Overview of Thoracic Radiology

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Common Indications

- Coughing
- Dyspnea/ tachypnea
- Suspect heart disease
- Cancer staging (met check)
- Trauma
- Exercise intolerance
- Weight loss
- Collapse
- Chest wall abnormality
Radiographic Technique

- **High kilovoltage peak (kVp)**
  - Lungs have inherent high contrast
  - Goal is to spread out grayscale latitude

- **Low mAs**
  - Highest mA possible
  - Allows shortest (fastest) time
    - Minimize respiratory motion
    - <1/30 second
Radiographic Technique

- Technique chart
- Sedate
  - Severely dyspneic/ debilitated patients are exceptions
  - DO NOT do chest rads under anesthesia unless that is the only way possible
- Maximize non-manual restraint
  - Tape the feet
  - Sandbags
Standard Projections

- Two orthogonal views standard
  - L or R lateral projection
    - Views named by recumbent side
  - VD or DV projection
    - Views named by beam entry-exit direction
- All views taken at peak inspiration
- Be consistent in your “standard 2-view” choices
Standard Projections

- Three views as needed
  - *Both* laterals and VD/DV
  - Metastasis, pneumonia
  - Anytime a mass, nodule or infiltrate is suspected!
  - If in doubt, do three views
Importance of Both Lateral Views
Determining Proper Positioning

- **Lateral**
  - Legs pulled forward
  - Center on heart or caudal edge of scapula
  - Include thoracic inlet to last rib
  - Rib heads superimposed
Determining Proper Positioning

- VD or DV
  - Legs pulled forward
  - Center on heart
  - Thoracic inlet to last rib
  - Spine superimposed on sternum
    - Teardrop-shaped dorsal spinous processes
Determining the Phase of Respiration

- Always expose at peak inspiration
  - Maximizes lung contrast
  - Reduces one variable
  - Inspiratory lateral view
    - Caudodorsal aspect of lung caudal to T12
    - Increased aeration of accessory lung lobe
    - Separation of heart silhouette and diaphragm
  - Inspiratory VD/DV view
    - Diaphragmatic cupola cd to mid T8
    - Lung tips caudal to T10
Inspiratory vs. Expiratory Lateral
Inspiratory vs. Expiratory VD
Determining Proper Exposure

- **Is it dark enough?**
  - Should be able to see individual vertebrae

- **Is it too dark?**
  - Should be able to see peripheral pulmonary vessels with naked eye

- **Correcting a bad exposure**
  - Minor—change kVp +/- 10% (usu. 5-8 kVp)
  - Major—double or half mAs
Quality Control

- Redo rads for the following reasons
  - Under or over exposure
  - Not at peak inspiration
  - Poor positioning
  - Part of thorax omitted
  - Motion

- The likelihood of a diagnosis is strongly dependent on quality (even if you send them to a radiologist)
Right Lateral Projection

- Right lateral recumbency
  - Heart more egg-shaped
  - Diaphragmatic crura parallel
    - Right crus always cranial
    - Cd vena cava silhouettes with right crus
  - Overlap of L and R cranial lobar vessels
  - Air in fundus
Left Lateral Projection

- **Left lateral recumbency**
  - Heart more circular
    - Apex lifts dorsally
  - Crura diverge dorsally
    - Left crus usually cranial
    - Right crus is caudal but still silhouettes with cava
  - Less overlap of L and R cranial lobar vessels
  - Air in pylorus
The Effects of Lateral Recumbency

- Lung lesions (mass, nodule, infiltrate) may only be seen on 1 view!!!
- Only the non-dependent (up) lung can be critically evaluated
  - Dependent lung loses aeration (atelectasis)
    - Increases in opacity
    - Silhouettes with lesions
Ventrodorsal Projection

- **Dorsal recumbency**
  - Positioned in trough
    - More consistent results
    - Tough on dyspneic patients
  - Heart more elongated
  - Diaphragm appears flatter
    - Crura superimposed on cupola
      - "Mickey mouse" ears
  - Aortic/MPA enlargement more apparent
  - Accessory lung lobe better aerated
Dorsoventral Projection

- Sternal recumbency
  - Positioned directly on table
    - Tough to get straight
    - Better for dyspneic/difficult patients
  - Heart more oval due to upright position
  - Diaphragm more elongated
  - Caudal pulmonary vessels better visualized
    - Magnification (increased distance from cassette)
    - Increased aeration of caudal lung lobes
Comparison of VD and DV Views
Special Views

- **Oblique VD**
  - Evaluate rib/ chest wall masses

- **Horizontal beam**
  - Position patient to move pleural fluid away from area of interest
    - Cranial mediastinal mass
    - Lung mass
Interpretation of Thoracic Radiographs

- Develop your own routine
- Systematically evaluate everything on every view
- Evaluate a specific structure simultaneously on both views (i.e. assess heart on lat and VD before moving on to cranial mediastinum)
Interpretation of Thoracic Radiographs

My “from the inside out” routine (in this order)

- Heart and great vessels (middle mediastinum)
- Cranial and caudal mediastinum
- Lungs including pulmonary vessels and pleura
- Extrathoracic structures
Heart and Great Vessels

- **Middle mediastinum**
  - Heart, Aortic arch, Ascending aorta, MPA, Tracheobronchial LN’s

- **Dogs**
  - Breed (and hence chest) conformation influences apparent size
  - Deep chested (Dobes)
    - Heart appears small on LAT compared to chest size
    - Upright and therefore rounded on VD
  - Barrel chested (Dachshunds)
    - Heart appears large on LAT compared to chest size
    - Normal size on VD
Heart and Great Vessels

- **Cardiac size (dogs)**
  - **Lateral**
    - 2.5-3.5 ICS wide
      - Measure at widest point
    - Approximately 2/3 height of thorax
    - Trachea should diverge ventrally from spine
  - **VD/ DV**
    - ½ to 2/3 width of chest
    - More elongated on VD
    - Apex on L side
Heart and Great Vessels

- **Cardiac size (cats)**
  - Lateral
    - 2-3 ICS wide
    - Measure perpendicular to apex/ carina axis
      - Heart tilts cranially with increasing age
  - VD/ DV
    - ½ to 2/3 width of thorax
Location of Specific Cardiac Chambers--Dog
Clock Face Analogy
Location of Specific Cardiac Chambers -- Cat
Pitfalls of Cardiac Radiology

Radiographs are insensitive for assessing heart size

- May be normal with severe cardiac disease
- Overlap of ST structures
- Wide variation in “normal”
- Chamber walls may severely thicken without visible change in cardiac silhouette size
  - HCM in cats
  - Echocardiography if cardiac dz suspected
Cranial Mediastinum

- Space between pleural sacs
  - Trachea
  - Multiple structures silhouette
    - Esophagus
    - Brachiocephalic and L subclavian arteries
    - Cranial vena cava
    - Thymus
    - Sternal/ mediastinal lymph nodes
Cranial Mediastinum

- Structures sometimes visible
  - Esophagus
    - Fluid or air filled
  - Thymus
    - Young animals
    - “Sail sign” on VD
  - Sternal/ mediastinal lymph nodes
    - Lymphadenopathy
Caudal Mediastinum

- Visible structures
  - Caudal vena cava
  - Descending aorta
  - +/- Esophagus
**Lungs**

- **Normal anatomy**
  - Left
    - Cranial (cranial subsegment)
    - Cranial (caudal subsegment)
    - Caudal
  - Right
    - Cranial
    - Middle
    - Caudal
    - Accessory
  - There is no dorsocaudal lung lobe!
Lungs

- Normal lung boundaries
  - 4\textsuperscript{th} to 5\textsuperscript{th} ICS on VD
    - Fissure b/w L cranial lung subsegments
    - Fissure b/w R cranial and middle lung lobes
  - 6\textsuperscript{th} to 7\textsuperscript{th} ICS on VD
    - Fissure b/w L cranial and caudal lobes
    - Fissure b/w R middle and caudal lobes
Lungs

- Regions of a specific lung lobe
  - Perihilar (hilar)
  - Midzone
  - Periphery

- Distribution of disease may lead to etiology
  - Edema
  - Pneumonia
Pulmonary Patterns

- Interstitial
  - Structured or unstructured
- Alveolar
- Bronchial
Pulmonary Patterns

- Interstitial
  - Structured (nodular)
    - Nodules (<3cm)
      - Must be at least 5mm to be visible if soft tissue
      - Smaller mineralized nodules may be visible
    - Masses (>3cm)
Structured or Nodular Interstitial Pattern
Pulmonary Patterns

- **Interstitial**
  - Unstructured
    - Fluid, cells, scarring in connective tissue
    - Lungs more opaque
    - Blurred but visible vascular margins
Unstructured Interstitial Pattern
Pulmonary Patterns

- **Alveolar**
  - **Consolidation**
    - Alveoli filled with blood, pus, edema, or other infiltrate
  - **Atelectasis**
    - Collapse of alveoli
  - **Radiographs**
    - Silhouetting of soft tissue structures
    - +/- Air bronchograms
      - Bronchial lumen remains filled with air
Alveolar Pattern
Bronchial Pattern

- Increased visualization of bronchial wall
  - Bronchial wall thickening
  - Peribronchial infiltrate
    - Increased soft tissue adj to bronchus
  - Radiographs
    - “Tram tracks and donuts”
Bronchial Pattern
Pulmonary Vasculature

- Disregard the use of "vascular pattern"
- Artery-bronchus-vein relationship
  - Veins are "ventral and central" to bronchus
  - Arteries are dorsal and lateral to bronchus
- Mild asymmetry OK
Pulmonary Vasculature

Normal vascular sizes

- Deciding if they’re too big...
  - Cranial lobar arteries and veins
    - Diameter < width of proximal 4th rib on LAT view
  - Caudal lobar arteries and veins
    - Diameter < width of 9th rib where vessel crosses rib on VD view

- Deciding if they’re too small...
  - Vessels should be \( \geq \) to half the rib width
Normal Pulmonary Vessels
Pulmonary Vasculature

- Type of vascular changes may indicate etiology
  - A few examples
    - Caudal lobar arteries may be dilated with HWD
    - Large veins may indicate LHF
    - Small vessels with dehydration
Pleura

- Two layers
  - Parietal
    - Lines thoracic wall and diaphragm
  - Visceral
    - Lines outer lung surface
  - Pulmonary (pleural) fissure lines sometimes visible
    - Pleural thickening in older patients
    - Fluid or air in pleura space
Extrathoracic Structures

- Sternum
- Vertebrae
- Ribs
- Adjacent soft tissues
- Diaphragm
Extrathoracic Structures

- Extrathoracic changes may indicate cause of intrathoracic findings
  - Examples
    - Pneumothorax
      - Rib fractures may suggest secondary to trauma
    - Pleural effusion secondary to rib or chest wall mass
The Limitations of Thoracic Radiography

- Multiple soft tissue structures silhouetting
- “Snapshot” in time
  - Radiographic changes may lag behind disease
- Poor assessment of cardiac enlargement
- Pleural effusion may obscure normal or abnormal structures
  - Repeat rads after thoracocentesis
The Strengths of Thoracic Radiography

- Cheap and easy
- Good screening exam
  - Lungs and extrathoracic tissues
  - Determine if other procedures are necessary
- Valuable for assessing cardiac failure
- ***Ultrasound cannot penetrate air, but X-rays can
Questions???