Part 1
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Disclaimer

- Farfalla Education, LLC
  - Owner and Primary Lecturer
- ALL patient information and confidentiality has been protected to the best of my ability.

Historical Perspectives
Wilhelm Conrad Roentgen
Dutch Physicist
- Discovered form of radiation – roentgen ray
- Unknown radiation – invisible, could penetrate objects and caused fluorescence known as X-strahlung (x-ray)
- Won Nobel Prize for Physics 1901

Birth of Radiology
- First recorded diagnostic use in 1896
- Physical effects of x-rays were observed
- Originally 2 types of radiology
  - Diagnostic
  - Therapeutic
- Currently
  - Diagnostic Radiology
  - Radiation Oncology
- Developing
  - Interventional Radiology

Radiographs
- Used for over a century for diagnostic purposes
- Increased use has improved lives
  - Early detection of illness, tumors, cancer
- Revolutionized medicine
- Led to the development of more precise testing modalities
  - CT Scan
  - Nuclear Medicine

Radiology Defined
Roentgen rays or X-rays
- Form of electromagnetic radiation or energy of extremely short wavelength
- Diagnostic range of x-rays on spectrum in Angstrom units
7 Radiographs
- Used for well over a century for diagnostic purposes
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  – Early detection of illness, tumors, cancer
- Revolutionized medicine
- Led to the development of more precise testing modalities (i.e. CT, nuclear medicine, etc)

8 Image Production
Physical Density
- Results from attenuation of x-rays by the material through which they pass
- Attenuation – process where x-rays are removed from a beam through absorption and scatter
- The greater the density the great amount of absorption
- The less dense the less amount of absorption
- Absorption can also be influenced by the atomic number of the structure

9 Image Production
Radiographic Density
- Degree of blackness of a film
- Radiographic contrast
- Difference in radiographic densities on a film
- Radiographic density related to the physical density on a film
- Effect on film occurs paradoxically
  – Structures with high physical density produce less radiodensity and vice versa

10 Radiolucent, Radiopaque, Radiodense
- Radiolucent
  – Blackening of the film
  – Permits passage of rays, low absorbency
- Radiopaque and Radiodense
  – Less blackening of the film
  – Doesn’t allow passage of rays, high absorbency

11 Radiographic Densities
Four Types
- Gas (air)
  – Black
- Fat
  – Gray-Black
- Soft tissue (water)
The greater the difference in either density or thickness of two adjacent structures the greater contrast between those structures within the image.

Image Quality
- Factors Affecting Image Quality
  - Motion – results in blurred image
  - Scatter – produced by deflection of some of the primary radiation beam producing “fog”
  - Magnification – two dimension representation of a three dimension object (magnification of objects distant to the cassette)

Thickness – the part imaged determines how much of the beam is removed or attenuated. Thicker the object more x-rays are needed - Obese patient VS Thin patient

Distortion – occurs if the object is too far from the cassette. Image will be bigger but with non-distinct margins

The Basics
- Anatomy and Physiology is key
  - Remember the body is 3-dimensional BUT...
  - Radiographs are 2-dimensional and shades of grey
- Depicting densities

In order to know that you are holding a pineapple and a banana, your friend would have to see your shadow in both positions and form a complete mental image

Plain Radiographs
- Evaluate air, fluid, and gas patterns in abdomen
- Visualize stones
- Identify gross abnormalities that may lead to further testing
- Foreign body identification

Difference Between Diagnosis and Reading
- Pneumonia = Diagnosis
- Right Middle Lobe Infiltrate = FINDING

THE RULES
- Treat the Patient not the radiograph
- History and physical examination before ordering
• Order radiographs only when necessary
• Look at the patient and the radiograph
• Look at the whole radiograph
• Re-examine the patient if incongruity exists
• Remember the rule of 2’s
  – Views, abnormalities, occasions, opinion, visits/procedures
• Failsafe measures in place

19 Ionizing Radiation
• Radiation exposure has been researched since the atomic bomb exposure
• Increased use of plain radiographs, nuclear medicine and CT scans has increased population exposure rates

20 The Basics
• X-rays are a type of high energy ionizing radiation
  – Upon contact with a material causes loss of electrons and become charged (ionized)
• Can cause damage to genetic material through diminished cell division
• Interrupt cell DNA causing mutations
• Organs and tissue have varying sensitivities
• Gender, pediatric and child bearing women
• Genetic components

21 Radiation Dose
• Three measures to describe radiation dose
  • Absorbed
    – Amount of energy absorbed/unit mass
  • Effective
    – All irradiated tissue and organ risk of exposure
  • Organ
    – Organ risk of exposure

22 X-Ray Equivalent
• Chest X-ray = 3 days of background radiation
• C-spine = 1.5 days of background radiation
• Pelvis = 14 days of background radiation
• Abdomen = 16 days of background radiation
• Thoracic spine = 24 days of background radiation
• Lumbar spine = 60 days of background radiation

23 Effective Radiation Dose (millisievert - mSv)
• Plain Radiographs
  – 0.02 – 6.4 (Chest x-ray – Lower GI)
• CT scan
  – 2.0 – 20–40 (Head – Pulmonary A-gram)
24 **Radiation Dose**

- Radiographs have recently been classified as carcinogenic
- Patients get multiple tests
- Statistically significant increases in cancer with doses over 50mSv
  - 10 – 25 mSv for single CT or nuclear medicine study

25 **Radiation induced Cancer**

- Studies suggest approximately 1% of cancer in the United States is from radiation exposure
  - Expanded evidence not available
    - Can take 1 – 2 decades for radiation induced cancer to develop after exposure

26 **Chest Anatomy**

27

28

29 **Lobes of the lung**

30 **Anatomy**

31 **Anatomy**

32 **Positioning**

- Posterior Anterior (PA)
  - Facing the cartridge
- Supine Anterior Posterior (AP)
  - Only in the critical patient
- Lateral Position
- Lateral Decubitus

33 **Normal PA and Lateral**

34 **PA vs AP**

35 **Lateral Decubitus Position**

- Assess volume, mobility or loculation of pleural effusion
- Dependent lung should have increased density d/t atelectasis from mediastinal pressure
  - Airtrapping if not present

36 **ABC’s of Interpretation**

- Adequacy, Airway
- Breathing

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• Circulation
• Diaphragm
• Edges
• Skeleton, Soft Tissue

37 Interpreation
• Trachea
  – midline or deviated, caliber, mass
• Lungs
  – abnormal shadowing or lucency
• Pulmonary vessels
  – artery or vein enlargement
• Hila
  – masses, lymphadenopathy
• Heart
  – thorax: heart width > 2:1? Cardiac configuration?
• Mediastinal contour
  – width? mass?
• Pleura
  – effusion, thickening, calcification
• Bones
  – lesions or fractures
• Soft tissues
  – don’t miss a mastectomy
• ICU Films
  – identify tubes first and look for pneumothorax

38 Adequacy and Airway
•
  • Normal Inspiration
  •
  • Penetration
  •
  • Rotation
  •

39 Normal Inspiration

40 Poor Inspiration

41 Expiration
• Desirable to evaluate a patient with:
  – Suspected pneumothorax
  – Suspected foreign body in bronchus

42 Foreign Body

43 Pneumothorax
Penetration

PA
- Thoracic disc spaces should be barely visible through the heart with vertebral bodies not visible
- Over-penetration = Dark
- Under-penetration = Light/White

Lateral
- Should see 2 sets of ribs
- Sternal edge may be visible
- Vertebrae appear darker as you move caudally

Under and Over Penetration

Rotation

The Rest of the A, B, Cs
- Breathing (Bird cages)
- Cardiac/circulation
- Diaphragm
- Edges
- Skeleton and Soft Tissue

What do you see????

Okay now for the Lateral

Pediatric Considerations
- Can be challenging
- Look different in children
- Different diseases
- Change with age
- Limited patient cooperation
- Thymus can cause confusion

Adult vs Child

Differences
Heart
- Newborn hearts can be more than ½ the width of the chest
- Good inspiration needed to judge heart size
- Poor inspiration can significantly change the look and position of the heart
Thymus
- Increases in size from birth through puberty BUT child grows so it appears smaller with age
• Can be variable in size and appearance (i.e. shrink rapidly due to illness or grow due to chemotherapy)

55 Look for a Bronchogram
• Outline of airway that is made visible by surrounding alveoli with fluid or exudate
• When visualized diagnostic for air space disease
• 6 causes
  – normal expiration
  – lung consolidation
  – pulmonary edema
  – nonobstructive pulmonary atelectasis
  – severe interstitial disease
  – Neoplasm

56 Bronchogram

57 88 year old Female
• Presents with complaints of shortness of breath
• PMH – arthritis, hypercholesterolemia, HTN, CAD, pulmonary HTN,
• PSH – CABG, Cataracts, Aortic Valve Repair
• Allergy – codeine, PCN
• PE – lungs decreased with bibasilar crackles
• Vital signs – BP 146/85, HR 85, RR 16, T 97.9F, pulse Ox 95% RA

58

59

What’s wrong with this picture????

60 Atelectasis
• Condition of volume loss in some portion of lung
• May involve subsegment, segment, lobe or entire lung
• Increased density usually linear
• Collapse or incomplete expansion of the lung or part of the lung
• Segmental and subsegmental collapse may show linear, curvilinear, wedge shaped opacities

61 Atelectasis
  Causes
  • Obstructive
    – Most common
    – Bronchus obstructed by mucous plug, neoplasm, or foreign body
  • Compressive
    – Normal lung compressed by tumor, emphysematous bulla or heart enlargement
  • Cicatization
    – Organizing scar tissue
    – Most often after healing granulomatous disease (i.e. TB), pulmonary infarct or
trauma
- **Adhesive**
  - Inactivation of surfactant (example: hyaline membrane disease)
- **Passive**
  - Normal compliance of the lung with pneumothorax or pleural effusion
  - Airway remains patent

**Linear Atelectasis**

**78 year old Male**

- Presents with shortness of breath for 1 day progressively getting worse.
- PMH – CAD, HTN, Hypercholesterolemia
- PSH – CABG, pacemaker or AICD pt and family not sure
- Allergies – none
- PE – pale, diaphoretic, in mild respiratory distress. Mild JVD. Lungs with course diffuse rhonchi. S1 S2 no M/G/C
- Vital signs – BP148/90, HR 102, RR 28, T 97.9F pulse Ox 94% RA

**Pulmonary Edema**

- Two basic types
  - Cardiogenic
    - increased hydrostatic pulmonary capillary pressure
  - Non-cardiogenic
    - altered capillary membrane permeability or decreased plasma oncotic pressure
    - NOT CARDIAC (Pneumonic)
      - 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

**Cardiogenic**

- Cephalization of the pulmonary vessels
- Kerley A lines
  - thin linear opacities in mid and upper zones radiating to hila
- Kerley B lines
  - linear opacities 1-2cm long and 1-2mm thick perpendicular to pleural surface caused by interstitial fluid (septal lines)
- Peribronchial cuffing
- "bat wing" pattern
  - perihilar and medullary consolidation of both lungs
- Patchy shadowing with air bronchograms
- Heart enlargement
- Pleural effusions

**Pulmonary Edema Cephalization of Vessels**

**Bat Wing Pattern**
Pulmonary Edema

Diffuse Pulmonary Edema

Congestive Heart Failure

3 year old female

- 1-day onset fever 102F, sinus congestion and drainage, cough
- PMH/PSH negative
- Medications – None
- Allergy – whole milk
- PE – only abnormal finding erythema
- Vital signs – HR 99; RR 24; T 102.8F, pulse Ox 98% RA

Pneumonia

- Airspace disease and consolidation
  - Air spaces are filled with bacteria or other microorganisms and pus

Types of Pneumonia

1. Lobar
   - classically Pneumococcal pneumonia
   - entire lobe consolidated and air bronchograms
2. Lobular
   - often Staphlococcus
   - multifocal, patchy, sometimes without air bronchograms

- Interstitial
  - Viral or Mycoplasma
  - latter starts perihilar and can become confluent and/or patchy as disease progresses, no air bronchograms

- Aspiration pneumonia
  - follows gravitational flow of aspirated contents
  - anaerobic
    - Bacteroides
    - Fusobacterium
• Diffuse pulmonary infections
  – community acquired
  – Mycoplasma
    • resolves spontaneously nosocomial
  – Pseudomonas
    • high mortality rate
    • patchy opacities, cavitation, ill-defined nodular
    • immunocompromised host
  – bacterial, fungal, PCP

Where is the Consolidation?
• Are both the heart borders and domes of the diaphragm easily visible?

  Right Heart Border = Middle Lobe
  Left Heart Border = Upper Lobe
  Right Diaphragm = Right Lower Lobe
  Left Diaphragm = Left Lower Lobe

Right Upper Lobe
Right Middle Lobe
Right Lower Lobe and Middle lobe

Left Upper Lobe
Left Lower Lobe

52 Year Old Male
• Complaints of not feeling well, chest tightness, and racing heart. Denied SOB or fever
• PMH – alcohol abuse, depression
• PSH – none
• Allergies – none
• Social – alcohol use daily 1 bottle of scotch; tobacco 1-2 PPD
• PE – unremarkable
• Vital signs – BP 154/103, HR 138, RR 27, T 100.8, pulse Ox 97% RA

Pleural Effusion
• Causes
  – CHF
  – Infection (parapneumonic)
  – Trauma
– PE
– Tumor
– Autoimmune disease
– Renal failure

89 Pleural Effusion

90 References


91 Thank you!!

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