PULMONARY PATTERNS AS THEY RELATE TO PULMONARY DISEASE

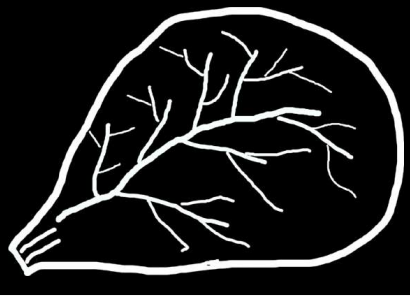
BRIAN A POTEET, MS, DVM, DACVR, DABSNM

PRESIDENT AND MANAGING DIRECTOR, VITALRADS RADIOLOGY CONSULTANTS

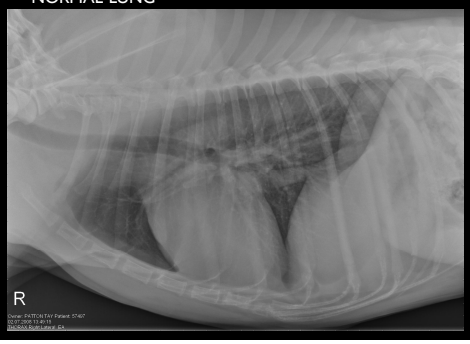
ASSOCIATE PROFESSOR, COLLEGE OF VETERINARY MEDICINE, TEXAS A&M UNIVERSITY

ASSISTANT PROFESSOR, SCHOOL OF VETERINARY MEDICINE, ST. MATTHEWS UNIVERSITY

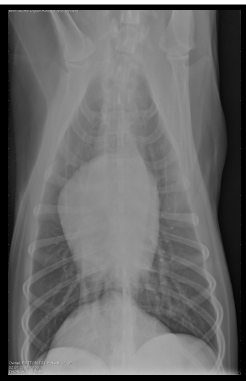
NORMAL LUNG



NORMAL LUNG



NORMAL LUNG



VARIATIONS ON A THEME

- Unlike in human medicine, there are a wide variety of animal sizes (not to mention species differences) we must keep in mind
- Welcome to veterinary medicine

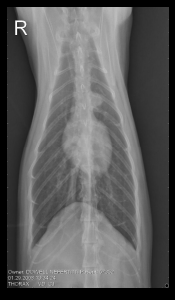
NORMAL DOBERMAN THORAX

NORMAL DOBERMAN THORAX

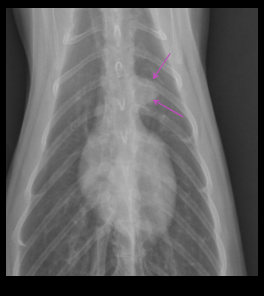
NORMAL BULLDOG LUNG

NORMAL "OLD" CAT

NORMAL "OLD" CAT



"OLD" CAT "AORTIC KNOB"



WHAT IS IT? WHERE IS IT?

- Key to diagnosis of pulmonary disease
  - Pattern recognition (what is it?)
  - Pattern distribution (where is it?)
- Type of pattern and it's distribution in the lung are basis for development of an appropriate list of differential diagnoses

PATTERNS OF PULMONARY DISEASE

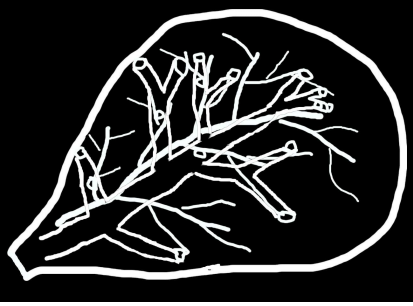
- Bronchial Pattern
- Alveolar Pattern
- Vascular Pattern
- Interstitial Pattern
  - Non-structured (no nodules or masses)
  - Structured (nodular)
- Mixed Patterns

BRONCHIAL PATTERN

- Roentgen Signs
  - Visualization of bronchial structures beyond perihilar, large diameter bronchi
  - Bronchial Walls
    - "Tramlines" – longitudinal view
    - "Donuts" - end-on view

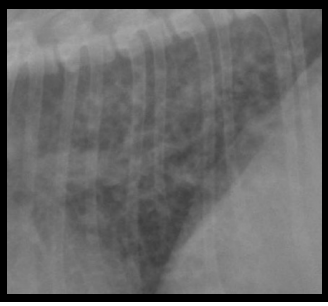
NORMAL LUNG

BRONCHIAL PATTERN

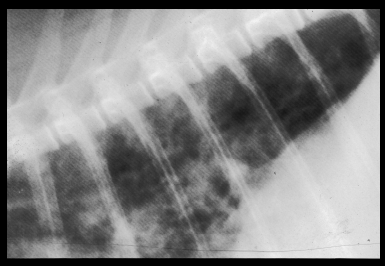


FELINE ASTHMA MODERATE - SEVERE

FELINE ASTHMA MODERATE - SEVERE



FELINE ASTHMA SEVERE



BRONCHIAL PATTERN

- Underlying pathology
  - Infiltration of bronchi or area surrounding bronchi by:
    - Inflammatory cells
    - Edema
    - Neoplastic cells
    - Mineral

ALVEOLAR PATTERN

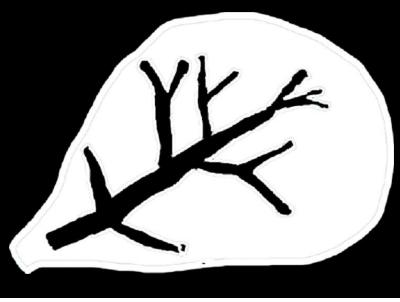
- Underlying Pathology
  - Infiltration of lung matrix with soft tissue opacity material to the point of saturation resulting in filling of the alveoli
  - Pulmonary atalectasis with loss of air within the alveoli
    - Will have associated mediastinal shift

ALVEOLAR PATTERN

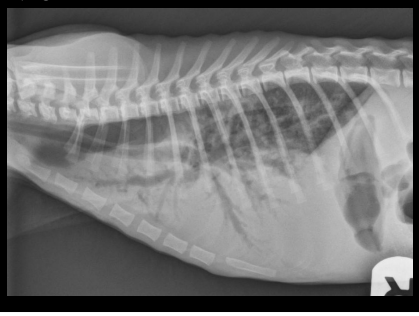
- Roentgen Signs
  - Soft tissue opacity (fluid) replaces air opacity in affected areas
  - Complete loss of visualization of pulmonary vessels in affected areas - silhouette
  - Air bronchograms
    - Air filled bronchus surrounded by soft tissue infiltrated lung (fluid)
  - Complete consolidation of lung
    - The bronchus is also filled with fluid

NORMAL LUNG

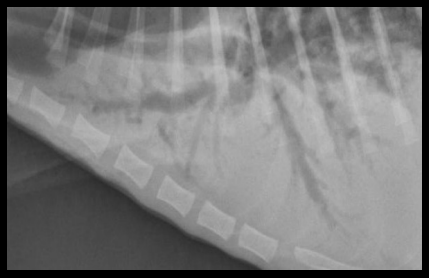
ALVEOLAR PATTERN



ALVEOLAR PATTERN



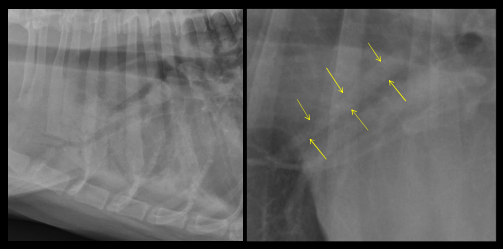
ALVEOLAR PATTERN



KEY TO AIR BRONCHOGRAMS…

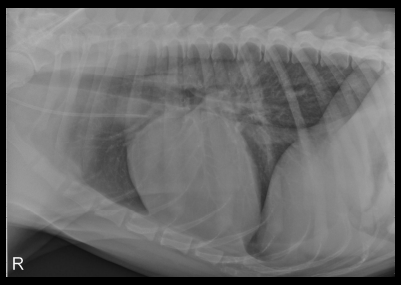
- Don't see "outside" margin of pulmonary vessels (due to silhouetting with fluid filled lung tissue)
- "Inside" margin of pulmonary vessels is still defined due to air-fluid interface (air still in the bronchus)

AIR BRONCHOGRAM



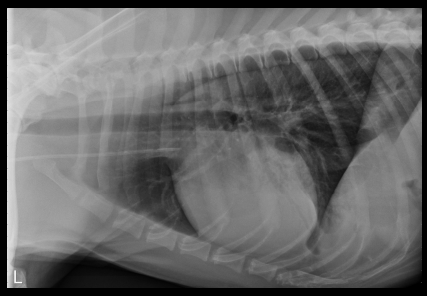
"TREES IN THE FOG"

NORMAL ?



ALWAYS GET TWO VIEWS!

AND SOMETIMES THREE!!



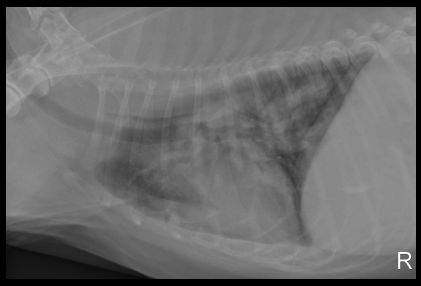
ALVEOLAR PATTERN

- Underlying Pathology
  - Infiltrate
    - "Blood"
    - "Pus"
    - "Water"
  - Atalectasis – lack of air

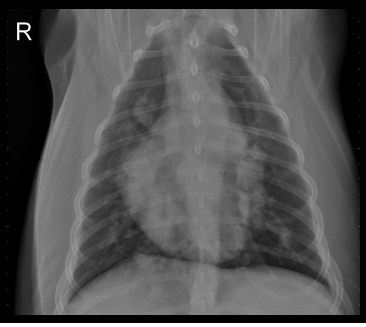
VASCULAR PATTERN

- Alteration in size or structure of pulmonary vessels
  - Increase or decrease in size of pulmonary vessels
  - Change in shape, tapering, branching patterns of vessels
  - Processes may affect arteries, veins or both

HEARTWORM DISEASE



HEARTWORM DISEASE



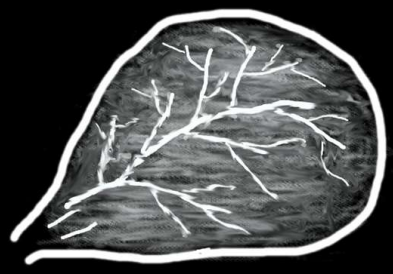
INTERSTITIAL PATTERNS

NON-STRUCTURED INTERSTITIAL PATTERN

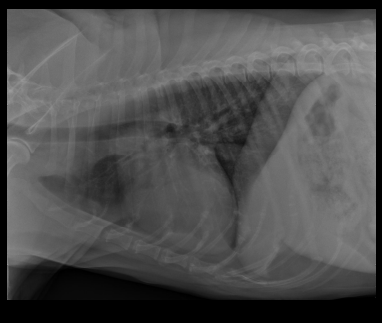
- Roentgen signs
  - Increased pulmonary opacity
  - Overall "haziness" or "busy" lung fields
  - Diminished visualization of pulmonary vessels due to partial silhouette

NORMAL LUNG

NON-STRUCTURED INTERSTITIAL

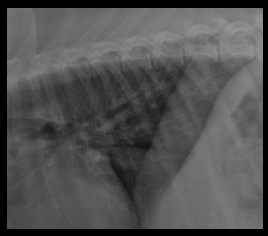


NON-STRUCTURED INTERSTITIAL



NON-STRUCTURED INTERSTITIAL

- Increased pulmonary opacity
- Decreased visualization of pulmonary vessels (especially secondary and tertiary branches) due to partial silhouetting



NON-STRUCTURED INTERSTITIAL PATTERN

- Underlying Pathology
  - Partial infiltration of lung matrix with soft tissue opacity material
    - Fibrous Tissue
    - Inflammatory Cells
    - Edema
    - Hemorrhage
    - Neoplastic Cells

STRUCTURED INTERSTITIAL PATTERN

- Underlying Pathology
  - Focal aggregate of tissue within pulmonary matrix
  - Etiologies
    - Neoplasia
      - Primary or Metastatic
    - Granulomatous
    - Degenerative
      - Pulmonary Osseous Metaplasia – "Osteomas"

STRUCTURED INTERSTITIAL PATTERN

- Roentgen Signs
  - Discrete nodular / mass opacities
  - May be soft tissue or mineral opacity

NORMAL LUNG

STRUCTURED INTERSTITIAL PATTERN

STRUCTURED INTERSTITIAL PATTERN

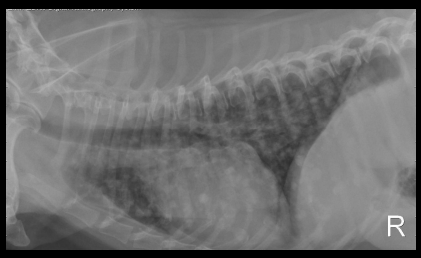
- Characteristics
  - Size
    - Similar or varied
    - Mass to miliary
  - Circumscription
    - Sharply marginated
    - Fuzzy margins
  - Opacity
    - Soft tissue vs. mineral

STRUCTURED INTERSTITIAL PATTERN

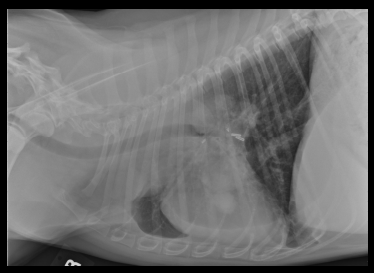
- Characteristics may give clues to etiology
  - Neoplastic nodules
    - Variably sized
    - Well circumscribed
  - Granulomatous Nodules
    - Similarly sized
    - Poorly circumscribed
  - Opacity
    - Mineralized nodules usually incidental
      - Osteomas
      - Healed granulomas

STRUCTURED INTERSTITIAL PATTERN

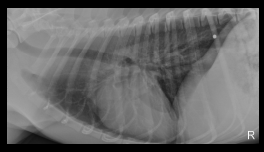
STRUCTURED INTERSTITIAL PATTERN



STRUCTURED INTERSTITIAL PATTERN



STRUCTURED INTERSTITIAL PATTERN CAVITARY LUNG NODULES

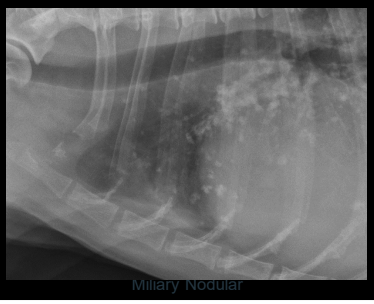


STRUCTURED INTERSTITIAL PATTERN

Miliary Nodular

STRUCTURED INTERSTITIAL PATTERN

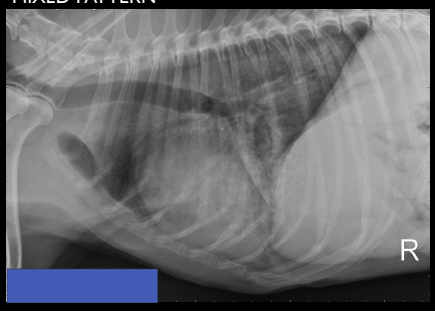
STRUCTURED INTERSTITIAL PATTERN PULMONARY OSTEOMAS



MIXED PATTERNS "NOT EVERYBODY READS THE BOOK"

- Underlying Pathology
  - May be present in variety of processes
    - Inflammatory – infectious and non-infectious
    - Granulomatous
    - Neoplastic – primary pulmonary
  - Patterns involved, distribution, signalment, history, and clinical signs assist diagnosis

MIXED PATTERN



DISTRIBUTION OF PULMONARY DISEASE OFTEN A KEY TO ETIOLOGY

- Distribution of Patterns
  - Generalized ?
  - Focal ?
  - Regional ?
  - Lobar ?
  - Symmetric / Asymmetric ?
  - Dorsal, ventral, perihilar, diffuse ?

PATTERN DISTRIBUTION

- Alveolar
  - Cranioventral – bacterial pneumonia, most likely aspiration
    - Right middle most common
  - Perihilar -> caudal dorsal (with big LA) – cardiogenic edema*
    - *except in cats and Dobermans who put there edema anywhere
  - Caudal dorsal (no perihilar and normal LA) – neurogenic edema
    - Associated with trauma, recent seizures, violent vomiting

PATTERN DISTRIBUTION

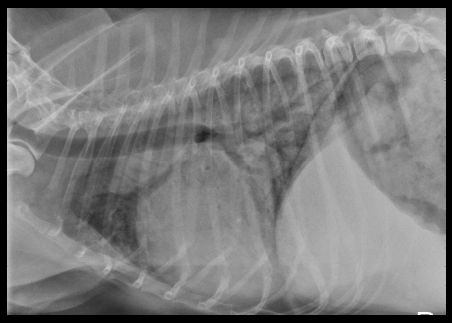
- Nodular
  - One or two large nodules in one region
    - Primary lung neoplasia
  - Multiple, variously sized nodules seen diffusely
    - Metastatic lung disease
  - If lymphadenopathy is present, consider fungal disease (especially if patient is young)

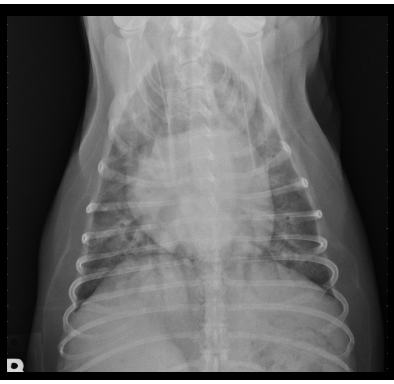
CASE EXAMPLES

LET'S PUT OUR KNOWLEDGE TO USE!

"GRETA"

- 10 year, FS, Poodle
- Coughing, heart murmur





CARDIOGENIC EDEMA

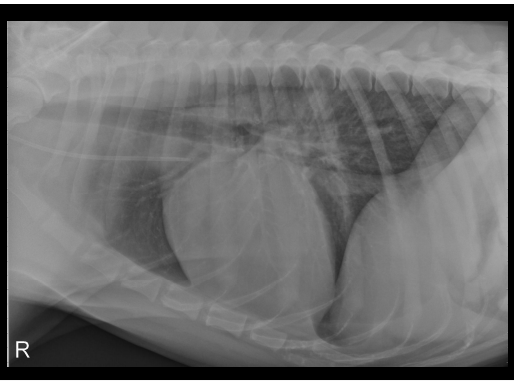
DILATED CARDIOMYOPATHY

MITRAL/TRICUSPID INSUFFICIENCY

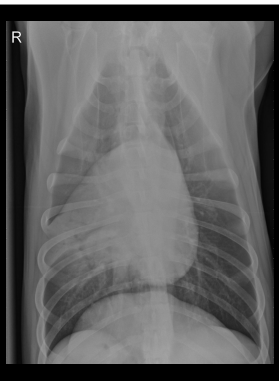
NON-COMPENSATED

"BAILEY"

- 7 year, Beagle, MC
- Cough, worsening, febrile, recent bout of pancreatitis



DIAGNOSIS?



BACTERIAL PNEUMONIA
RIGHT MIDDLE LUNG LOBE

ASPIRATION VERY LIKELY

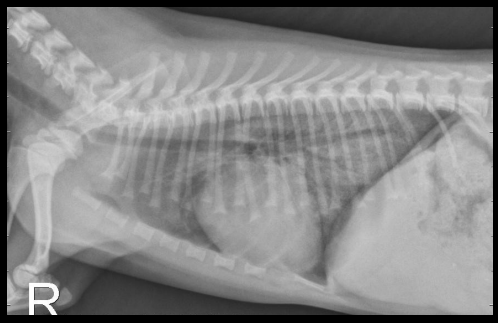
WHICH LATERAL VIEW IS BEST TO SEE RIGHT MIDDLE LUNG LOBE?

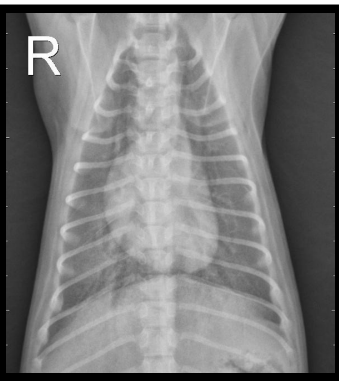
LEFT LATERAL

(YOU SEE THE UP LUNG BEST)

"HAILEY"

- 3 month, Female, poodle

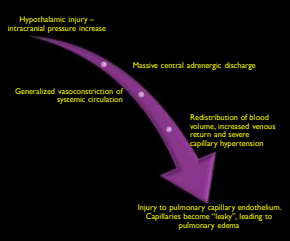




NEUROGENIC EDEMA

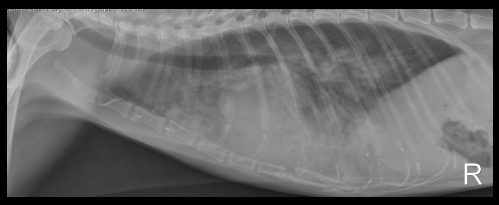
CAUGHT UNDER GARAGE DOOR

NEUROGENIC PULMONARY EDEMA



"ENGEL"

- 6 year, DSH, MC
- Lethargy

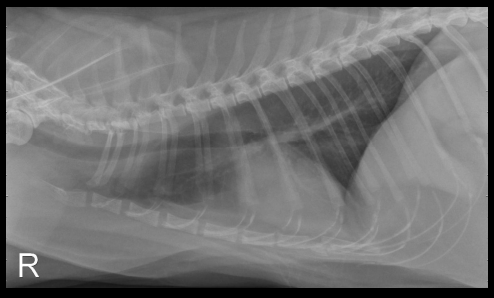


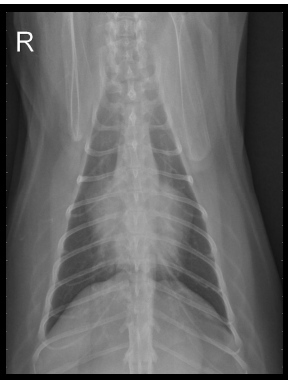
NON-COMPENSATED HYPERTROPHIC CARDIOMYOPATHY

CATS AND DOBERMANS PUT THEIR CARDIOGENIC EDEMA ANYWHERE THEY WANT TO

"SPOT"

- 11 yr, DSH, MC
- yearly wellness exam

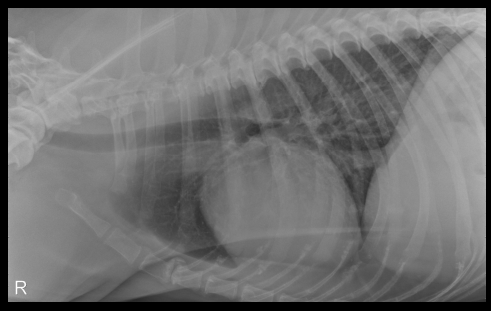


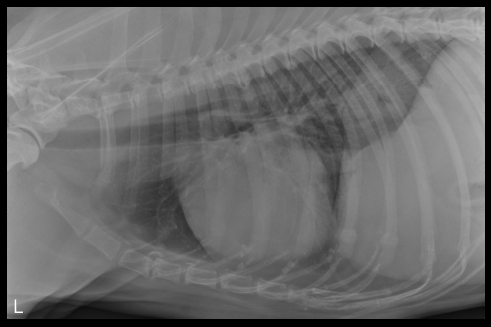


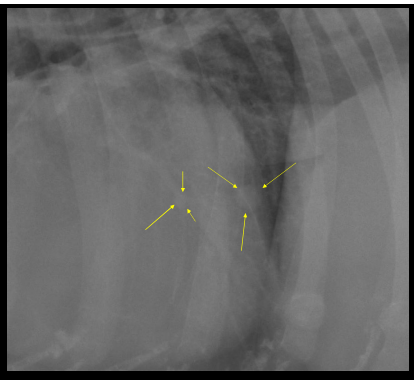
NORMAL FAT CAT

"HUTCH"

- 12 year, MC, Cocker
- TCC in urinary bladder recently found





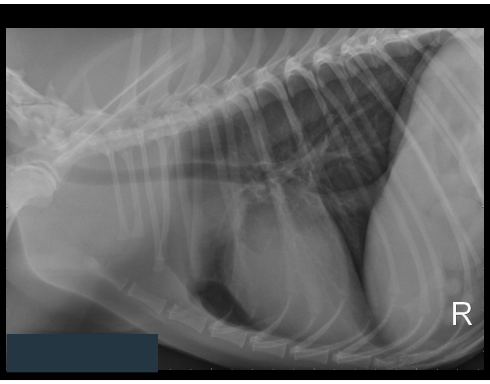


METASTATIC LUNG DISEASE

SUBTLE

"CATO"

- 9 year, MC, Mixed Breed
- Cough, getting worse

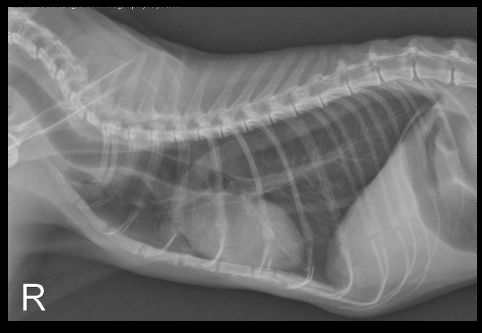


CRANIAL MEDIASTINAL MASS

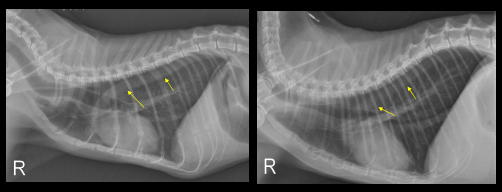
THYMOMA, THYMIC LYMPHOSARCOMA, LYMPHOSARCOMA, THYROID ADENOCARCINOMA

"BABY"

- 17 year, FS, DSH
- Chronic renal disease, hyperthyroid



SIDE BY SIDE



"Baby" Normal

METASTATIC MINERALIZATION OF SOFT TISSUES (AORTA)

HYPERCALCEMIA, CHRONIC RENAL DISEASE, PARATHYROID ADENOMA

"LUCKY"

- 5 year, Aust. Shepherd, MC
- Possible heart murmur, increased lung sounds, intermittent cough

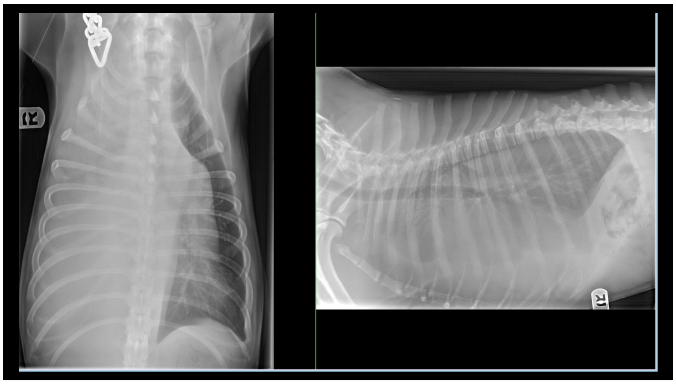
PROBABLE NORMAL THORAX

RECUMBENT ATALECTASIS SECONDARY TO GENERAL ANESTHESIA

TEX

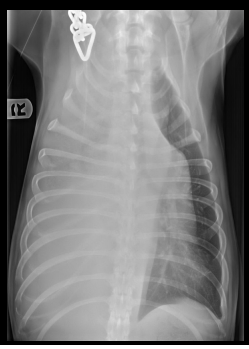
- 6 year old, Pug mix, MC
- Difficulty breathing
- Cannot hear lung sounds on right
- Muffled heart sounds
- Modality of choice?

- Radiographs
  - Consider both lateral views and a VD view



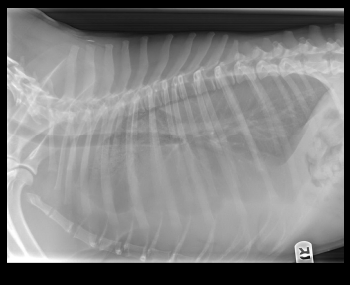
TEX – ROENTGEN SIGNS

- Severe R sided pleural effusion
- Difficult to evaluate the heart on VD view, heart looks pretty normal in size and shape on lateral
- Trachea is of normal diameter
- No significant osseous abnormalities



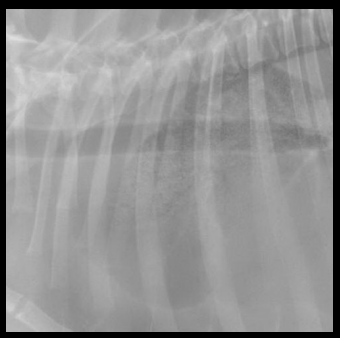
TEX – ROENTGEN SIGNS

- Pleural effusion
- Rounded lung lobe margins
- R or L lateral? Which is better in this case?
  - When the lung is filled with air (normally), the "up lung" shows up best
  - Right lateral view typically shows pathology in the left lung lobes
  - Left lateral view typically shows pathology in the right lung lobes
  - Standard of care currently is to get both laterals



TEX – ROENTGEN SIGNS

- Milliary, stippled air pattern with a few irregular appearing air bronchograms extending into cranial thorax
- Severe pleural effusion
- Next step?
  - Pleurocentesis
    - Modified transudate with blood
  - CT would be great if available
    - But was not available



TEX – RADIOGRAPHIC DIAGNOSIS

- Pleural effusion = millilary lung pattern with irregular air bronchograms…
- Pug influence….
- Lung lobe torsion > pulmonary neoplasia > pleural neoplasia > infection
- Surgery was performed and right cranial lung lobe was torsed and removed

CONTACT INFORMATION

- Brian A. Poteet, DVM, DACVR, DABSNM
- drpoteet@vitalrads.com
- Cell – 713-817-8435
- www.vitalrads.com