Lecture 5

Chest Radiography

Switch mobile phone off or to silent
References and useful websites

References

• Textbook of radiographic positioning and related anatomy; Kenneth L. Bontrager, 6th, 7th editions

Useful Websites

http://www.e-radiography.net/
http://training.seer.cancer.gov/module_anatomy/unit1_3_terminology.html

Chest Radiography

At the end of the lecture, the student should be able to

1. Identify the major anatomical structures of the chest
2. State the common indications for chest radiography
3. Identify the technical factors used for chest radiography
4. List the basic / Optional radiographic projections of the chest.
5. Discuss the
   - Body position
   - Part position
   - Central ray
   - Center point
   for specific positions of chest
7. Evaluate chest radiographs, based on (position, collimation and central ray, exposure, and structure best shown)
Chest Anatomy

- Thoracic cavity (chest)
  - Surrounded by boney thorax
  - Separated from abdomen by diaphragm
    - Muscular partition, dome shaped
    - Lungs drape over diaphragm

Boney Thorax

- ENCLOSE THE ORGANS
  - STERNUM (breast bone)
  - 12 PAIR OF RIBS
  - 12 THORACIC VERTEBRA
  - ATTACH UPPER EXTREMITY
    - 2 CLAVICLES
    - 2 SCAPULA

Anterior  Posterior
Thoracic Cavity

- Sections of the thoracic cavity
  - Pleural portion (lungs)
  - Mediastinum (between lungs)
  - Pericardial portion (heart)

Respiratory System

1. Lungs
   - Lobes
     - Right 3 lobes
     - Left 2 lobes
   - Terminology
     - Apex
     - Hilum
     - Base
     - Costophrenic angles
**Bronchial Tree**

2. Bronchi

- Air tubes leading into the lung
- Right more vertical than left
- Branching structure
  - Primary ➔ 2ndary ➔
- Only primary visible on PA projection

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**Miscellaneous**

- **Mediastinum contents**
  - Trachea
  - Major vessels
  - Esophagus
  - Lymphatic's
  - Heart
  - Thymus
Some Common Indications

- **Trauma** (e.g. Fractures)
- **Pneumonia**: an inflammatory condition of the lung affecting primarily the microscopic air sacs
  - **pulmonary Koch’s** (Pulmonary tuberculosis) or **tubercle bacillus** (TB)
  - Is a contagious bacterial infection of the lungs
- **Congestive Heart Failure (CHF)** – Cardiomegaly -
- **Chronic obstructive pulmonary diseases (COPD)**
  - **Emphysema**: Over-inflation of the air sacs (alveoli), causing a decrease in lung function
  - **Bronchiectasis**: Permanent enlargement of the bronchi and bronchioles
  - **Asthma**: A condition of chronic swelling of the airways
- **Pleural Effusion**: abnormal collection of fluid in the pleural space resulting from excess fluid production or decreased absorption
- **Medical Check up**
- **Pulmonary Embolism (PE)**: Is a blockage in one of the pulmonary arteries by blood clots

Some Common Indications

- **Pre-operative evaluation**
- **Follow-up of a previously abnormal chest X-ray**
- **To confirm the proper placement of certain devices within the chest, such as pacemakers, endotracheal (breathing tubes**
- **Some Terms signs and symptoms related to chest Requests**
- **Cough**
- **Chest pain**
- **Breathlessness** (dyspnea): Shortness of breath
- **Fever**
- **POU** (pyrexia of unknown origin)
- **Hemoptysis**: coughing up blood or blood-stained mucus from the bronchi
For chest radiography, a lead-rubber Gonadal shield should be employed so to protect the abdomen below the chest (using vinyl-covered lead apron) around the waist for all patients of reproductive age, children, and pregnant women. Otherwise, an adjustable mobile lead shield screen must be used.

Low contrast (long-scale contrast) contrast must be adopted using ‘High kV Technique’ (100 - 130 kvp) with low mAs (3 mAs) at 72 inches (180 cm) FFD (SID) on full second inspiration, to produce more shades of gray that shows fine lung markings behind the heart and lung bases due to the higher penetration.

Higher mA and short exposure times (0.01 s) must be used to reduce movement blur (due to movement Unsharpness, (U_m)). Overall optimum density with sufficient mAs is necessary, which can be proved by seeing faint outlines of mid and upper vertebrae and posterior ribs.

Technical Aspects

A moving or high-lattice fine-line) focused grids must be used with the high kV technique. Grids should not be used with mobile and bed-side patients (mobile radiography).

For Paediatrics and newborns
- lower kV (60 – 70 KV) must be used with lower mAs
- Higher-speed films and screens are used to reduce motion and dose

For Geriatrics (old age) higher center point (CP) must be used because of less inhalation capability of old people that produces ‘shallow lung fields.

X-ray chest must be taken in full arrested second inspiration to show the lungs well expanded and full with ‘contrasting air’. In pneumothorax, another full exposure on expiration must be done (on the same film) for diagnostic comparison purposes, with an increase of (+5 kvp) and half the usual mAs.
Technical Aspects

- All chest radiographs must be taken in ‘standing’ erect to allow the diaphragm to move down to show greater areas of the lung fields and possible chest/subphrenic abscess or air-fluid levels.
- FFD for PA chest must be 72 inches (180 cm) to maintain the ‘natural’ size of the heart which is usually less in PA than in AP, and prevent geometrical unsharpness and magnification as a result of the increased OFD.

A left lateral chest film must be done routinely as the heart is located on the left side, unless certain pathology in the right lung necessitates the need for a right lateral.

Patient’s neck must be extended (chin up) to prevent superimposition of chin or neck on lung apices. Also, large female breasts must be displaced away from lung fields to avoid creating ‘breast shadows.

Basic (routine) views are: PA and lateral. Special views include: AP or PA apical, Lordotic, lateral Decubitus, AP supine (or semi-erect), LAO, and LPO.
**Patient Position**
- Patient erect with feet separated slightly
- Weight equally distributed on both feet

**Part Position**
- Align MSP to center and midline of IR.
- Hands on lower hips, palms out, elbows partially flexed
- Shoulders rotated forward against IR (to allow scapulae to move laterally clear of lung fields
- Shoulders depressed downward to move clavicles below the lungs apices.
- Exposure made at end of second full inspiration

**Central Ray (CR)**
- Horizontal and Perpendicular (90° to IR).

**Center Point (CP)**
- Level of T7 (Inferior angle of scapula)

**NB:** Top of IR 5 cm above the shoulders (to include the apices),

Reference: Text book of radiographic positioning and related anatomy; L. Bontrager. 6th editions Page (96)

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**PA Erect chest (Image Evaluation)**

- The lung apices, Costophrenic angles, and lateral margin of the ribs should be included in the film.
- The scapulae should be moved lateral to the lung fields
- The spine should be centered on the film
PA Erect chest **(Image Evaluation)**

- The heart should be adequately penetrated showing sharp outlines, with vascular markings near lateral lung margins.

- The distance between the medial end of the clavicle and sternum (sterno-clavicular joints) should be equal in both sides.
PA Erect chest (Image Evaluation)

- 10 posterior ribs should be demonstrated above the diaphragm.
**PA Erect chest (Radiographic Anatomy)**

- **Patient Position**
  - Patient supine on cart or bed, if possible
  - Raise the head end of the cart into semi erect position
  - Roll patient’s shoulders forward by rotating arms medially

- **Part Position**
  - Place IR Behind patient
  - Align center of IR to CR.
  - Top of IR about 4-5 cm above shoulders
  - Exposure made at end of second full inspiration

- **Central Ray (CR)**
  - CR angled caudad to be Perpendicular to long axis of sternum (to prevent clavicles from obscuring the apices)

- **Center Point (CP)**
  - Level of T7 (3-4 inches below jugular notch)

**NB:** Minimum SID 40 inches (100 cm) for supine position

**AP chest (Supine or Semi erect)**

**PA chest VS AP chest**

<table>
<thead>
<tr>
<th>Features</th>
<th>PA view</th>
<th>AP view</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position of clavicle</td>
<td>Oblique</td>
<td>Horizontal</td>
</tr>
<tr>
<td>Scapula</td>
<td>Away from lung field</td>
<td>Over the lung field</td>
</tr>
<tr>
<td>Breathing (Position of diaphragm)</td>
<td>Down</td>
<td>Up</td>
</tr>
</tbody>
</table>

**What is else??** Heart
Chest x-ray (Cardio-Thoracic Ratio)

A/B x 100 = Ratio

In PA view
Cardiomegaly when ratio is more than 50%.

In AP view
Cardiomegaly when ratio is more than 60%

Patient Position
- Patient erect, left side against Bucky (unless patient complaint is on right side).
- Weight equally distributed on both feet
- Hands raised above head with chin up

Part Position
- Center PT to CR and to IR anteriorly and posteriorly.
- Coronal pane is perpendicular and sagittal plane is parallel to IR
- Make Exposure at end of second full inspiration

Central Ray(CR)
- Horizontal and Perpendicular (90° to IR).

Center Point(CP)
- Level of T 7 (Inferior angle of scapula/3-4 inches below level of jugular notch)

NB: Lower CR and IR slightly to include Costophrenic angles.

Reference: Text book of radiographic positioning and related anatomy; L.Bontrager, 6th editions Page (98)
Lateral Erect chest (Radiographic Anatomy)

(A) Esophagus
(B) Trachea
(C) Lung hili
(D) Heart
(E) Lung apices
(F) Scapulae
(G) Thoracic vertebra
(H) Thoracic intervertebral foramen
(I) Superimposed posterior ribs
(J) Costophrenic angles

Yellow Arrows

Diaphragm

The lung apices, Costophrenic angles, spine and sternum should be included in the film.

The thorax should be in the center of the collimated area.

The heart should adequately penetrated showing sharp outlines, with vascular markings behind the sternum and heart.

Patient arms and chin should not superimposed over the upper lung fields.

Reference: Text book of radiographic positioning and related anatomy; L.Bontrager, 6th editions Page (98)
Lateral Erect chest (Image Evaluation)

Patient Position
- Patient seated on cart with ensuring that cart does not move
- For wheel chair remove armrests or place pillow under patient
- Have patient lean forward and place support behind back
- Arms crossed above head or hold on to arm support
- Chin kept up

Part Position
- Center PT to CR and to IR anteriorly and posteriorly.
- Ensure no rotation
- Make Exposure at end of second full inspiration

Central Ray (CR)
- Perpendicular (90° to IR).

Center Point (CP)
- Level of T7 (Inferior angle of scapula/3-4 inches below level of jugular notch)

Reference: Text book of radiographic positioning and related anatomy; L.Bontrager, 6th editions Page (98)
**Lateral Decubitus (AP Horizontal beam)**

**Patient Position**
- Patient lying on RT or LT side complaint is on right side.
- Raise chin, hands above head to clear lung field
- Hands raised above head with chin up

**Part Position**
- Knees flexed slightly and coronal plane parallel to IR
- Back of patient firmly against the vertical IR
- Center PT to CR and to IR.
- Make Exposure at end of second full inspiration

**Central Ray (CR)**
- Horizontal and Perpendicular (90° to IR).

**Central Point (CP)**
- Level of T7 (inferior angle of scapula/3-4 inches below level of jugular notch)

Reference: Text book of radiographic positioning and related anatomy; L. Bontrager, 6th editions Page (101)

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**PA Erect VS Lateral Decubitus**

**Fluid Level**

**PA Erect**
PA Erect VS Lateral Decubitus

For patients who unable to stand to demonstrate small pleural effusions (air-fluid levels) or pneumothorax. A (DECUBITUS) marker should be used.

Oblique Chest (RAO/LAO)

**Patient Position**
- Patient erect, rotated 45° (left anterior shoulder against film for LAO, and right anterior shoulder against film for RAO). Hands raised above head with chin up

**Part Position**
- Center PT to CR and to IR.
- Patient arm flexed nearest IR and hand placed on hip.
- Opposite arm raised to clear lung fields and hand rested on head or on chest unit support.

**Central Ray (CR)**
- Horizontal and Perpendicular (90° to IR).

**Center Point (CP)**
- Level of T 7 (Inferior angle of scapula/3-4 inches below level of jugular notch).
- 72 inches SID

**NB:** For heart patient should be rotated 55 to 60° in the LAO

Reference: Text book of radiographic positioning and related anatomy, L. Bechtager, 6th editions Page (103)
Oblique chest (Image Evaluation)

- The lung apices, costophrenic angles, lateral margins of the ribs should be included without cut.
- The heart should adequately penetrated with showing sharp outlines and without over exposure of the lungs.
- The width from the spine to the lateral margin of the thoracic cage of the side away from the film should be twice the width of the side contact with the film.
  (This indicate true or correct oblique)

AP Lordotic chest

**Patient Position**
- Patient seated or standing in erect AP with feet slightly separated and about 1 ft from the stand Bucky.
- The patient bends backward until the shoulders are supported by the stand Bucky.
- The patient hand on the hip with moving shoulder and elbow forward to scapulae from the lung fields.

**Part Position**
- Center PT to CR and to IR.
- IR should be about 3 inches above shoulder.
- Exposure at end of second full inspiration.

**Central Ray (CR)**
- Perpendicular (90° to IR).

**Center Point (CP)**
- Level of mid sternum (3-4 inches below level of jugular notch).
- 72 inches SID.

**NB:** To show calcifications and masses beneath the clavicles.
**AP Lordotic chest**

NB: To show calcifications and masses beneath the clavicles.

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**Lordotic chest**

If the patient unable to perform the Lordatic position angle the CR 15° to 20° cephalic for AP Lordatic or 15° to 20° caudad for PA Lordatic.
AP Upper Airway

For pathology (e.g., soft-tissue swellings) involving air-filled larynx and the trachea and their relation to thyroid, and the upper esophagus.

**Patient Position**
- Patient seated or standing in erect AP

**Part Position**
- Align midsagittal plane to CR and midline of Bucky
- Center Upper airway to CR and to IR.
- Adjust IR height 3-4 cm below EAM

**Central Ray (CR)**
- Perpendicular (90° to center of IR).

**Center Point (CP)**
- Level of T1-2 (1 inch above jugular notch)
- Exposure during slow inhalation to fill the trachea with air.
- 40 inches SID

Reference: Text book of radiographic positioning and related anatomy; L. Bontrager, 6th editions Page (106)

Tracheobronchial anatomy

Images downloaded from www.vh.org

Tracheal Displacement Due to Goiter
Lateral Upper Airway

**Patient Position**
- Patient seated or standing in lateral position

**Part Position**
- Center Upper airway to CR and to IR.
- Rotate shoulders posteriorly with arms hanging down
- Clasp hands behind back

**Central Ray (CR)**
- Perpendicular (90° to center of IR).

**Center Point (CP)**
- Level of C6 or C7 (Midway between laryngeal prominence of the thyroid cartilage and the jugular notch)
- Exposure during slow inhalation to fill the trachea with air.
- 65-75 KV to visualize soft tissue with 72 in. SID

Reference: Textbook of radiographic positioning and related anatomy; L. Bontrager, 6th editions Page (105)
Lateral Upper Airway

Lateral neck for soft tissue

Enlarged Adenoid