Digital Radiography &
Fluoroscopic Radiation Safety
for the Certified Radiologic
Technologist

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Visual Physiology

Let's See What You Learned:

- The light receptor structures found on the retina are called:
  - –Rods & Cones
- The protective covering of the eye is called the:
  - –Cornea

Let's See What You Learned:

- The function of the lens of the eye is:
  - –To focus incoming light onto the retina.

Let's See What You Learned:

–What controls the amount of light admitted to the eye?
- The Iris

Let's See What You Learned:

- Where are the rods concentrated?
  - –On the periphery of the retina

Let's See What You Learned:

– What kind of vision do rods provide:
  - *Scotopic* or night vision
  - Perceive grays
  - Poor visual acuity

Let's See What You Learned:

- Where are the cones concentrated?
  – *The fovea centralis*

Let's See What You Learned:

- What kind of vision do the cones provide?
  – *Photopic* or daylight vision
  – Perceive color
  – Visual acuity

Let's See What You Learned:

- How much greater is the visual acuity of photopic (cone) visual acuity over scotopic (rod) visual acuity?
  – 10X greater

Summary

- Visual acuity is dramatically ↑ by obtaining high image brightness with the use of image intensifiers.
- Image intensifiers bring the illumination of the image into the cone vision region.

Summary

- Dim the room light
- Excessive light
  – ↓ the ability of the eye to resolve detail on the television screen
  – May indirectly cause the operator to ↑ technical factors to produce a brighter image.

Summary

- ↑ technical factors (mA, kVp) will directly affect patient's & operator's radiation dose.
- Provisions must be made to eliminate extraneous light.

Image Intensifiers - IIs

Things to Remember

- Operator dose
  - –Scatter from the patient
  - –Directly proportional to patient dose
- Image brightness
  - –Directly proportional to radiation dose rate at the input phosphor

Radiation Dose

- ↑ magnification, ↓ field size, markedly ↑ patient dose

Radiation Dose & Tube Angulation

- When rotating the mobile C-arm:
  - –↑ beam angle
  - –↑ tissue thickness
  - –↑ tube current
  - –↓ source to skin distance (SSD)
  - –↑ skin dose

Radiation Dose Reduction

- ↑ boost, ↑ dose
- Pulse mode ↓ dose (depending on pulse rate & fluoro time)

Radiation Dose Reduction

- Last image hold
  - Last fluoro image left on the screen after exposure
- Virtual collimation
  - Capacity to position the collimation blades using the last image hold

Operator Dose Reduction

- Whenever possible, the C-Arm should be positioned with the:
  - II/IR above the patient
  - X-ray tube below the patient
- Scatter radiation direction will be:
  - Towards the operator's feet
  - **Not** towards the operator's head

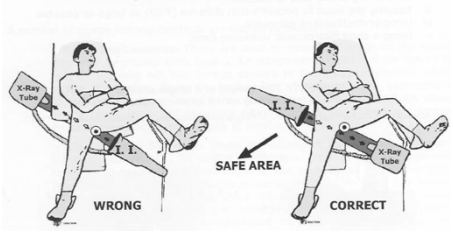
Operator Dose Reduction

- The highest scatter component is:
  - Scatter reflected from the primary beam
  - On initial impact with the patient
- Fluoroing across the patient:
  - Operator stands on the same side of the patient as the II/IR
  - **Not** on the x-ray tube side

Operator Dose Reduction

- II/IR & tube positioning
  - II Lowered to touch, or come as close as practical, to the patient's skin
  - Maximize the distance between the x-ray tube & the skin
  - Fixed fluoro unit - lowering II/IR will lower skin dose

Correct positioning in the lateral projection



- **Backscatter from thigh- high dose to operator**
- **Position prevents close positioning of II**
- **Forward scatter towards the operator is attenuated by mass of thigh**
- **Patient at edge, allows close positioning of II**

IAEA Training Course on Radiation Protection for Doctors (non-radiologists, non-cardiologists) using Fluoroscopy

L06A. Anatomy of Fluoroscopy & CT Fluoroscopy Equipment

Radiation Dose Reduction

- ↓collimated area, ↓tissue irradiated, ↓dose, ↓scatter, ↑contrast
- ↑kVp, ↑x-ray penetrability, markedly ↓patient dose at a slight ↓in contrast

California Code of Regulations, title 17, Section 30307 (a)(8)(A)

- Who?
  - Physicians and fluoroscopy personnel
- What?
  - Exemption to remove the spacer cones
  - Operate at source-skin distances of **not less than** 20cm (7.87402")
  - If the cone is contraindicated or compromises the procedure

Why?

- So that California's regulations avoid conflict with the requirements of Title 21 Code of Federal Regulations, Part 1020.32

What Else?

- The Registrant **shall**:
  - Establish a policy & procedure that describes the use of the equipment
  - Include a list of procedures for which a physician deems spacer cone removal necessary

Answer True or False

- The flat panel detectors (FPD) are coupled with a CCD camera to capture images
- False
  - The FPD does not require a camera since its principle of image acquisition is different from image intensifiers.

Answer True or False

- There is lag in FPD systems at low exposure levels
- True
  - At low levels of exposure, FPD systems suffer from lag similar to vidicon cameras.

Answer True or False

- Use of virtual collimation can reduce radiation dose to patients
- True
  - Virtual collimation is understood as the capacity to position the collimation blades in the desired position using the last image hold & without extra radiation for the patient

Pediatric Fluoroscopy

- Performed
  - –If radiography cannot provide the necessary information
  - –If benefits out weight the risk
  - –Motion kept to a minimum
    - Sedation
    - Anesthesia

Pediatric Fluoroscopy Distance

- Shortest patient-to-image intensifier distance
  - – ↓ radiation dose
  - – ↓ motion blur
- ↑ patient-to-image intensifier distance
  - – ↑ radiation dose
  - – ↑ motion blur

Pediatric Fluoroscopy ↓ Radiation Dose

- Smallest beam size possible
- Collimate to smallest area possible
- Do not use whole image receptor
- Minimum Cine frame rates to ↓ dose
- No grids – significantly ↓ dose
- Digital spot film cameras ↓ exposure times, ↓ motion blur

Pediatric Fluoroscopy Eliminating Motion

- Education
- Instruction
- Mechanical immobilization
- Sand bags
- Compression bands

Pediatric Fluoroscopy Eliminating Motion

- Parents & hospital personnel
  - –Physical restraint without immobilization devices may be necessary
  - –Must wear leaded aprons & gloves, etc.

Pediatric Fluoroscopy Eliminating Motion

- –Monitor devices must be worn by personnel who frequently hold patients

Pediatric Fluoroscopy Gonadal Shields

- ≥ 0.5mm lead equivalent
- Must be used for children
  - Whenever possible
  - If it does not interfere with the examination
- Use of gonadal shielding cannot be emphasized enough!

Pediatric Fluoroscopy Artifacts

- Remove
  - All clothing
  - Bandages
  - Diapers
  - Anything that might cause an artifact particularly at low exposure settings

What Else?

- All physicians & fluoroscopy personnel **shall** receive training regarding spacer cone use & restrictions.
- Documentation of training **shall** be maintained for inspection.

What Else?

- The spacer cone **shall** be reinstalled upon completion of the examination(s) for which removal is authorized.

Things to Remember

- Technical factors
  - Compromise between image quality & patient dose
  - No selected factor will be optimal for both image quality & patient dose

Things to Remember

- Technical Factors which **directly** influence radiation dose rate at the panel or tabletop
  - mA – milliamperage
  - kVp – kilovoltage
  - Collimation
  - Filtration
  - Exposure time
  - Target-panel distance

Things to Remember

- Technical Factors which indirectly influence radiation dose
  - Lighting in the fluoroscopy room
  - Poor image receptor quality
  - Low absorption tabletop

Pediatric Fluoroscopy Distance

- Shortest patient-to-image intensifier distance
  - ↓ radiation dose
  - ↓ motion blur
- ↑ patient-to-image intensifier distance
  - ↑ radiation dose
  - ↑ motion blur

Pediatric Fluoroscopy ↓ Radiation Dose

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