Introduction to CXR and Chest CT

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Objectives

- **Technique**
  - Learn the difference between PA vs. AP CXR
  - Learn the utility of a lateral decubitus CXR
- **Anatomy**
  - Learn the basic anatomy of the fissures of the lungs, heart borders, bronchi, and vasculature that can be seen on a chest x-ray and CT
- **Interpretation**
  - Develop a consistent technique
  - Learn the silhouette sign

**Pathology**

- Learn the concept of atelectasis and the ability to recognize it on a chest x-ray
- Appreciate the appearance of pulmonary edema
- Appreciate the difference findings of atelectasis and pneumonia
- Recognize pleural effusions and pneumothorax
- Recognize the signs of COPD
- Pulmonary nodules & masses
- Others…
Lateral View
Ribs and Diaphragm
Postero-anterior or Antero-posterior
Lateral Decubitus

-Assess the volume of pleural effusion and demonstrate whether a pleural effusion is mobile or loculated.

-You could also look at the nondependent hemithorax to confirm a pneumothorax in a patient who could not be examined erect.
- The patient should be examined in full inspiration.

- The diaphragm should be found at about the level of the 8th - 10th posterior rib or 5th - 6th anterior rib on good inspiration.
Right and Left Upper Lobes
Right Middle Lobe
Right and Left Lower Lobes

Left Upper Lobe
Major Fissure
Left Lower Lobe

Right Upper Lobe
Minor or Horizontal Fissure
Right Middle Lobe
Major Fissure
Right Lower Lobe
- **Right Lung containing:**
  - RUL: Apical Segment
  - RUL: Posterior Segment
  - RUL: Anterior Segment
  - RML: Lateral Segment
  - RML: Medial Segment
  - RLL: Anterior Basal Segment
- **Left Lung containing:**
  - LUL: Apical Posterior Segment
  - LUL: Anterior Segment
  - LUL: Lingula Superior Segment
  - LUL: Lingula Inferior Segment
  - LLL: Anteromedial Segment
CT Anatomy
CT Anatomy
Pulmonary Vasculature
Fissures
Lobes and Fissures
Lobes and Fissures
How to Read a Chest X-Ray

- Patient Data (name, history, age, sex, old films)
- Routine Technique: AP/PA, supine or erect
- Trachea: midline or deviated, caliber, mass
- Lungs: abnormal shadowing or lucency
- Pulmonary vessels: vascular enlargement
- Hila: masses, lymphadenopathy
- Heart: thorax: heart width > 2:1? Cardiac configuration?
- Mediastinal contour: width? mass? Course of aorta
- Pleura: effusion, thickening, calcification
- Bones: lesions or fractures
- Soft tissues: don't miss a mastectomy
- ICU Films: identify tubes first and look for pneumothorax
Looking for Abnormalities

Do a directed search of the chest film rather than simply gazing at the film.
Silhouette Sign

- One of the most useful signs in chest radiology
- Described by Dr. Ben Felson
- The silhouette sign is in essence elimination of the silhouette or loss of lung (air)/soft tissue interface caused by a mass or fluid in the normally air filled lung.

- If an intrathoracic opacity is in anatomic contact with the heart border, then the opacity will obscure that border.
- The sign is commonly applied to the heart, aorta, chest wall, and diaphragm.
- The location of this abnormality can help to determine the location anatomically.
Which lobe is it?
For the heart, the silhouette sign can be caused by an opacity in the RML, lingula, anterior segment of the upper lobe, and anterior portion of the pleural cavity.

This contrasts with an opacity in the posterior pleural cavity, posterior mediastinum, or lower lobes which cause an overlap and not an obliteration of the heart border.
Silhouette Sign
Silhouette Sign
Air Bronchogram

- Is a tubular outline of an airway made visible by filling of the surrounding alveoli by fluid or inflammatory exudates.
- Six causes of air bronchograms are:
  - lung consolidation,
  - pulmonary edema,
  - nonobstructive pulmonary atelectasis,
  - severe interstitial disease,
  - neoplasm, and
  - normal expiration.
Atelectasis

- Collapse or incomplete expansion of the lung or part of the lung
- Often caused by an endobronchial lesion, such as mucus plug or tumor
- Extrinsic compression centrally by a mass such as lymph nodes or peripheral compression by pleural effusion

- Atelectasis is almost always associated with a linear increased density on chest x-ray
- Indirect signs of volume loss include vascular crowding or fissural, tracheal, or mediastinal shift, towards the collapse.
- Segmental and subsegmental collapse may show linear, curvilinear, wedge shaped opacities. This is most often associated with post-op patients
Atelectasis
RUL Collapse
Pulmonary Edema

- Two basic types of pulmonary edema.
  - **cardogenic edema** caused by increased hydrostatic pulmonary capillary pressure.
  - **noncardogenic** pulmonary edema, and is caused by either altered capillary membrane permeability or decreased plasma oncotic pressure.

- **NOT CARDIAC**
  - Near-drowning,
  - Oxygen therapy,
  - Transfusion or trauma,
  - CNS disorder,
  - ARDS, aspiration, or altitude sickness,
  - Renal disorder or resuscitation,
  - Drugs,
  - Inhaled toxins,
  - Allergic alveolitis,
  - Contrast or contusion.
Pulmonary Edema
Pulmonary Edema

June 2, 2009

June 4, 2009
Congestive Heart Failure

- Congestive heart failure (CHF) is one of the most common abnormalities evaluated by CXR.
- The earliest CXR finding of CHF is cardiomegaly, detected as an increased cardiothoracic ratio (>50%).
- In the pulmonary vasculature of the normal chest, the lower zone pulmonary veins are larger than the upper zone veins due to gravity.
In a patient with CHF, the pulmonary capillary wedge pressure rises to the 12-18 mmHg range and the upper zone veins dilate and are equal in size or larger, termed cephalization.

With increasing PCWP, (18-24 mm. Hg.), interstitial edema occurs with the appearance of Kerley lines.

Increased PCWP above this level is alveolar edema, often in a classic perihilar bat wing pattern of density. Pleural effusions also often occur cardiomegaly, alveolar edema, cephalization and haziness of vascular margins.
CHF
Kerley B lines

Horizontal lines less than 2cm long, commonly found in the lower zone periphery. These lines are the thickened, edematous interlobular septa.

Causes include: pulmonary edema, lymphangitis carcinomatosa and malignant lymphoma, viral and mycoplasmal pneumonia, interstitial pulmonary fibrosis, pneumoconiosis, sarcoidosis, chronic CHF
Atelactasis vs. Pneumonia

**Atelectasis**
- Volume Loss
- Associated Ipsilateral Shift
- Linear, Wedge-Shaped
- Apex at Hilum

**Pneumonia**
- Normal or Increased Volume
- No Shift, or if Present Then Contralateral
- Consolidation, Air Space Process
- Not Centered at Hilum

Air bronchograms can occur in both.
indistinct borders, air bronchograms, and silhouetting of the right heart border.
--- Pneumonia
Lung abscess
Pleural Effusion

- **Upright film,**
  - will cause blunting on the lateral and if large enough, the posterior costophrenic sulci.
  - A large effusion can lead to a mediastinal shift away from the effusion and opacify the hemithorax.
  - Approximately 200 ml of fluid are needed to detect an effusion.
Pleural Effusion
Pericardial Effusion

- An enlarged heart shadow that is often globular shaped (transverse diameter is disproportionately increased).
- Serial films can be helpful in the diagnosis especially if rapid changes in the size of the heart shadow are observed.
- Approximately 400-500 ml of fluid must be in the pericardium to lead to a detectable change in the size of the heart shadow on PA CXR.
- Pericardial effusion can be definitively diagnosed with either echocardiography or CT
Pericardial Effusion
COPD
COPD / Emphysema
Calcified Granuloma
Tubes, Lines & Catheters
Tubes, Lines & Catheters
Pneumothorax

Defined as air inside the thoracic cavity but outside the lung.

- A tension PTX; air enters the pleural cavity and is trapped during expiration usually by some type of ball valve mechanism. This leads to increasing intrathoracic pressure. Eventually the pressure buildup is large enough to collapse the lung and shift the mediastinum.
Mass vs. Infiltrate

[Images of chest X-rays showing a mass and infiltrate]
Mass Location; Intraparenchymal vs. pleural vs. extrapleural

Three locations that a mass can exist in the thoracic cavity.
A = intraparenchymal
B = pleural
C = extrapleural
Mass Location; Intraparenchymal vs. pleural vs. extrapleural
Sub-centemetric Nodules
• **Low Risk Patient**
  - $\leq 4\text{mm}$ No follow-up needed
  - 4–6\text{mm} 12\text{mo}; if no change - stop
  - 6–8\text{mm} 6–12\text{mo}; no change - follow-up at 18–24\text{mo}
  - $> 8\text{mm}$ CT follow-up at 3, 9, 24\text{mo or PET/CT, or biopsy}

• **High Risk Patient**
  - $\leq 4\text{mm}$ 12\text{mo}; if no change - stop
  - 4–6\text{mm} 6–12\text{mo}; no change - follow-up at 18–24\text{mo}
  - 6–8\text{mm} 3–6\text{mo}; no change - follow-up at 18–24\text{mo}
  - $> 8\text{mm}$ CT follow-up at 3, 9, 24\text{mo or PET/CT, or biopsy}
Solitary Pulmonary Nodule

• A common finding on a chest x-ray.
• Most nodules are benign.
• Nodules are diagnosed as benign if they
  - Show little or no growth for 2 years
  - Calcification
    • Central, laminated or diffuse pattern indicates a granuloma
    • Eccentric calcification can be seen in a carcinoma or in a cancer that has engulfed a granuloma.
Hiatal Hernia
PET/CT
CT  Calcium Score & CT Coronary Angiography
Pulmonary Emboli
Aortic Aneurysm
New Developments
- This is a chest x-ray of an adult female patient.

- The silhouette of the right upper Mediastinum is lost and the consolidation is confined inferiorly by the horizontal fissure.

- Within the consolidation air bronchograms are evident.

- There is consolidation of the right upper lobe.
- In a patient of age 56, the presence of an upper lobe collapse should alert one to the possibility of an endobronchial neoplasm.

- An endobronchial malignancy may be the underlying cause for an upper lobe collapse or an upper lobe pneumonia which fails to resolve with treatment.

- Referral for bronchoscopy is advised.
Air bronchograms are due to the air within bronchi surrounded by consolidated lung. These smaller bronchi are not normally delineated from the lung, but due to consolidation a contrast difference occurs. They are not always present, but when they are they suggest consolidation (usually infection) in the lung.
Left upper-lobe collapse
Trachea deviated to L
Ill-defined opacity
Indistinct elevated L hilum

Left lower-lobe collapse
Triangular opacity visible through the heart with loss of medial end of diaphragm

Lingular consolidation
Indistinct L heart border

Right upper lobe collapse
Trachea deviated to R
Horizontal fissure and R hilum displaced upwards
Triangular opacity with well-defined margins

Right middle lobe collapse
Horizontal fissure displaced down
Ill-defined opacity adjacent to R heart border
Loss of R heart border
Well-defined triangular opacity running from hilum

Right lower lobe collapse
Horizontal fissure displaced downwards
Oblique fissure and hilum displace posteriorly
Well-defined posterior opacity

Well-defined opacity adjacent to R heart border (R heart border still visible)
A = Right Main Stem Bronchus
B = Right Upper Lobe Bronchus
  B1 = Apical Segmental Bronchus
  B2 = Anterior Segmental Bronchus
  B3 = Posterior Segmental Bronchus
C = Bronchus Intermedius
D = Right Middle Lobe Bronchus
  D4 = Lateral Segmental Bronchus
  D5 = Medial Segmental Bronchus
E = Right Lower Lobe Bronchus
  E6 = Superior Segmental Bronchus
  E7 = Medial Basal Segmental Bronchus
  E8 = Anterior Basal Segmental Bronchus
  E9 = Lateral Basal Segmental Bronchus
  E10 = Posterior Basal Segmental Bronchus
F = Left Main Stem Bronchus
G = Left Upper Lobe Bronchus
  G1, G2 = Apicoposterior Segmental Bronchus
  G3 = Anterior Segmental Bronchus
H = Lingular Bronchus
  H4 = Superior Lingular Segmental Bronchus
  H5 = Inferior Lingular Segmental Bronchus
I = Left Lower Lobe Bronchus
  I6 = Superior Segmental Bronchus
  I7 = Medial Basal Segmental Bronchus
  I8 = Anterior Basal Segmental Bronchus
  I9 = Lateral Basal Segmental Bronchus
  I10 = Posterior Basal Segmental Bronchus
Lobes and Fissures