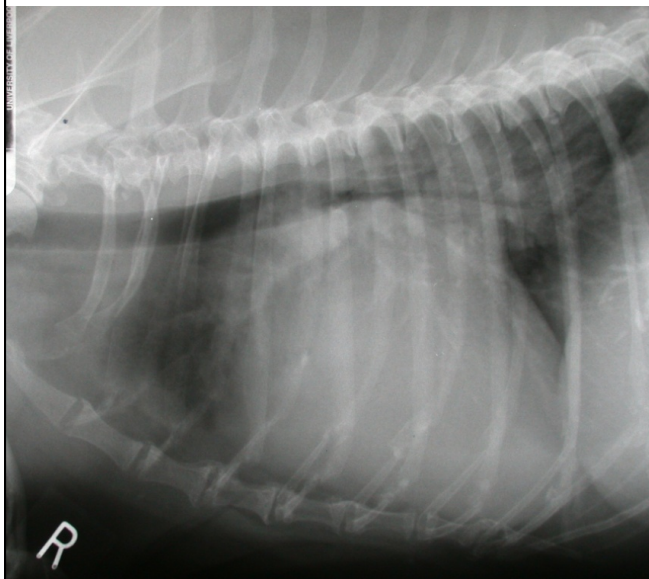
Question



Based on history and physical examination findings, which would be the most appropriate diagnostic test to perform next to guide emergency treatment?

1. ECG
2. Thoracic radiography – **CORRECT ANSWER**
3. Echocardiography
4. Haematology / Biochemistry

Thoracic radiography to confirm CHF



Generalised
cardiomegaly
VHS = 13.5

Left atrial
enlargement

Pulmonary
venous
congestion

Perihilar
pulmonary
oedema

Management of acute CHF

(ACVIM Guidelines 2009)

- Hospitalisation for cage rest and close monitoring
- Oxygen therapy
- Furosemide intravenously (or intramuscularly)
 - 1 - 4 mg/kg boluses
 - Assess respiratory rate 1 hour after giving bolus and if no response, repeat bolus
- Pimobendan IV or orally q 12 hours
- 0.25 – 0.3 mg/kg PO q 12 h (or 0.15 mg/kg IV q 12h)
- (Thoracocentesis and abdominocentesis as required)

Management of chronic CHF

(ACVIM Guidelines 2009)

- **Furosemide** (1-2 mg/kg PO q 12hr, but can be increased to 4-6 mg/kg PO q 8hr if necessary)
- **ACE-I** (e.g. enalapril 0.5 mg/kg PO q 12hr)
- **Pimobendan** (0.25 – 0.3 mg/kg PO q 12hr)

No consensus reached on the use of the following:

- Spironolactone (although frequently used in class C2 dogs)
- Digoxin +/- Diltiazem for rate control for atrial fibrillation
- Beta-blockers (CARE if ventricular systolic dysfunction!)
- Bronchodilators / cough suppressants
- Diet - restrict Na, monitor K, omega-3 supplement

Diuretic resistance

- Unfortunately, impaired response to diuretics can develop in CHF patients and is associated with adverse outcomes.
- Definitions vary:
 - Persistent oedema despite adequate and escalating diuretic doses.
 - Decreased efficacy of diuretics with prolonged treatment.

Diuretic resistance

- In mild CHF, diuretic resistance is not commonly encountered, as long as renal function is preserved.
- In moderate and severe CHF patients, diuretic resistance occurs more frequently and often becomes a clinical problem.
- Although difficult to quantify, diuretic resistance is thought to occur in as many as 1 in 3 human patients with CHF.

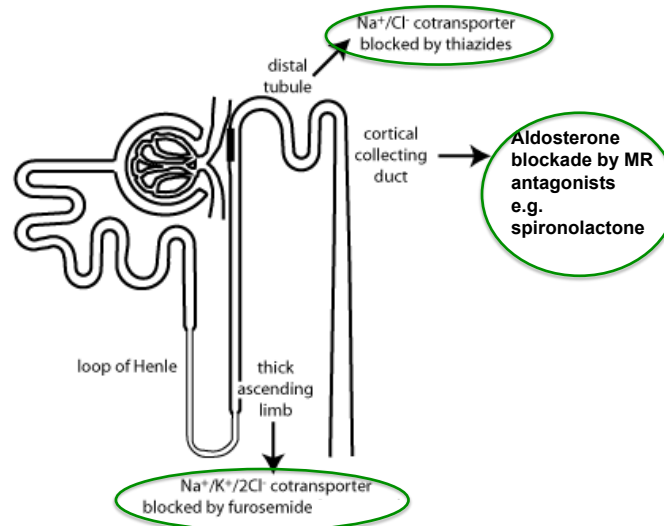
Strategies for overcoming diuretic resistance

- Change loop diuretic
- Sequential nephron blockade

Change loop diuretic

- Oral torasemide has higher bioavailability than oral furosemide due to its relatively consistent absorption and longer half-life.
 - Suitable for once daily dosing.
- Remember, torasemide is much more potent than furosemide!
 - Typically dose torasemide at 1/10th of the furosemide dose

Sequential nephron blockade by combining diuretics



Case 4

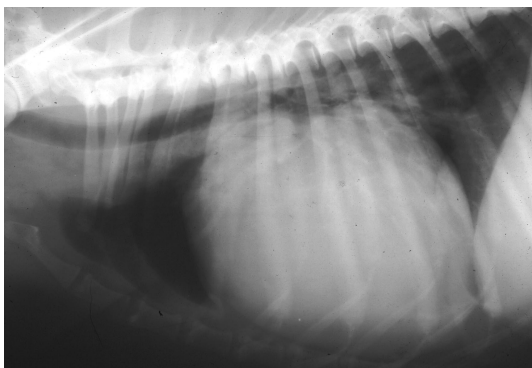
- 7 year old male castrated GSD x 38 kg
- Lethargy and abdominal swelling for 1 week
- Collapsed this morning, conscious but unwilling to get up



Physical examination

- Muffled heart sounds
- Rapid heart rhythm
- No audible heart murmur
- Weak arterial pulses
- Distended jugular veins
- Fluid-filled abdomen
- Muscle wasting / cachexia

Thoracic radiography



Globoid cardiac silhouette
- generalised cardiomegaly
- well defined borders



Question

What is your ECG diagnosis?

Lead II 25 mm/sec 10 mm/ mV



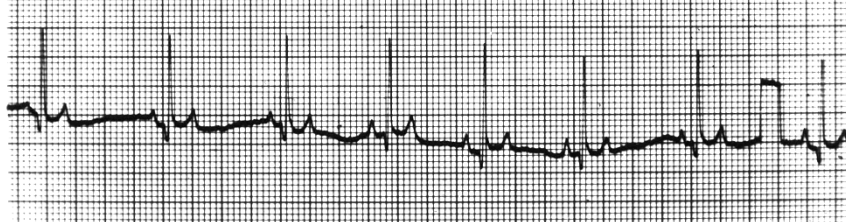
1. Sinus arrhythmia
2. Atrial fibrillation
3. Ventricular bigeminy
4. Electrical alternans – **CORRECT ANSWER**

Sinus rhythm with electrical alternans

PRE-DRAINAGE

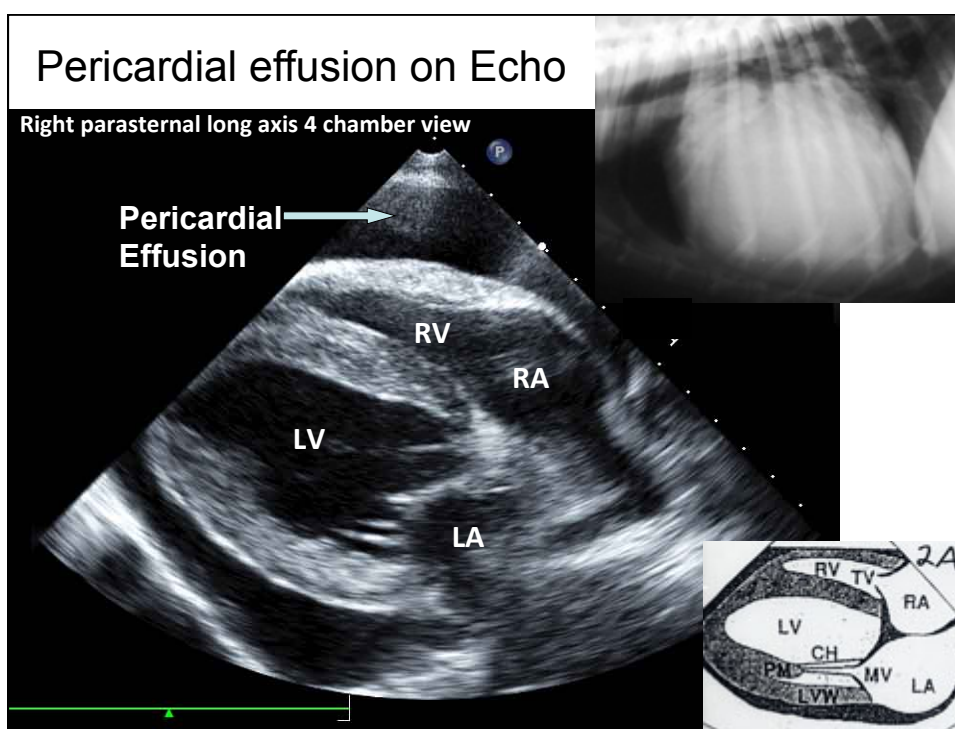


POST-DRAINAGE

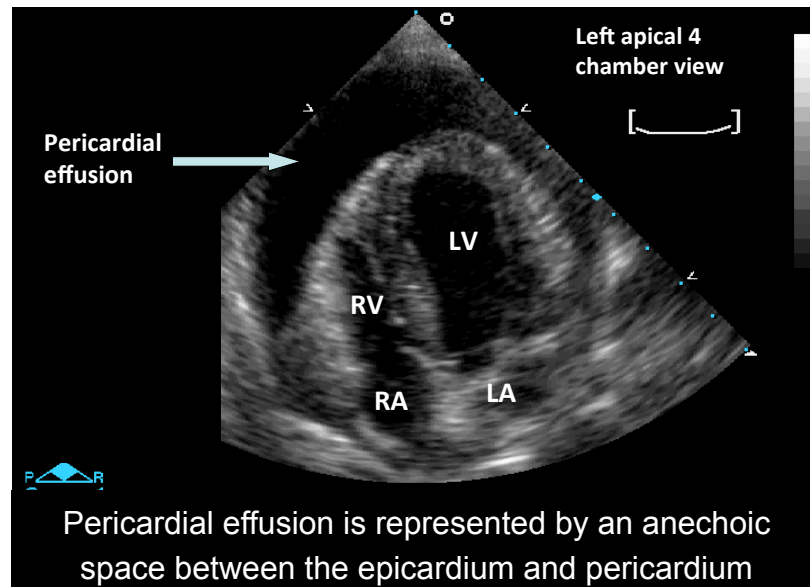


Electrical alternans

- Beat to beat variation in amplitude of sinus QRS complexes as heart swings within fluid filled pericardial sac
 - NOT present in all cases of pericardial effusion
 - But if present, is a highly suggestive finding (as long as other physical examination findings are consistent with diagnosis of pericardial effusion)

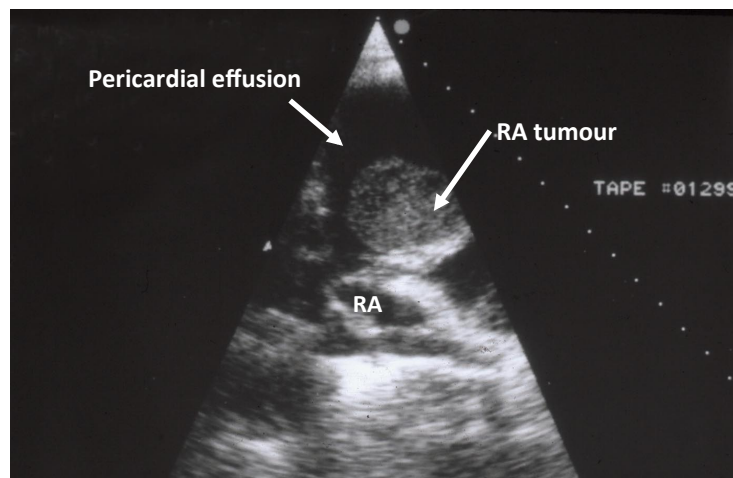


Pericardial effusion on Echo

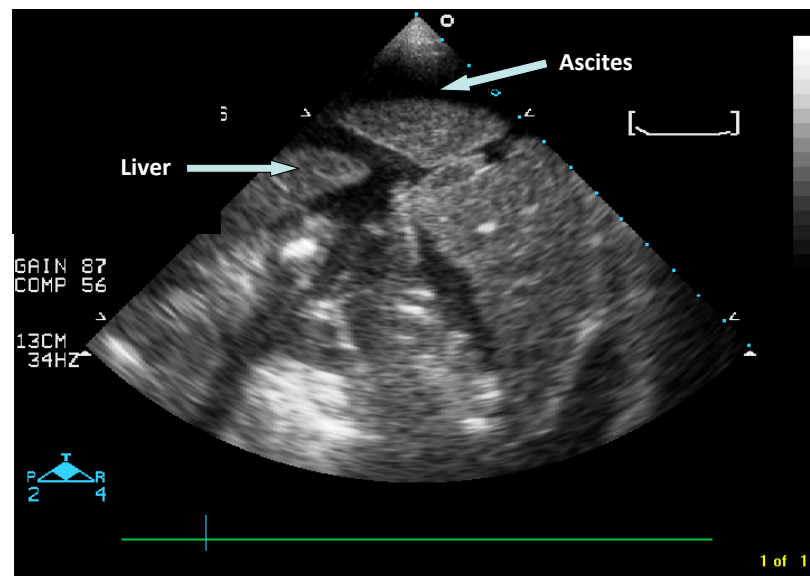


Right atrial mass - highly suspicious for haemangiosarcoma due to location and appearance.

Improved chance of visualising mass if effusion is present, as anechoic fluid contrasts with soft tissue mass



If cardiac neoplasia is found, it is recommended to perform abdominal ultrasound to check for metastases



Therapeutic strategies

- If there is tamponade, pericardiocentesis **MUST** be performed urgently.
- **Diuretics are not indicated as will decrease blood pressure and cardiac output**
- Give IV fluid therapy (typically at 2-3 x maintenance rate) to stabilise blood pressure before drainage
 - Increases venous pressures
 - Will make dog more stable for sedation

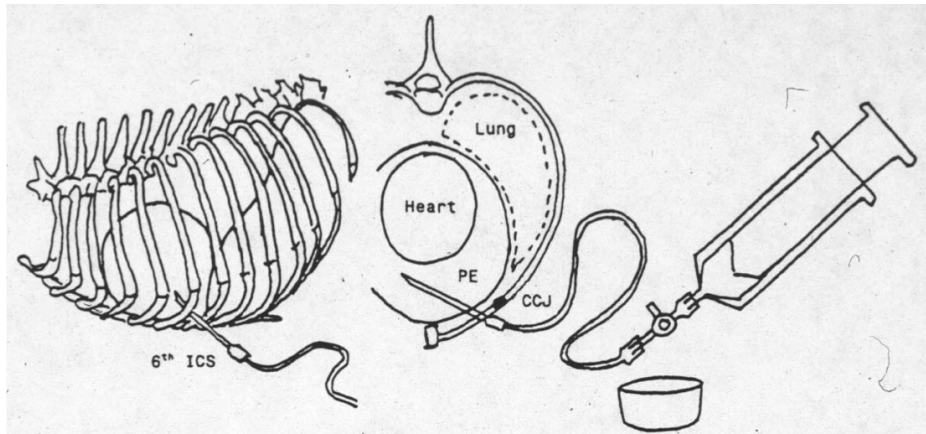
Therapeutic strategies

- Expect a dramatic clinical improvement after drainage and resolution of cardiac tamponade
 - Improved demeanour
 - Decrease in heart rate
 - Improved peripheral pulse quality
 - Resolution of jugular distension
 - Resolution of electrical alternans
 - Resolution of ascites (may take 3-5 days, usually no need to give diuretics)

Pericardiocentesis technique



Pericardiocentesis technique



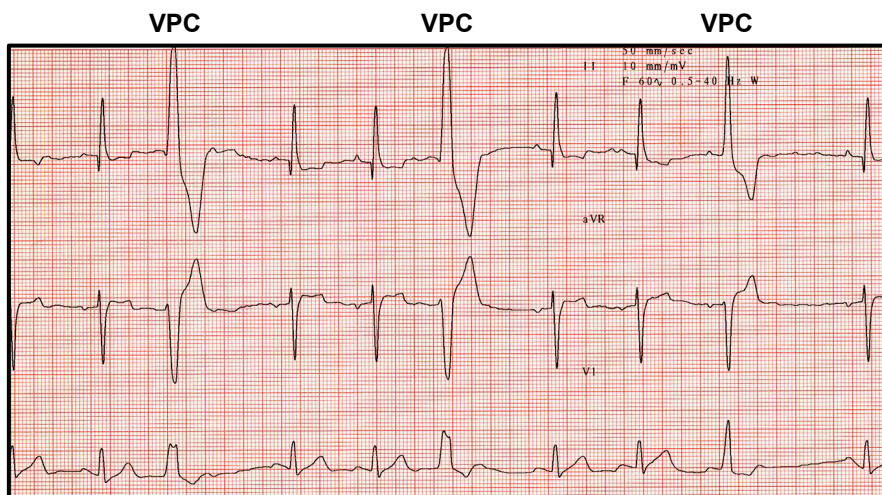
Landmark for insertion of drainage catheter is 5th or 6th intercostal space on left side **or** 4th or 5th intercostal space on right side, below the level of costochondral junction (CCJ), at caudal aspect of intercostal space (to avoid intercostal artery)

Pericardial fluid analysis

- Diagnostic potential is limited for typical haemorrhagic effusions
- Many intra-pericardial neoplasms do not readily exfoliate
- High number of reactive mesothelial cells occur in all pericardial fluid samples



It is important to have ECG monitoring during pericardiocentesis to monitor for ventricular arrhythmias



Treatment and prognosis

- Idiopathic effusions
 - Pericardiocentesis
 - Effusion may or may not recur (approx 50%)
 - If effusion recurs requiring drainage > 3 times
 - recommend thoracotomy + pericardiectomy
 - ALWAYS submit pericardium for histopathology to rule out mesothelioma
 - **Good long-term prognosis** if no neoplastic aetiology present

Treatment and prognosis

- Neoplastic effusions
 - Pericardiocentesis on initial presentation
 - Effusions will recur within days/weeks
 - Require repeat drainage (palliative)
 - Prognosis very guarded, especially for haemangiosarcoma
 - Chemotherapy protocols are of limited benefit

Treatment and prognosis

- Neoplastic effusions
 - Thoracotomy and pericardiectomy for biopsy / debulking (confirmation of diagnosis)
 - Unlikely to improve prognosis with haemangiosarcoma
 - May give symptom-free months to years with chemodectoma
 - Thoracoscopy for creating a **pericardial window**
 - Palliative procedure



Case 5

- 12 week female English Bulldog puppy
- Presented for 2nd vaccination
- Asymptomatic
- Physical examination:
 - Grade 5/6 left base systolic murmur
 - HR 120 bpm, regular rhythm
 - Pink mucus membranes with good femoral pulses
 - RR 20/min



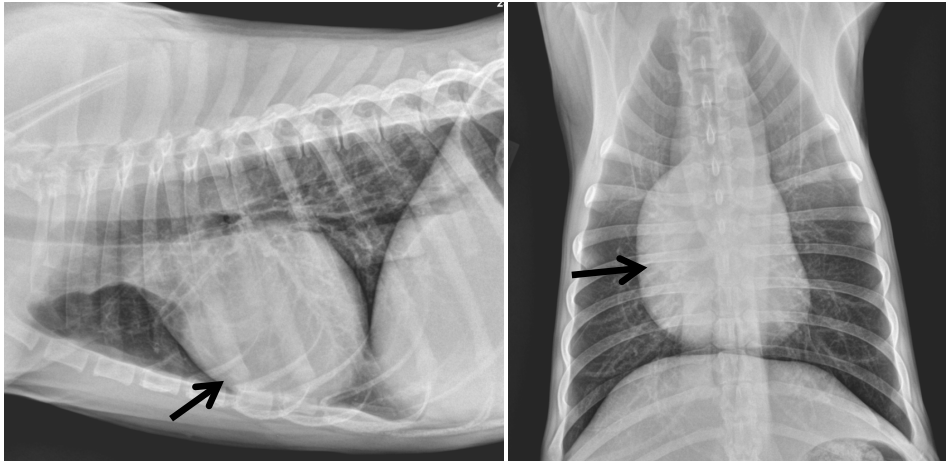
Findings from thoracic radiography, performed to assess heart size and specific chamber enlargement

- Increased sternal contact suggesting right ventricular (RV) enlargement on lateral
- “Reverse D” appearance on DV / VD suggestive of right ventricular hypertrophy (RVH)
- Pulmonary artery (PA) bulge at 2 o’ clock position on cardiac silhouette on DV / VD
- Lung vessels and lung fields appear normal

Thoracic radiography

RV enlargement on lateral

“Reverse D”



Question



Based on the breed, age, physical examination findings and thoracic radiograph findings, what is the most likely diagnosis?

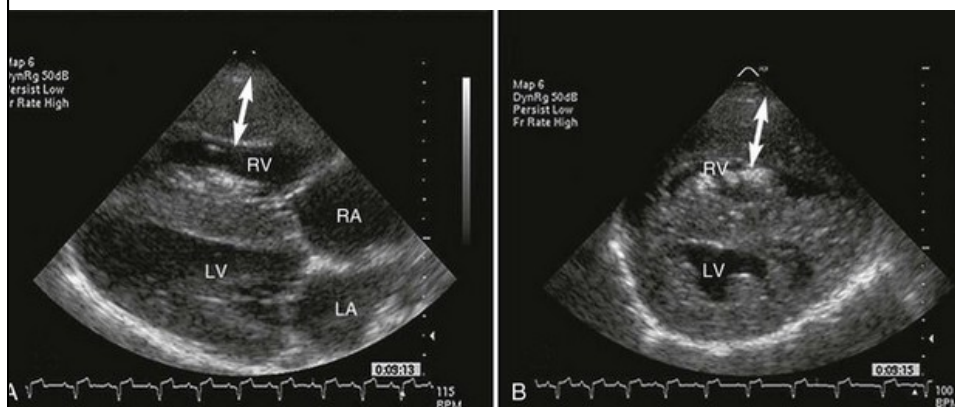
1. Patent ductus arteriosus (PDA)
2. Pulmonic stenosis (PS) – **CORRECT ANSWER**
3. Subaortic stenosis (SAS)
4. Ventricular septal defect (VSD)

Typical echocardiography findings with Pulmonic Stenosis

- Concentric RV hypertrophy
- Normal to small RV chamber
 - may be dilated if concurrent Tricuspid valve dysplasia (TVD) and Tricuspid regurgitation (TR) due to additional volume overload
- Right atrium (RA) normal to mildly enlarged
 - may be enlarged if TVD and TR
- Normal to small LV and LA
- Thickened pulmonic valve (PV)
- Post stenotic dilation of main pulmonary artery (PA)

Concentric right ventricular hypertrophy caused by pressure overload

The white arrow indicates the thickened RV wall, which should normally be less than half of the thickness of LV wall



From <http://veteriankey.com/chapter-65-pulmonic-stenosis/>

Doppler echocardiography

- Turbulent flow in region of stenosis
 - Colour flow Doppler
 - Spectral Doppler
- Turbulent flow extends into post-stenotic dilation of main PA
- Degree of acceleration of blood flow across the site of obstruction equates to severity of obstruction

Spectral Doppler confirming severe pulmonic stenosis

Transvalvular pressure gradient (PG) = $4 \times \text{Velocity}^2$

Velocity (V) = 6.5 m/s; therefore PG = approx 170mmHg in this example



Treatment options

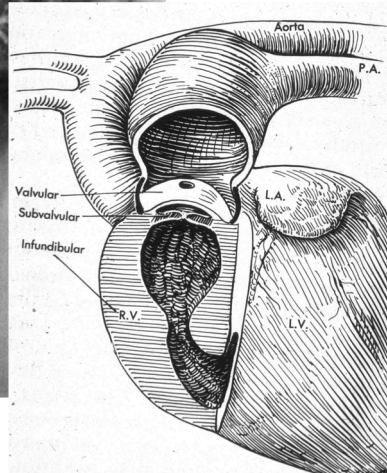
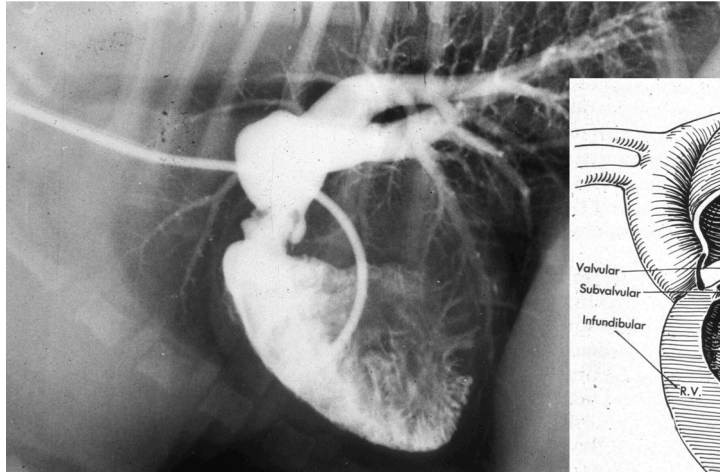
- **Mild PS** (PG < 40 mmHg)
 - no intervention
 - Good life expectancy if no TVD/TR
- **Moderate PS** (PG 40-80 mmHg)
 - no intervention UNLESS symptomatic or severe RVH or TVD/TR on echo
- **Severe PS** (PG > 80 mmHg)
 - recommend balloon valvuloplasty
 - +/- beta blockers to decrease RV workload and oxygen demand

Balloon valvuloplasty

- Balloon dilation catheter
- Passed from femoral vein or jugular vein through RA, RV and into PA
- Balloon positioned across stenotic valve
- Balloon inflated one or more times
- Aim to tear/stretch stenotic valve
 - relieve stenosis and drop PG to decrease RV work load
 - usually create some pulmonic insufficiency (well tolerated)

Right Ventricular Angiogram

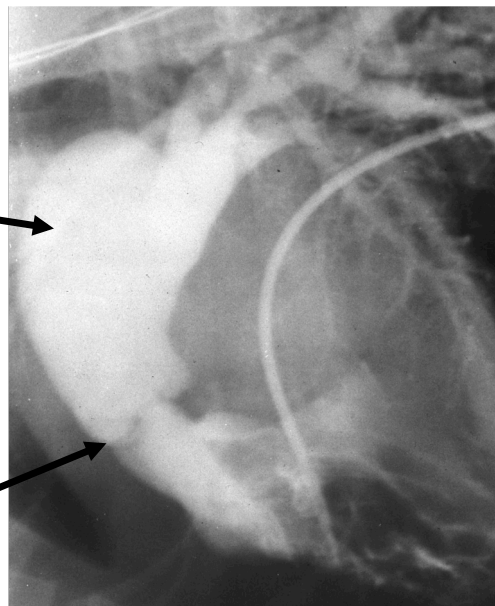
Contrast is injected directly into RV through a catheter inserted via jugular vein, positioned in RV chamber



RV Angiogram Before Balloon Dilation

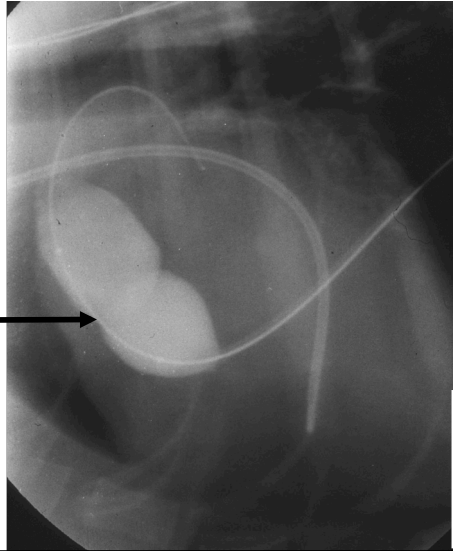
Post-stenotic
dilation of
main
pulmonary
artery

Stenotic
pulmonic
valve
indicated by
filling defect
ie. region that
contrast does
not highlight



Balloon on dilation catheter is inflated across stenotic pulmonic valve

“Waist”
develops as
balloon
inflates

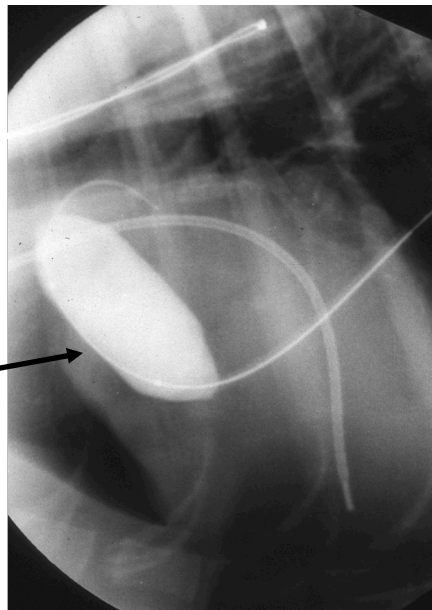


Balloon dilation
catheters



Successful Balloon Dilation!

“Waist”
disappears as
valve tears





ANY QUESTIONS?