Interpretation Of The Chest Radiograph
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Learning Objectives:
- Identify normal landmarks and technical defects on a chest radiograph.
- Identify common abnormal features on a chest radiograph.

Production Of The Radiograph

Components
- Cathode tube- electron source
- Anode (target)- converts to x-rays
- Patient- tissues absorb x-rays on basis of density
- Film cassette- captures image from x-rays that are not absorbed

Density and Appearance
- Air: Appears black- the least radiodense substance in tissue.
- Fat: Appears gray-black- present subcutaneously, along muscle sheaths and surrounds organs.

- Air: Appears black- the least radiodense substance in tissue.
- Fat: Appears gray-black, present subcutaneously, along muscle sheaths and surrounds organs.
- Water: Appears gray- fluid filled tissues such as blood, muscle, cartilage, etc.
- Bone: Appears white- bone and teeth are the most radiodense normally occurring substances.
Density and Appearance
- Contrast media: Produces bright white outline of the structure injected; e.g., barium.
- Heavy metals: Solid white, metals used for artificial joints, pins, etc. appear as white on radiographs.

Magnification
- Images produced by x-rays are magnified.
- Objects closer to source, furthest from film are more magnified

Magnification
- Images produced by x-rays are magnified.
- Objects further from source, closer to film are less magnified

Standard Chest Views
- Postero-anterior (PA)- standard view
  - Scapulae rotated out of field on PA
  - Low magnification of heart (C:T < 1:2)
  - Anatomic positioning

Standard Chest Views
- Anteroposterior (AP)
  - critically ill patients (bedridden)
  - greater magnification of heart
  - scapulae usually visible
  - often expiratory view
Standard Chest Views

- Lateral view
  - Adds dimensionality to study
  - Left lateral least magnifies heart
  - View cardiac structures
  - View mediastinal abnormalities

Click to see normal lateral view
http://www.rad.msu.edu/Education/pages/Gls_Resourses/Common/pages/Allen_Rad_tutor/images/ChestView1c.jpg

Standard Chest Views

- Lateral decubitus
  - Side-lying to visualize fluid level
  - Primarily used to identify pleural effusion

Click to see normal lateral view
http://www.rad.msu.edu/Education/pages/Gls_Resourses/Common/pages/Allen_Rad_tutor/images/ChestView1c.jpg

Evaluating Quality

ALWAYS evaluate image quality before attempting to interpret. A film of poor quality should be repeated, rather than interpreted.

Technical Errors

- Exposure - vertebral bodies should be just visible under cardiac silhouette
  - Overexposed film appears black (radiolucent)
  - Underexposed film appears white (radio-opaque)

Click to see radiograph with correct exposure
http://imaging.cmpmedica.com/consultantlive/images/articles/2007/01/08/20070108ConYaakob1.jpg

Technical Errors

- Patient alignment - spine should be centered on trachea, clavicles
  - Rotation will magnify some structures
  - Rotation will make some structures appear radio-opaque

Click to see rotation on chest radiograph
Technical Errors

- Inspiratory view - 6 ribs should be visible above diaphragm
  - expiratory - exaggerates pulmonary markings
  - expiratory - enlarges appearance of heart (looks like cardiomegaly)
  - expiratory shows elevated hemidiaphragms

Click to see inspiratory view
http://www.e-radiography.net/technique/chest/cxreval5.jpg
Click to see expiratory view
http://www.e-radiography.net/technique/chest/cxreval4.jpg

Normal Landmarks

Systematic Analysis

- Check placement on view box
- Check patient's name
- Check date, time
- Evaluate technical quality

Systematic Analysis

- Mediastinum
  - Tracheal size and position
  - Heart borders
  - C:T < 1:2 (adults)
- Hilum - pulmonary arteries & bronchi
- Lung fields

Systematic Analysis

- Dome of diaphragm
- Pleural surface
- Costophrenic angle
- Bones
- Clavicles
- Vertebrae
Systematic Analysis
- Scapulae
- Ribs
- Skin and soft tissue
- Sub-diaphragm

Chest Radiograph Abnormalities

- Silhouette sign
  - Obliteration of heart border indicates anterior lung infiltrate
  - Overlap of infiltrate and heart border, with sharp heart border indicates posterior infiltrate

Click for information and x-rays of silhouette sign
http://radiology.rsna.org/content/246/3/697/F67.expansion.html

- Air bronchogram
  - Consolidated or collapsed alveoli surround air-filled bronchi
  - Present in pneumonia, edema, ARDS

Click to see air bronchograms (scroll down)
http://robochest.com/WebHelp/The_Consolidative_Model.html

- Pneumonia- usually infectious, with fluid-filled alveoli
  - Lobar
  - Bilateral
  - Diffuse

Click to see left lower lobe pneumonia
http://radiographics.rsna.org/content/vol21/issue4/images/large/g01jl24g12a.jpeg
Click to see right middle lobe pneumonia
Click to see bilateral pneumonia
http://www.yale.edu/imaging/cases/pneumonia_bilateral/graphics/rad1.gif

- Interstitial lung disease
  - Common causes
    - Pneumoconiosis
    - Hypersensitivity pneumonitis.
    - Sarcoidosis
    - Pulmonary fibrosis
    - Bronchiolitis obliterans
  - Collagen vascular disease

Click to see pulmonary fibrosis
http://rad.usuhs.mil/rad/handouts/feigin/abnlcxr/case006/top.htm
Click to see BOOP
http://www.cop-boo.org.uk/
Chest Radiograph Abnormalities

- Localized atelectasis- consistent with post-surgery, obstruction
  - Radiographic signs
    - Volume loss on affected side
    - Mediastinal shift toward affected side
    - Elevation of hemidiaphragm

Click to see lobar atelectasis
http://rad.usuhs.mil/rad/handouts/feigin/abnlcxr/case009/top.htm

Chest Radiograph Abnormalities

- ARDS
  - Radiographic signs
    - Generalized opacity
    - Volume loss
    - Hyaline membrane (sometimes)
    - Air bronchograms

Click to see ARDS with pneumomediastinum
http://www.aic.cuhk.edu.hk/web8/0234_ARDS_pneumomediastinum_2.jpg

Chest Radiograph Abnormalities

- Cardiogenic pulmonary edema
  - Consistent with hx of myocardial infarction
  - Radiographic signs
    - Generalized opacity
    - Prominent lung vasculature
    - Cardiomegaly
    - Kerly B lines- full lymphatics

Click to see cardiogenic pulmonary edema
http://www.e-radiography.net/technique/cheest/cxreval9.jpg

Chest Radiograph Abnormalities

- Hyperinflation- consistent with asthma, emphysema
  - Radiographic signs
    - Generalized hyperlucency
    - Enlarged intercostal spaces
    - Normal or small heart
    - Flattened diaphragms

Click to see asthma with aspergillus mycetoma
http://images.radiopaedia.org/images/627568/1a99908653cb5800d602be389b4a51.jpg
Click to see bullous emphysema
http://rad.usuhs.mil/rad/handouts/feigin/abnlcxr/case008/top.htm

Chest Radiograph Abnormalities

- Pneumothorax- consistent with chest trauma, surgery, insertion of central line
  - Radiographic signs
    - Localized hyperlucency
    - Visible pleural edge
    - Mediastinal shift away from affected side (tension pneumothorax)

Click to see tension pneumothorax
http://www.unboundedmedicine.com/2005/10/23/you-should-never-take-this-chest-x-ray/
Click to see non-tension pneumothorax
http://www.meddean.luc.edu/lumen/mededmedicine/pulmonar/images/pneum03.jpg
Click to see bilateral pneumothorax
http://upload.wikimedia.org/wikipedia/commons/d/d1/Bilateral_pneumothorax_pneumomediastinum.jpg

Chest Radiograph Abnormalities

- Pleural effusion, hemothorax- consistent with trauma, pulmonary edema, carcinoma, etc.
  - Radiographic signs
    - Blunting of costophrenic angle
    - Whiteout of affected side with AP supine view
    - Fluid level on lateral decubitus view

Click to see pleural effusion PA and lateral views
http://rad.usuhs.mil/rad/handouts/feigin/abnlcxr/case011/top.htm
Chest Radiograph Abnormalities
- Pleural effusion

Medical Devices on Radiographs
- Endotracheal tube
- Pulmonary artery catheter
- Intraaortic balloon catheter
- Central venous lines
- Nasogastric tubes
- Pacemakers
- Sternal wires (post- sternotomy)

Medical Devices on Radiographs
- Lateral decubitus view

Medical Devices on Radiographs
- Endotracheal tube - correct position
  - 3-5 cm above carina or
  - 4th thoracic vertebra

Medical Devices on Radiographs
- Lines and tubes in ICU chest x-rays
  - Nasogastric tubes - may enter lung

Summary & Review
- Components of imaging system
- Effects of density & magnification
- Technical quality of radiographs
- Standard radiographic views
- Normal landmarks
- Systematic evaluation
Summary & Review

- Abnormalities
  - signs - silhouette & air bronchogram
  - pneumonia
  - interstitial disease
  - atelectasis
  - ARDS
  - cardiogenic pulmonary edema
  - hyperinflation - emphysema & asthma

Summary & Review

- Abnormalities
  - pneumothorax
  - pleural effusion & hemothorax
  - medical devices; e.g., endotracheal tubes, lines, etc.

Reference