Skeletal Anatomy and Radiographic Techniques

Components of an X-ray Tube

- There are 3 main components:
  1. Cathode
  2. Anode
  3. Glass Housing

Cathode

- The cathode is the source of the electrons for x-ray production.
- Because electrons have a negative charge, the cathode is the negative terminal of the x-ray tube.
- It consists of two wire (tungsten) filaments (one large and one small) embedded in a focusing cup.
- An electric current runs through the filament, heats it up, and causes it to “boil off” electrons.
CATHODE – THERMIONIC EMISSION

- When these electrons are released from the filament, it is called thermionic emission.

CATHODE

- The number of electrons that are “boiled off” is controlled by the mA (milliamperage) setting on the control panel of the x-ray machine.
  - THIS CONTROLS DENSITY / DARKNESS on a film.
- Usually, an mA of less than 200 will heat up the small filament, while a higher mA will heat up the larger filament.

ANODE

- The Anode is the positive terminal of the x-ray tube.
- The electrons that are produced within the cathode are attracted to the positive anode.

BREMSSTRAHLUNG

- "Braking" radiation

https://www.youtube.com/watch?v=uPoD0jv93Ks
**ANODE**
- As the electrons strike the anode, they produce heat and x-rays.
- It is important to remember that too much heat can cause cracking or pitting of the anode.
- The anode can be damaged by a single exposure that produces enough heat to exceed the tube’s capacity, or by not allowing enough cooling time between multiple exposures.
- Two important charts provided by the manufacturers: **tube rating charts** and **anode cooling charts**.

**X-RAY GENERATION**
- The number of electrons that are boiled off the filament by thermionic emission is controlled by the **mAs**.
- This ultimately controls **QUANTITY** aka... **DENSITY** (darkness)

**X-RAY GENERATION**
- In order to propel the electrons from the cathode to the anode, a potential difference needs to be set up.
- The potential difference is controlled by the **kVp**.
- The greater the potential difference (or the higher the kVp), the faster the electrons will travel across the tube.
- This controls **QUALITY** – penetrating power!!

**X-RAY PRODUCTION**

**FOUR FACTORS THAT INFLUENCE EXPOSURE**
- 1. milliamperage (mA)
- 2. exposure time (s)
- 3. kilovoltage (kVp)
- 4. source-image distance (SID)
**Milliamperage (mA)**

- mA controls the amount of x-rays that will be produced.
- The mA control on the x-ray panel adjusts the current flowing through the filament in the cathode.
- The higher the mA, the higher the current in the filament, and the higher the number of x-rays in the anode.

- mA directly controls the density, or the degree of blackness, on the x-ray film.

**Exposure Time**

- Exposure time controls the length of the x-ray exposure.
- This works in conjunction with mA to control the density of the x-ray image.
- Usually, time and mA will be noted as a single unit: mAs
- This is just mA multiplied by time
  - (mA x seconds)

- Exposure time is also used to control patient motion.
- The longer the exposure time, the more likely a patient is to move – even slightly!
- This will reduce the sharpness of the image.

- In general, especially with upright films, choose the shortest exposure time possible!

**Mas Controller of Radiographic Density**

- A film that is **too dark**, or has too much density, is said to be **overexposed**.
- A film that is **too light**, or is lacking density, is said to be **underexposed**.
In order to LIGHTEN a film – cut mAs in half

In order to DARKEN a film – double the mAs

Kilovoltage (kVp)

- kVp is the force that drives the electrons across the tube from the cathode to the anode.
- kVp controls the penetrating power of the beam.
- kVp controls the contrast, or gray tones, on the x-ray film

In general, low kVp gives high subject contrast (short scale contrast)
High kVp gives low subject contrast (long scale contrast)

Penetrating Power

- kVp and Tissue Density
  - The tissue types will determine how much kVp is needed. There are four basic tissue types:
    
    Air filled
    Fat
    Muscle
    Bone
    least dense
    more dense
    more dense
    most dense

kVp --- Penetrating Power

- Relates to Subject Contrast
- Gas
- Fat
- Cartilage
- Empty Hollow Organ
- Muscle
- Solid Organ
- Full Hollow Organ
- Bone
Kilovoltage (kVp)
- kVp directly affects CONTRAST on a film
- kVp indirectly affects the density of the film.
- kVp should not be increased to correct a film that is too light. Instead, mAs should be increased.

Kilovolt Peak (kVp)
- kVp and the density of the body part impacts the amount of scatter radiation.
  - High kVp = more scatter = low contrast = more penetration = more shades of grey
  - Low kVp = less scatter = high contrast = less penetration = less shades of grey

What Needs to be Changed? mAs or kVp?
Adjusting kVp and mAs is a balancing act.

When kVp is increased, mAs must be decreased.

We are balancing both density and contrast of the image.

If kVp is increased without reducing the mAs, penetration increases and contrast is reduced.

Over penetrated images lack contrast and have high density (darker). (because of too much scatter/too many shades of gray-causing fogging!)

Under penetrated images have very high contrast with dense structures being poorly penetrated (lighter).
As we age, we lose bone and muscle mass. The kVp must be reduced to compensate for this.

- Very muscular patients require more kVp to assure proper penetration.
- Disease processes that impact bone and tissue density will require adjustment of the kVp.

The higher the kVp used, the less interaction the photons will have with the tissue being exposed.

- When we increase kVp by 10, we reduce the exposure by about 25%.
- Trade off: Use as high as possible kVp that will provide adequate contrast (for patient protection).

What's Wrong with This Film?
- Over Penetrated -- Too High kVp
- Appears gray and lacks contrast.
- The upper lumbar spine is hard to visualize

**The 15% Rule or the Rule of 10**
- Increase kVp 8% = reducing mAs 25%
- Decrease kVp 8% = increasing mAs 25%

BUT….Remember that it takes an approximate 30% change in mAs to see a visible difference in the density of the image.

- An 8% or more change in kVp will make a visible change on the film for density.

**Source Image Distance (SID)**
- SID is the distance from the source of the x-rays on the anode focal spot to the film.
- Standard is 40 inches or 72 inches

SID is not variable, because changes in distance alter magnification and sharpness on an x-ray image.

**Source Image Distance (SID)**
- If kVp is increased by 15%, then reduce mAs by 50%.
- If kVp is reduced by 15%, then double mAs.
- If you have between 60 and 90 kVp, an adjustment of 10 kVp equals ~ 15%.

- A change of the SID also results in a change in the density.
- This is explained by the inverse square law:

  The intensity of the x-ray beam is inversely proportional to the square of the distance.
  - For example: if you decrease the SID by ½, the film density will increase by 4
SID – SOURCE IMAGE DISTANCE
- OR...In other words...

When you increase SID, you will LIGHTEN the film (due to decreased density from decreased x-ray photon intensity.)

SCATTER RADIATION - FOG
- When the x-ray beam interacts with the patient, secondary and scatter radiation are produced.
- Scatter radiation leaves the patient in all directions. When it strikes the film, it increases the density, but reduces the contrast.
- Scatter radiation also decreases radiographic detail.

FOG

SCATTER RADIATION
- Scatter radiation is increased with:
  - high kVp / low mAs techniques
  - thicker body parts (and larger patients in general)
  - larger field sizes

- High contrast images are produced with low kVp/ high mAs techniques

SCATTER RADIATION
- However, the advantages of high kVp techniques include:
  - Decreased motion
  - Decreased patient dose
  - A broader exposure latitude

- The trade off with a high kVp technique is decreased contrast. (more shades of grey)

SCATTER RADIATION
- As the size of the patient, and often the field size, cannot be controlled, scatter radiation can be reduced by:
  1. Collimation – restricting the x-ray beam
  2. The use of grids
  3. The air-gap technique
**Grids to Absorb Scatter Radiation**
- A Grid is a special, selective lead filter that is placed between the patient and the film.
- It is automatically installed inside the front of your bucky.
- A grid is needed when the patient body part measures >10 cm OR when using > 70 kVp

**Factors Affecting Scatter Radiation**

**TROUBLESHOOTING GUIDE**
- Refer to manufacturer’s manual and other guides for troubleshooting problems with
  - Low or High Density
  - Low or High Contrast
  - Fog
  - Marks on emulsion surfaces
  - Slow Drying
  - Streaks on Radiographs
  - Lack of Detail or Fuzziness
  - Static

**LOW DENSITY**
- Underdevelopment
  1. Improper development (time too short, temp too low)
  2. Exhausted developer (age or contamination)
  3. Diluted developer
  4. Incorrectly mixed developer

**HIGH DENSITY**
- Overexposure
  1. Wrong factors (kVp or mA too high or time too long)
  2. Meter out of calibration
  3. Timer out of calibration
  4. Inaccurate setting of meters or timer
  5. Surge in incoming line voltage
  6. Photocell timer out of adjustment
  7. Incorrect centering of patient to photocell

**LOW DENSITY**
- Underexposure
  1. Wrong factors (kVp or mA too low, time too short)
  2. Meter out of calibration
  3. Timer out of calibration
  4. Inaccurate setting of meters or timer
  5. Drop in line voltage
  6. Photocell timer out of adjustment
  7. Incorrect centering of patient to photocell
  8. Central ray not on film
  9. SID out of grid radius
  10. Bucky Timer inaccurate
**High Density**
- Improper Development
  1. Time too long
  2. Temperature too high
  3. Combination of both
  4. Inaccurate thermometer
  5. Insufficient dilution of concentrated developer
- Fog
  1. Light struck
  2. Radiation
  3. Chemical
  4. Film deterioration

**Low Contrast**
- Over-penetration from too high kVp
  1. Over-measurement of part
  2. Incorrect estimate of tissue density
  3. Meters out of calibration
  4. Meters inaccurately set
  5. Surge in incoming line voltage
  6. Under-measurement of focal-film distance
- Scatter radiation
  1. Failure to use bucky
  2. Failure to use grid
  3. Failure to use collimation
  4. Failure to use lead backed cassette
- Exposure too short
- Improper development

**High Contrast**
- Under-penetration from too low kVp
  1. Under-measurement of part
  2. Incorrect estimation of tissue density
  3. Meter out of calibration
  4. Meter inaccurately set
  5. Drop in incoming line voltage
  6. Over-measurement of focal-film distance
- Exposure too long
- Improper development

**Fog**
- Unsafe light
  1. Light leaks
  2. Safelights
  3. Luminous clock and watch faces
- Radiation
- Chemical
  1. Prolonged development
  2. Developer or chemical contamination
- Deterioration of film
  1. Age
  2. Storage (too hot or too humid)
  3. Delivery conditions (moisture condensation when opening cold box in a warm room – store at room temperature overnight before opening)
- Excessive pressure on emulsions of unprocessed film
- Loaded cassettes stored near heat, sunlight, or radiation
MARKS ON EMULSION SURFACES
- Runs
  1. Insufficient fixing
  2. Drying temperature too high
  3. Contact with hot view box
- Blisters
  1. Developer reacting with fixer
  2. Unbalanced processing temperatures
- Reticulation
  1. Nonuniform processing temperature
  2. Weak fixer

MARKS ON EMULSION SURFACES
- Drying marks from uneven drying of gelatin
  1. Excessive drying temperatures
  2. Extremely low humidity
  3. Streaks (water splashes, air flow too rapid, uneven squeeze from last roller)
- White spots
  1. Screens pitted
  2. Grit or dust on film or screens
- Artifacts
  1. Crescents (rough handling)
  2. Smudge marks (fingerprints or finger abrasions)

LACK OF DETAIL OR FUZZINESS
- Motion (tube, film, patient)
- Poor contact of intensifying screens
- Improper distance
- Improper focal spot

STATIC
- Low Humidity
- Insulation
- Improper handling when removing from box

GRID LINES
GRID CUT-OFF & DIGITAL PROCESSING

- **Good** because the image doesn’t have annoying grid lines in it which could superimpose anatomy or pathology.
- **Bad** because the CT doesn’t know that there is cut-off occurring.

GRID CUT-OFF WITH DIGITAL PROCESSING CAUSES:

- Decreased contrast
- Increased brightness
- Increased Exposure Index (EI) number
- More (mAs) needed
- Possible decreased sharpness of detail.

DARK ROOM SUPPLIES

- Name (Identification)
- Patient Age
- Date
- Facility / Doctor Name and Address
- Markers

ID REQUIREMENTS
MARKERS
- Weight-bearing vs. Recumbent
- Right / Left
- RAO/LAO and RPO/LPO
- Flexion / Extension

MEASUREMENTS

MEASUREMENTS – SPECIAL CONSIDERATIONS
- Patient Density
- Positioning of Central Ray

PATIENT PROTECTION
- 10 Day Rule
- Perfect Procedure
- Shielding
**CONSIDERATIONS FOR PATIENT PROTECTION**

1. Good technique
   - Any re-take causes an increase of 100% in patient exposure for that procedure.

2. Collimation and Film Size
   - Limit the size of the field only to the area of interest
   - Should see a thin, unexposed margin on at least three sides of a film when using a rectangular, adjustable collimator

3. Beam Filtration
   - Important for film quality and for patient protection.
   - Patient exposure is lessened if most of the low-energy photons that cannot penetrate the body are removed from the x-ray beam before it reaches the patient.
   - State regulations require total filtration (inherent + added) be not less than 2.5mm aluminum for a tube operated above 70 kVp

4. High kVp Technique
   - Hard x-rays penetrate the body tissues more efficiently than soft x-rays.
   - In spite of the disadvantages of scatter radiation (fogging), higher kVp may be used when sensitive tissues and organs (gonads) must be in the x-ray beam.
   - This helps reduce the absorbed dose by the patient.

5. Avoiding Over or Underexposure
   - Underexposure will actually result in more re-takes, therefore increasing radiation to the patient.

6. Screens and High Speed Film
   - In chiropractic offices, generally rare earth screens and high speed films are used.
   - The faster the film speed, the lower the exposure factors can be.
   - Caution... the faster the film speed, the corresponding decrease in definition occurs... need to balance these two factors!

7. Gonad Shielding
   - Lead shielding should be used over the gonads when the reproductive organs lie within the area of clinical interest, but are not themselves the objects of diagnostic interest.
   - Should be used on all patients who have reproductive potential as long as the shields do not obscure the anatomy that needs to be seen for diagnostic requirements.

**TECHNIQUES TO MINIMIZE PATIENT EXPOSURE**

1. Make sure the filter is in place in the primary beam.
2. Collimate the beam carefully to the minimal area required for a good radiograph.
3. If the gonads are in the exposed area, use gonad shielding unless ordered otherwise.
4. Select the highest tube voltage that will give adequate contrast.
TECHNIQUES TO MINIMIZE PATIENT EXPOSURE

- 5. If possible, select the highest speed film/screen type available unless there is a specific reason not to.
- 6. For optimal results – select proper exposure factors and develop film under proper conditions – solution strength, temperature, time.

MORE HINTS

- Develop a routine and stick to it.
- Take only the views/radiographs that were authorized.
- Do not take “practice” radiographs of anyone.
- Do not allow a non-essential person in the x-ray room during exposure.
- Consider the entire beam path. Will it pass through any additional body part, such as the gonads of a seated person during a wrist x-ray.

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REDUCTION OF RADIATION FOR TECHNICIANS

TIME

DISTANCE

SHIELDING

OCCUPATIONAL EXPOSURE

- Minimize by following safety rules of Time, Distance and Shielding
  - Time
    - Keep time (seconds) ALARA (as low as reasonably achievable)
  - Distance
    - Inverse Square Law – as the distance is doubled, the intensity of the x-ray beam is decreased by ¼
    - The radiation intensity is inversely proportional to the square of the distance.
  - Shielding
    - .5mm lead for aprons and .25mm lead for gloves

Safety Features:
- Control panel behind booth with lead shielding
- Lead window
- “Dead-Man” Control Switch
- Primary Beam directed away from operator
- Use of Lead shields or aprons

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SUMMARY OF RECOMMENDATIONS

OCCUPATIONAL EXPOSURE

Effective Dose Limits
- a) Annual  
- b) Cumulative  10 mSv x age

Equivalent Dose Annual Limits for Tissues & Organs
- a) Lens of Eye  150 mSv
- b) Skin, hands and feet  500 mSv

PERSONNEL DOSIMETRY
- Dosimeter – device used to detect and measure accumulated dosage of radiation.
- Should be worn at chest or waist level, or collar outside of lead apron
- Do not wear when receiving an x-ray
- Keep out of sunlight as gamma radiation is also measured
- Keep proper lifetime records

TYPES OF MONITORING DEVICES
- Film Monitor or Badge
- Pocket Dosimeter
  - Must be read daily
- TLD – thermoluminescent dosimeter

POINTS TO REMEMBER:
- If you increase kVp above optimal = decreased film quality
- If you set the factors properly for a bucky view but you do not set the control panel for the bucky, you will overexpose the film by 2-4x:
  - The film will not be diagnostic.
  - It will have poor density and contrast.
Radioographic Quality Overview

1. Density
   - Mostly controlled by mAs
   - mAs is the “amount” of radiation available
     - INCREASE mA and/or time for darker film
     - DECREASE mA and/or time for lighter film
   - For film that is too dark, decrease mAs by half. For film that is too light, increase mAs by 2.

2. Contrast
   - Controlled primarily by kVp
   - Low kVp/ high mAs = high contrast, black & white, short scale, narrow latitude
   - High kVp/ low mAs = low contrast, many shades of grey, long scale, wide scale, broad latitude
   - A change of 4-7% of kVp can be detected on films. kVp is the penetration-controlling factor

To change the density of the film, if you just change the kVp, then you will lose control of the scale of contrast.
This results in high contrast (black & white) films on thin people and low contrast (grey films) on large people.

To broaden the scale of contrast (to see more greys and less contrast), increase the kVp 16% and cut the mAs in half.
To narrow the scale of contrast (more black and white and more contrast) Decrease the kVp 16% and double the mAs.

Just increasing kVp will darken a film, but it is not the optimal way to control density because you lose control of the scale of contrast… therefore obtaining
   - Black and white films on thin people and
   - Grey films on big people

3. Definition
   - Affected by many factors:
     1. Motion (pt or equipment) – control by keeping time short
     2. Screen speed (faster = less definition)
     3. Film speed (faster = less definition)
     4. Film quality (some lesser known brands have insufficient silver)
     5. Film/screen contact (tight contact is necessary)
6. Grids (ration, lines-per-inch, focal range)
7. Collimation (tighter = better definition)
8. OFD/SID (if OFD is increased, SID must also be increased) e.g. lateral cervical taken at 72°
9. Focal spot (small = better definition) e.g. cervical, extremities
10. Light fog (light leaks in darkroom or safelight problems)
11. Chemical fog (chemicals not changed frequently enough and become oxidized)

4. Distortion
   • Central ray needs to be perpendicular to and at the level of the desired structure.

Digital Imaging Acquisition Systems

Digital Radiography

- Patient is still exposed to radiation
- Conventional film processing is not needed
- Image is produced when a digital detector acquires the image
In 1980, Computed Radiography (CR) was first used, and in 1994 Direct Digital Radiography (DR) was introduced. Both of these are considered to be digital radiography. Direct Digital Radiography (DR) and Computed Radiography (CR) can both acquire images in seconds and create a digital image that can be viewed on virtually any computer.

CR – Computed Radiography
- Less expensive
- PSP – phosphor storage plate
  - reusable film substitute
  - captures the “latent” image

ADVANTAGES OF CR
- A digital image is generated
- Ability to retrofit to existing radiography equipment
- Mobile or cross table radiography is easily accomplished
- Excellent image quality
- Initially less expensive than DR
**Disadvantages of CR**
- Still must process an imaging plate (cassette)
- Similar workflow to conventional film
- Time savings may be possible through decreased repeats but the workflow is essentially similar to film radiography

**DR - Direct Digital Radiography**
- More expensive
- Faster than CR
- CCD - charged coupled device
  - Converts analog light signals for processing directly to the computer
  - Does not need to be "read" or "erased"
  - Works like a digital camera

**Advantages of DR**
- No processing time
- Image is seen almost immediately on computer screen
- No imaging plates or cassettes to hassle with
- Excellent image quality

**Similarities between CR and Conventional X-Rays...**
- Both require a cassette and use the same radiographic equipment to take/make the x-ray
- Both also comparable because once the image is captured in the cassette further processing is required to view the images.
**CR**
- Workflow is similar to conventional films
- Latent image is obtained on a special cassette (PSP)
- Cassette is manually placed into a plate reader
- Latent image is downloaded & sent to computer
- Latent image on PSP cassette is read, erased, readied for next exposure

**DIFFERENCES BETWEEN CR AND CONVENTIONAL X-RAYS**
- CR uses a PSP - phosphor storage plate - within the cassette, versus the emulsion-gelatin film for conventional radiography.
- To process the image in conventional radiography the film has to be removed from the cassette in a darkroom so that no light can expose the film, and the film is then run through a processor to receive the hard-copy image.
- In CR, the cassette is placed in a "reader" that digitizes the image onto a computer screen. This is known as a soft-copy image.

**DR VS. CR AND CONVENTIONAL FILM X-RAYS**
- With DR, no cassette is needed
- The image is directly captured on a flat plate reader
- The image is seen within seconds on a computer monitor

**OVERALL ADVANTAGES OF DIGITAL X-RAY**
- Overall decrease of radiation dose to the patient in most cases d/t less re-takes
- Faster processing time
- Images are stored digitally
- Digital images can be manipulated on the computer to make the image diagnostically better and easier to interpret
- Darkroom is no longer necessary and the chemicals used in the processor are not needed

**OVERALL DISADVANTAGES OF DIGITAL X-RAY**
- Not many disadvantages of digital radiography besides cost
- Digital radiography systems cost more to set up and are more expensive to replace if parts go bad.
- Tendency for a technologist to routinely over-expose patients (drift), knowing the image will turn out good versus what the image would look like if it was under-exposed. (This disadvantage can be lessened by good quality assurance programs and following the manufacturer’s recommended exposure index or sensitivity number)

**6 STRANGE BUT TRUE X-RAYS**
- [https://www.youtube.com/watch?v=XaWsHzPGwqQ](https://www.youtube.com/watch?v=XaWsHzPGwqQ)
ANATOMICAL LANDMARKS & DEFINITIONS

PLANES OF THE BODY
- Sagittal
  - Mid-sagittal
  - Parasagittal
- Coronal
- Transverse
- Oblique

- Cephalad or Cephalic: towards the head
- Caudad or Caudal: towards the tail (feet)
- Superior: top
- Inferior: bottom
- Medial: inside
- Lateral: outside
- Dorsal: back
- Palmar: front
- Distal: away from the body (the trunk)
- Proximal: closer to the body (the trunk)

COMMON LANDMARKS IN RADIOLOGY
- Sternum
- T6 – midsternum
- C7 or VP (vertebral prominence)
- Iliac Crest – L4
- Umbilicus
- Pubic Symphysis
- ASIS
SPINAL ANATOMY
Cervical, Thoracic, Lumbar, Sacrum, Pelvis
**CERVICAL VIEWS**
- APLC
- APOM
- Lateral
- Flexion and Extension
- Obliques
- Davis Series: APLC, APOM, Lateral, Right and Left Obliques, Flexion, Extension

**TYPICAL VERTEBRAE:**
**CERVICAL, THORACIC, LUMBAR**
What radiographic view is necessary to see Cervical IVF’s (Intervertebral Foramina)?

CERVICAL OBLIQUE ANATOMY

MARKERS FOR OBLIQUE VIEWS
- Markers for oblique views (cervical, lumbar, ribs, etc.) are placed ON THE SIDE OF THE BODY CLOSEST TO THE FILM!!!!!!
  - Think of oblique views as an angled lateral view!!
- Anterior Cervical Obliques
  - See Ipsilateral (same side) IVF’s
- Posterior Cervical Obliques
  - See Contralateral (opposite side) IVF’s
Anterior Obliques
- Anterior side against the film
- See same side IVF's
- Marker appears at the "back" of the spine

Posterior oblique – posterior side against the film
- See opposite side IVF's
- Marker appears "in front of" the spine

How much do I angle the beam? 15 degrees caudal for PA technique (LAO/RAO) and 15 degrees cephalic for AP technique (LPO/RPO)

What Went Wrong?
- The patient is under-rotated (too PAish).
- The patient's head is not in the lateral position causing the mandible to be superimposed over C1/C2.
- The IVF's (intervertebral foramina) are partially "closed", especially at the lower cervical level.
- Poor beam collimation.
- This patient is severely over-rotated.
- Some of the IVF’s (intervertebral foramina) are visible but are obscured to varying degrees.
**Thoracic Views**

- **AP Thoracic**
- **Lateral Thoracic**
- **Swim Lateral**
- **Ribs**

**Breathing Techniques**

- Full inspiration / inhalation
  - Lowers the diaphragm
  - Used in thoracic views
- Expiration / exhalation
  - Raises the diaphragm
  - Helps to decompress the abdominal soft tissue—makes it easier to penetrate with x-ray
  - Used in lumbar views
- Make exposures on end respiration with pt holding breath in order to reduce motion

**Swimmer’s Lateral View**

- 8x10 film size or 10x12
- SID = 40” (39” = 40 – 1 to adjust for tube tilt)
- Grid
- Tube tilt: 5° cephalad
- Pt standing in lateral position w/shoulder against the grid. Place the arm against the grid over the head and rest hand on top of head. The hand of the arm away from the grid is placed on the hip. Keeping head and spine in lateral position, the shoulders are rotated ~5° with grid shoulder forward and away shoulder back. **Can also be performed opposite (far arm up on bucky & turned into grid).**
- CR = at C7
- Collimation: to film size
- Measure: through CR – from side of neck to lateral aspect of thorax
- Marker: Mark the side next to film – place in the upper anterior corner
- kVp: 80’s
- Breathing: suspended expiration

**Wedge Filter**

- 8x10 film size or 10x12
- SID = 40” (39” = 40 – 1 to adjust for tube tilt)
- Grid
- Tube tilt: 5° cephalad
- Pt standing in lateral position w/shoulder against the grid. Place the arm against the grid over the head and rest hand on top of head. The hand of the arm away from the grid is placed on the hip. Keeping head and spine in lateral position, the shoulders are rotated ~5° with grid shoulder forward and away shoulder back. **Can also be performed opposite (far arm up on bucky & turned into grid).**
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LUMBAR Vertebrae—
SUPERIOR VIEW

AP Lumbar or AP Lumbo-Pelvic
Lateral Lumbar
L5/S1 Spot
Oblique Lumbar

LUMBAR VIEWS

- AP Lumbar
  - 1” above iliac crest
- AP Lumbo-Pelvic
  - 1 1/2” below iliac crest or 1” below ischial tuberosity
- Lateral Lumbar
  - 1” above iliac crest
- Lateral L5/S1 Spot
  - 2” below iliac crest
- Obliques
  - 1” above iliac crest

QUIZ TIME!!!

What anatomy is seen on a lumbar oblique film?
Par Interarticularis

- Posterior Lumbar Oblique –
  - See same side (ipsilateral) pars

- Anterior Lumbar Oblique—
  - See opposite side (contralateral) pars

Lumbar Obliques

- 10x12 film size
- SID = 40"
- Grid
- Tube tilt: none
- Pt upright or recumbent at 45° angle to the grid. The film is named by the quadrant of the pt that is closest to the film.
- CR = at L3: Horizontal: 1" above the iliac crest
  - Vertical: for Anterior - halfway between the SP and the side of the pt farthest from the film
  - for Posterior – halfway between the umbilicus and the side of the pt that is farthest from the film
- Collimation: top to bottom to film, side to side 8"
- Measure: at central ray
- Marker: In front of spine for Posterior, behind spine for Anterior
- kVp: 80’s
- Breathing: suspended expiration
- RAO – see the left pars;  RPO – see the right pars
Grading of Spondylolisthesis

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Abdominal Aortic Aneurysm

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MISSING PEDICLE (METASTASIS)

SACRUM AND COCCYX

PELVIS – ANTERIOR VIEW
**Skeletal Anatomy & Radiographic Techniques**

**Spinal Curves**
- Lordosis
- Kyphosis

**Anatomy of the Appendicular Skeleton**
THE SKELETON DANCE

- Appendicular Skeleton: the skeleton of the pectoral and pelvic girdles and limbs
- Axial Skeleton: the skeleton of the head and trunk

https://www.youtube.com/watch?v=Jpvugj5nv6U

Appendicular Skeleton: the skeleton of the pectoral and pelvic girdles and limbs
Axial Skeleton: the skeleton of the head and trunk
**SHOULDER STUDY**

- AP Shoulder
  - Palm of hand flat against bucky
- Internal Rotation
  - Arm internally rotated and back of hand against patient’s side
- External Rotation
  - Arm externally rotated and back of hand against patient’s side
- “Baby Arm”

- AP Shoulder “Stress View”
  - 15 lbs for women, 25 lbs for men
**ELBOW SERIES**

- **AP Elbow**
  - Elbow extended & palm up
- **Medial Oblique**
  - Elbow extended & palm down
- **Lateral**
  - Elbow bent 90 degrees – thumb up
- **Olecranon (Jone’s View or Tangential View)**
  - Elbow bent with hand on pt's shoulder – CR – 2’ above tip of olecranon

- Study is performed non-bucky. Pt is seated low enough to permit the arm to be extended onto the cassette at about the same plane as the shoulder.
Lateral Elbow

Tangential Elbow

Lateral Condyle
Capitellum

Humerus
Radius
Ulna
Capitulum
Intertrochlear facet
Lateral epicondyle
Medial epicondyle
Trochlea
Coronoid process
Epicondylar region
Medial collateral ligament
Lateral collateral ligament
Motor branch of the ulnar nerve
Radial collateral ligament
Radial head
Triangular fibrocartilage complex
Ulna
**Wrist Series**

- **PA Wrist**
  - Palm faced down (pronated) and loose fist
- **Medial Oblique Wrist**
  - 45 degree angle rotated with thumb side high ("OK")
- **Lateral Wrist**
  - Elbow flexed 90 degrees & forearm in true lateral position. Wrist straight with thumb side up

- **Special Views:**
  - Ulnar Deviation (for scaphoid/navicular)
  - Carpal Tunnel
**Hand Series**

- PA Hand
- Oblique Hand
- Lateral Hand
LOWER EXTREMITY

AP PELVIS
- 14 x 17 film size - crosswise
- SID = 40"
- Grid
- Tube tilt: none
- Pt stands AP. Flare arms slightly. Rotate feet in ~ 15° to midline.
- CR = place cassette crosswise 1" above the iliac crests and align central ray to the cassette.
- Collimation: to film size
- Measure: at central ray
- Marker: Mark the appropriate side – upper corner of film.
- kVp: 80 (75-85)
- Breathing: suspended expiration

HIP SERIES
- AP Hip
  - Internally rotate leg 15 degrees. CR = 2" medial to ASIS and drop 1" below
- Lateral Hip – Frog Leg
  - Flex hip and knee and abduct as far as possible. CR = midway between ASIS and pubic symphysis, drop 1" inferior
INFANT – HIP DISLOCATION
-LIKELY CONGENITAL

CHILD – HIP DISLOCATION

LEGG CALVE PERTHES
SCFE – SLIPPED FEMORAL CAPITAL EPhipYSIS

KNEE SERIES
- AP Knee
  - Tube Tilt 5 degrees cephalad – enters 1/2” below inferior margin of patella
- Lateral Knee
  - Tube Tilt 5-10 degrees cephalad. Knee flexed 30 degrees. CR midpoint of knee

Special Views:
- PA - no tube tilt – CR directed to exit at center of patella
- Tunnel – Pt prone & knee flexed 45°. CR 45° caudally, enter through popliteal fossa and emerge through the bottom of patella
- Tangential or Sunrise – pt prone & knee fully flexed 60°. CR thru patello-femoral joint
**ANKLE SERIES**
- AP Ankle
- Medial Oblique (Mortise View)
- Lateral Ankle
FOOT SERIES

- AP Foot
- Lateral Foot
- Medial Oblique

Special Views:
- Calcaneus
- Lateral Calcaneus
PUTTING IT ALL TOGETHER!

PATIENT CONSIDERATIONS
- Children

- Adult
  - Male
  - Female
    - 10 Day Rule

- Elderly

THE THREE “O’s”
- Obesity
- Osteoporosis
- Obvious Instability, Imbalance, or Anxiety
KVP AND TISSUE DENSITY

- As we age, we lose bone and muscle mass. We must reduce kVp to compensate for this.
- Very muscular patients require more kVp to assure proper penetration.
- Disease processes that impact bone and tissue density will require adjustment of the kVp.

OTHER CONSIDERATIONS

25 STRANGEST THINGS FOUND IN AN X-RAY

http://youtu.be/sCXfG6xRHIIE

THE END...