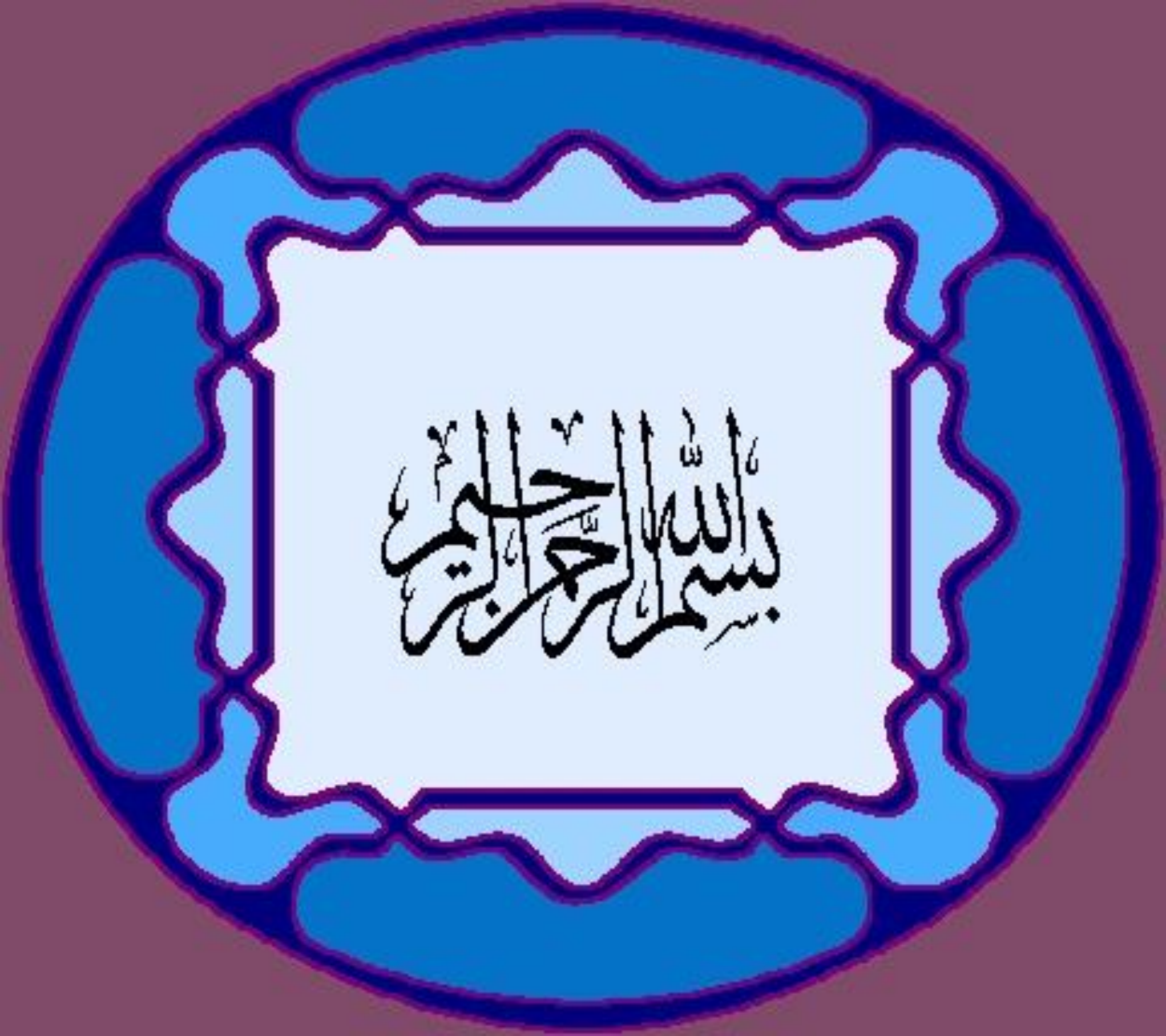

بسم الله الرحمن الرحيم

RAD 332

Image Quality

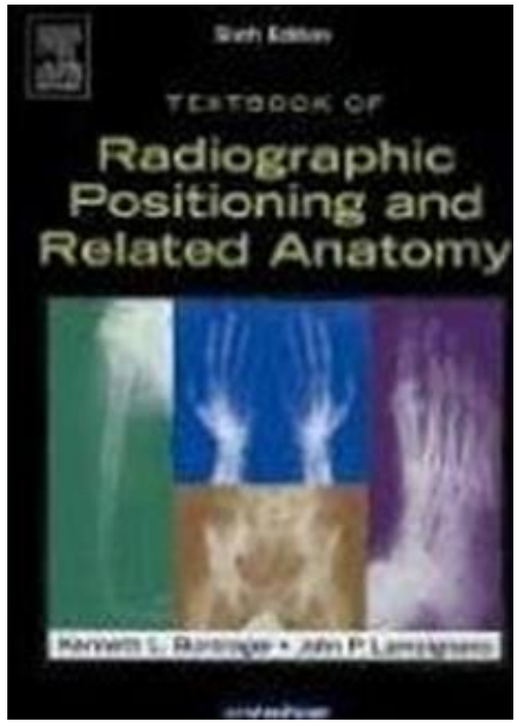
Nora Alohaly
Ashwaq alarfaj
Afaf madani

Switch mobile phone off or to silent

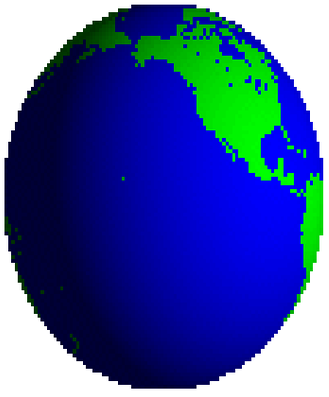
References and useful websites

References

- Text book of radiographic positioning and related anatomy; by Kenneth L.Bontrager, 6th ,7th editions



Websites



http://www.e-radiography.net/
http://www.theodora.com/anatomy/surface_anatomy_index.html
http://training.seer.cancer.gov/module_anatomy/unit1_3_terminology.html
http://pubs.rsna.org/doi/full/10.1148/radiographics.20.4.g00jl301115

Equipment and accessories

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

- X-ray properties.
- Describe the process of producing a radiograph
- Differentiate between transmit vs. absorb vs. scatter
- Definition of density, contrast and sharpness and explain the controlling factors of each .
- Definition of distortion and its controlling factors
- Distinguish Between size distortion and shape distortion

Properties of x-ray

1. Penetration

Able to pass through matter in varying degrees.
The amount absorption depend on x-ray energy , the atomic number and density of the object.

Low atomic no./density – more x-rays through –more black
High atomic no./density – less x-rays through – less black

- Metals = most difficult
- Bone = easier than metal
- Muscle= easier than bone
- Air = easiest

Properties of x-ray

2. Photographic Effect

- Exposes film/detector by darkening it & produce latent image (invisible to eye).
- This image is made visible by processing the film.
  - MANY X RAYS = BLACK
  - FEWER X RAYS = GRAY
  - NO X RAYS = WHITE (CLEAR)

Examples:

- AIR = BLACK
- MUSCLE = DARK GRAY
- BONE = LIGHT GRAY
- METALS = **WHITE**

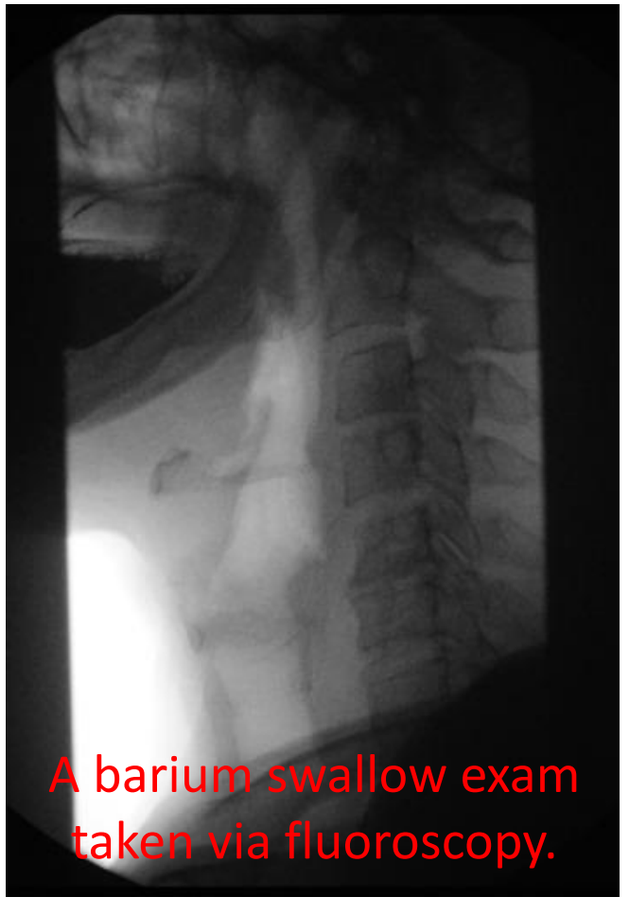
Properties of x-ray

3. Fluorescent Effect

- Causes certain materials to emit light (fluoresce) after absorbing x-ray.
- Fluoroscopy & Radiography.

- Fluorescent- screens
- Intensifying screens, film/cassette
- Flat-panel detectors-FPD

(The newest technology combined with digital radiography)

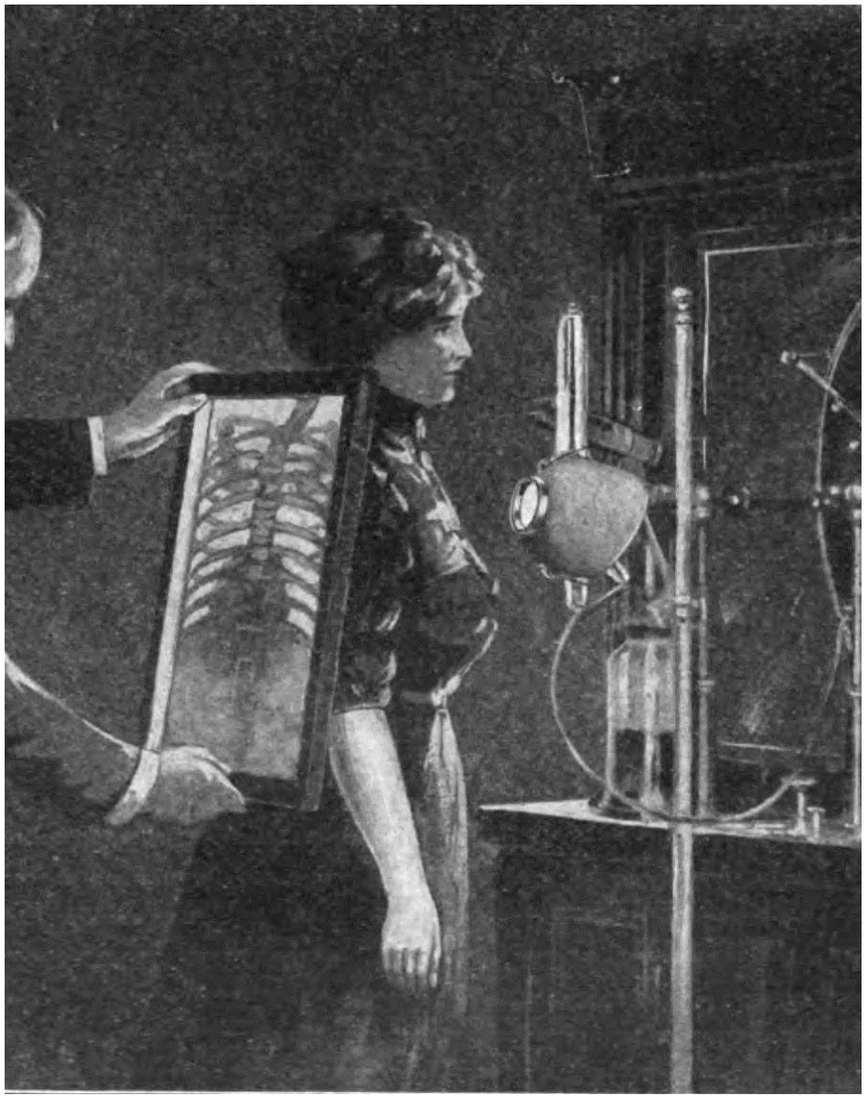


A barium swallow exam taken via fluoroscopy.

4. Ionization

- X-ray produce ionization of atoms through which they pass. (formation of ions).
  - Able to free electrons from orbiting around the nucleus of an atom.
  - Energy of x ray used to "free" the electron.(free radicals)

3.Development of fluoroscopy



Thoracic fluoroscopy using handheld fluorescent screen 1909

Photograph shows an early (1933) fluoroscopic system in use before the development of image intensification. An actual fluoroscopic examination with this device would have occurred in a darkened room.

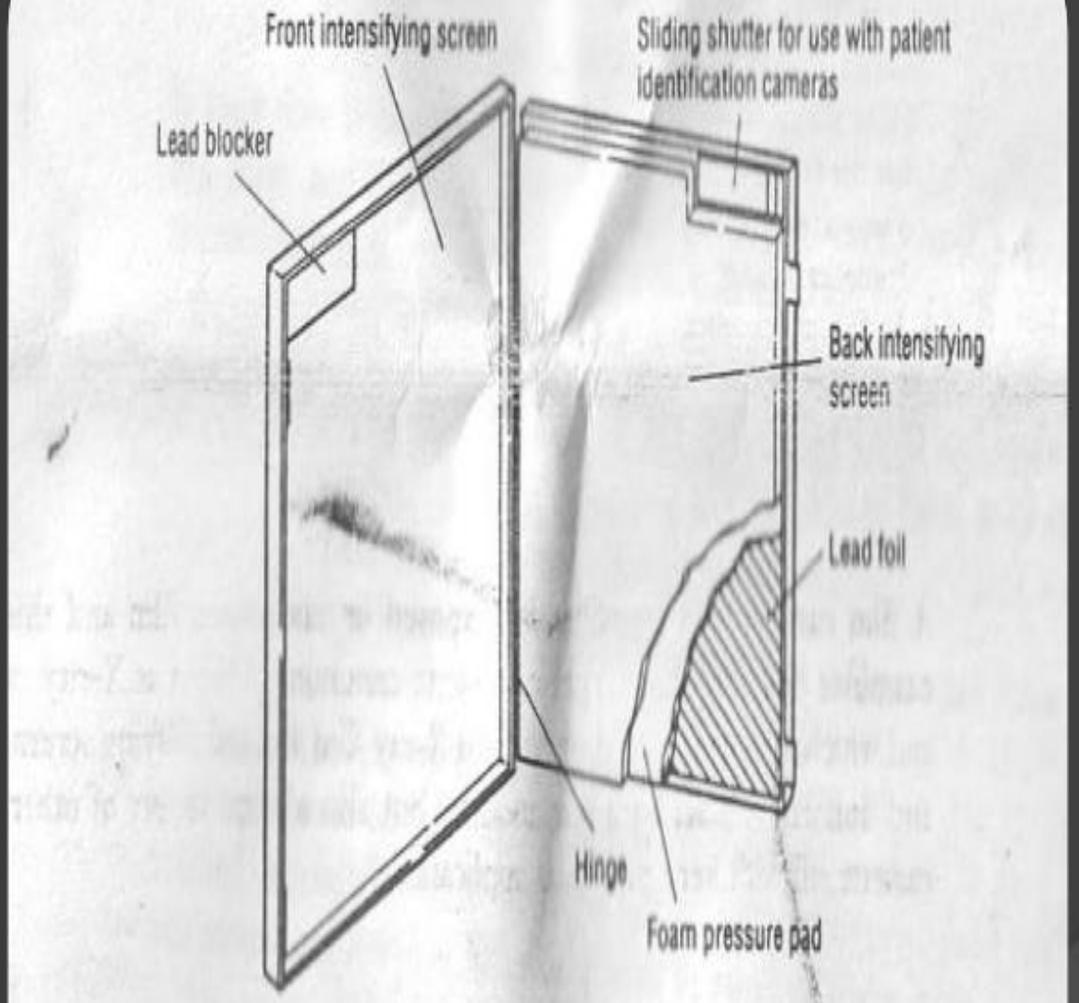
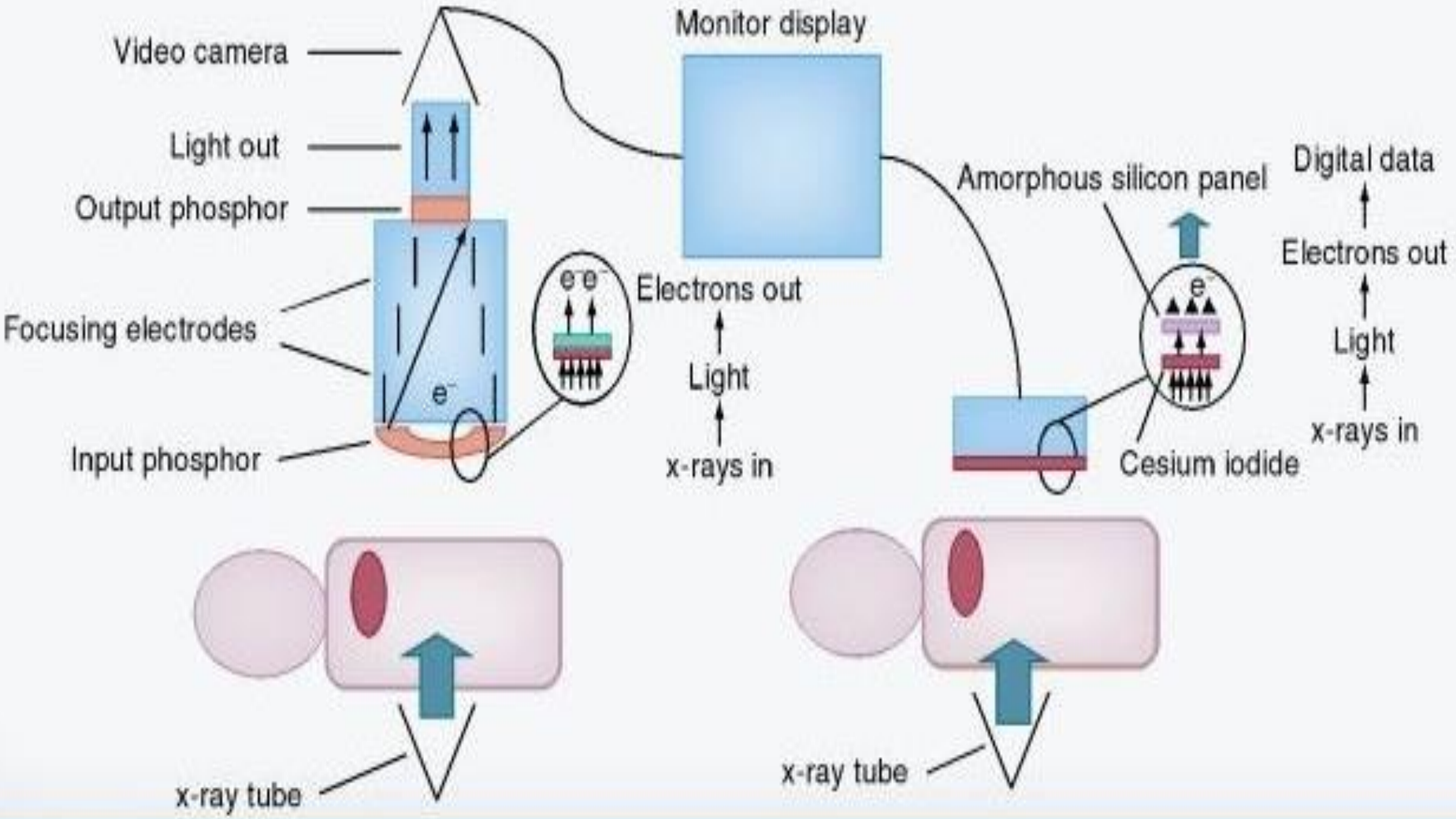


Fig. 8.1 X-ray cassette construction.

The new fluoroscopy machine

Image-intensifier system	Flat-bed panel device
Curved input phosphor leading to peripheral field of view distortion	Flat detector with maintained spatial resolution in periphery
X-ray detector not sensitive	Highly sensitive x-ray detector
Small dynamic range of x-rays detected	Large dynamic range of x-ray detected
Magnification requires higher x-ray exposure	Magnification requires less x-ray exposure
System developed using analog technology	Digital technology



Properties of x-ray

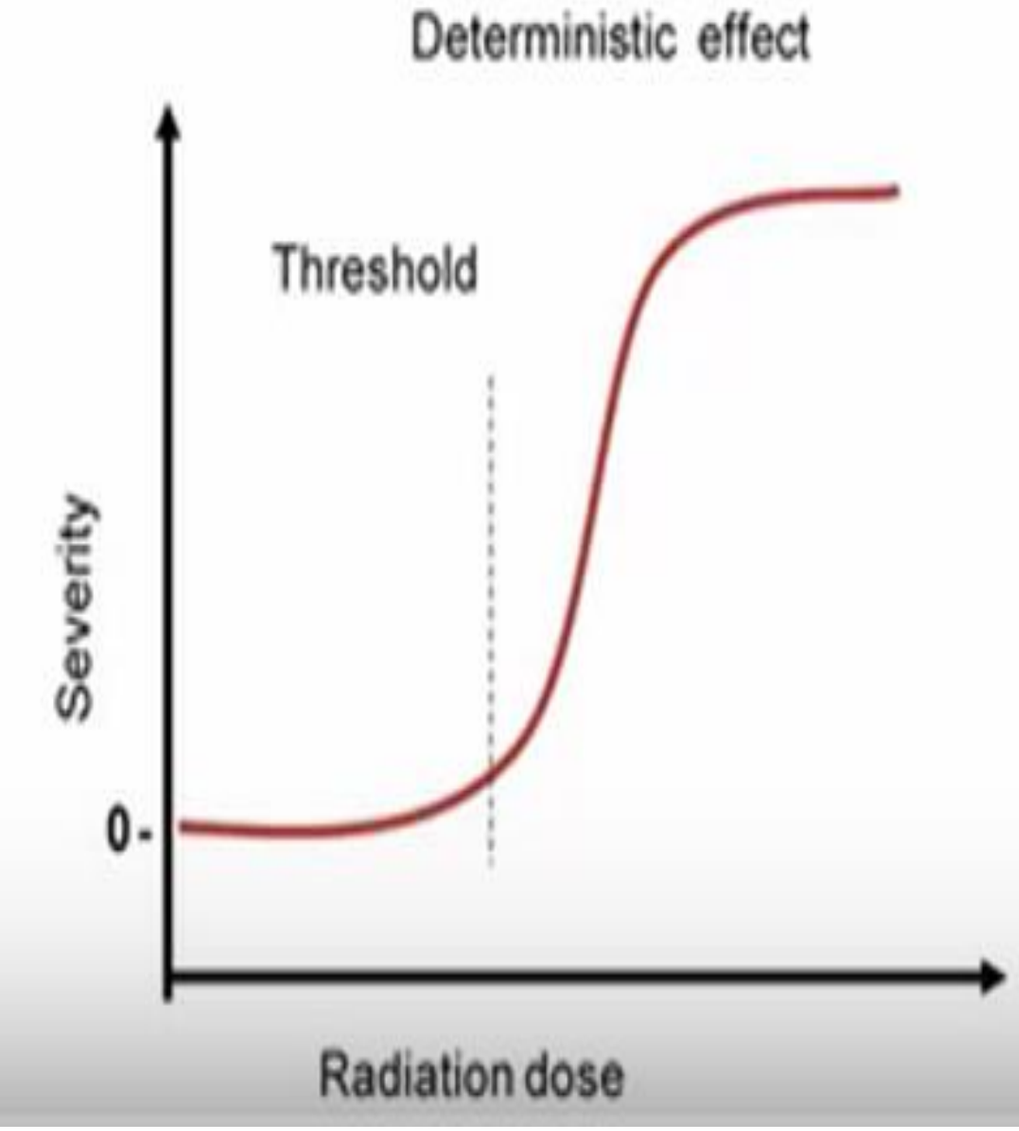
5. Biologic effects

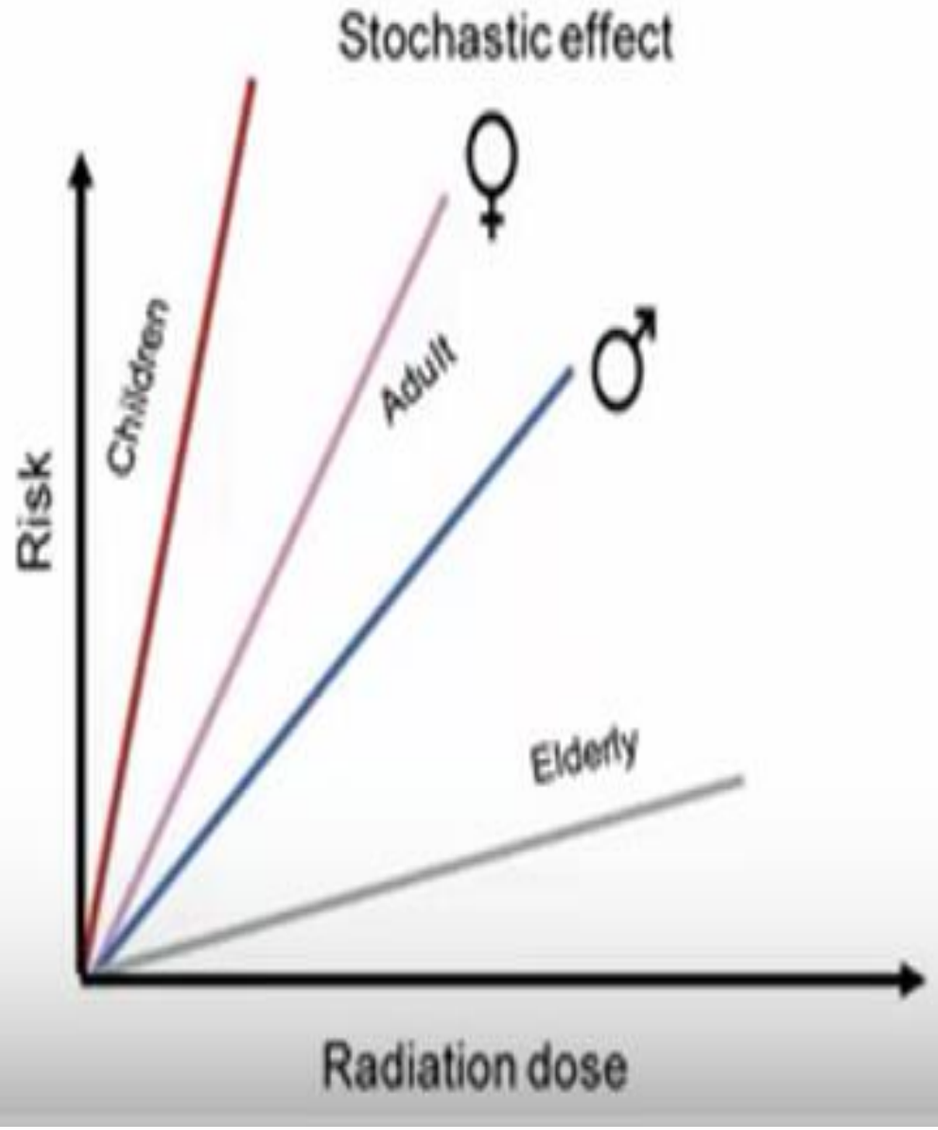
- harmful effects caused by the ionization of atoms in living organisms
- **Deterministic effects:** cell death by high radiation dose that increase in **severity** with increasing dose above a threshold level. Its associated with a high dose delivered over a short period of time. eg: Skin erythema ,cataract

* occur once the threshold of exposure has been exceeded. It should be noted, that these thresholds are rarely exceeded in well-managed clinical environments.

- **Stochastic effects:** cell transformations which do not impair the cell's capacity for reproduction. eg:
  - pregnancy(fetal development defects)
  - Tissue damage (luekemia)
  - Organ damage(heart defects)

* Occur by chance and consist of cancer and genetic mutations . Its often show up years after exposure. As the dose to an individual increases, the **probability** to occur will also increase not the severity. (no threshold)





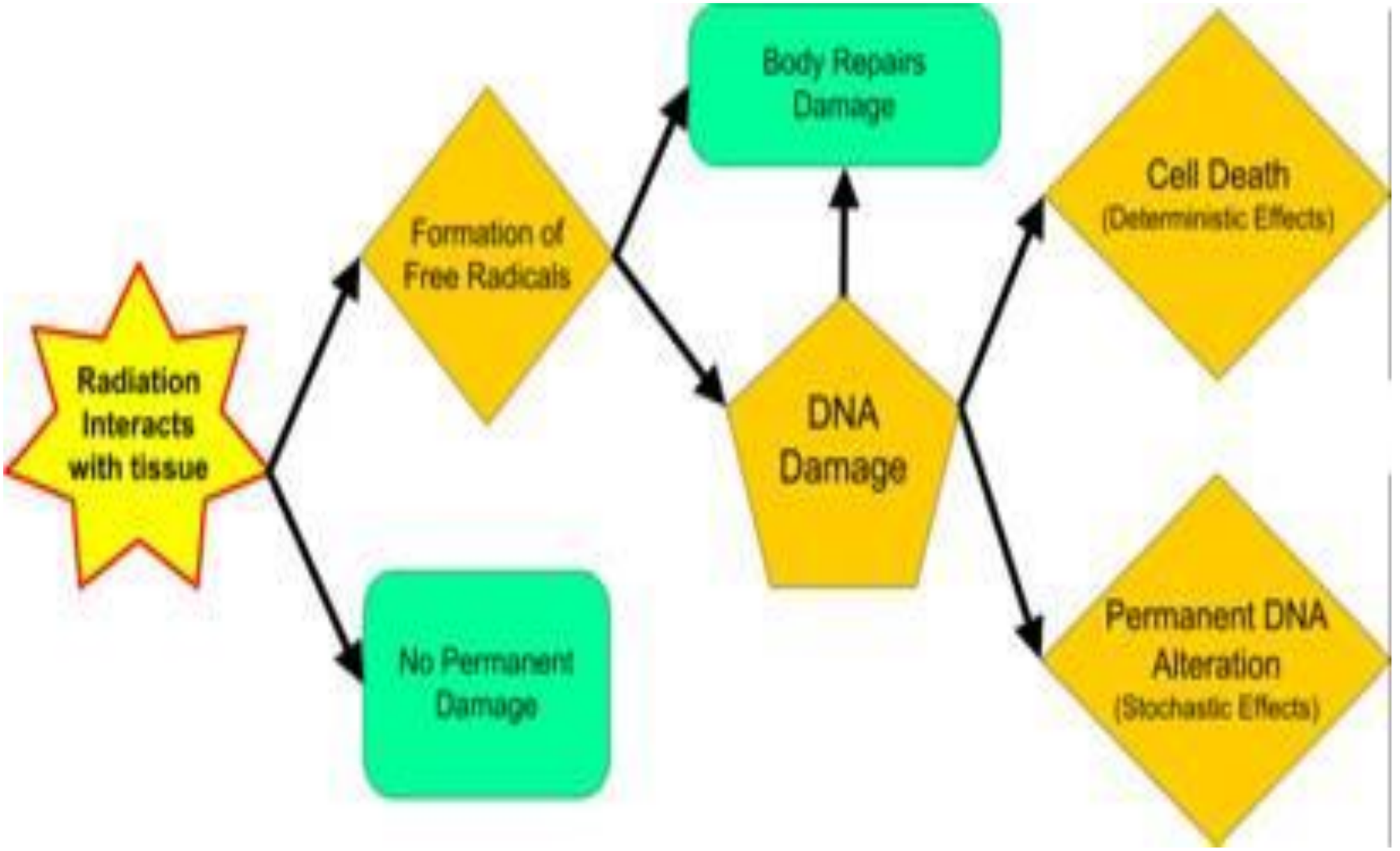
The **severity** increases across the threshold (usually high dose)

Skin erythema
Epilation
Cataracts

The **probability** increases with increasing the dose

Cancer
Genetic mutation

Biological effects



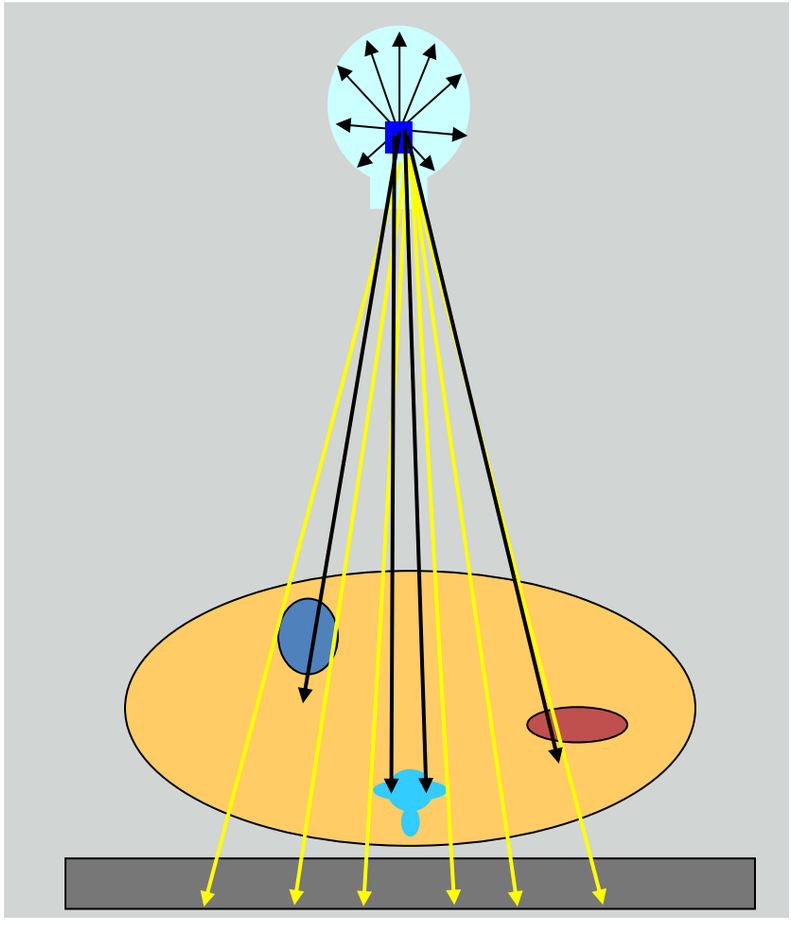
Radiography Process

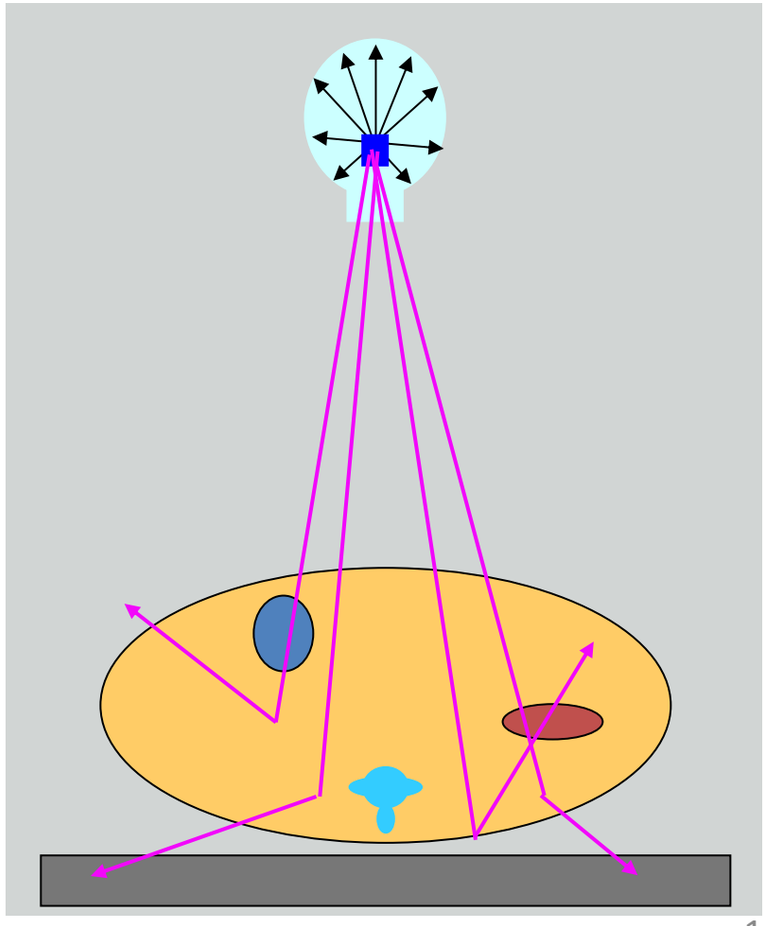
- Machine produced X RAYS that directed toward & through an object
  - X rays travel in straight lines.
  - interact with object.

1. Transmitted (pass straight through the object and help to form the image)
2. Absorbed by structures in object.
3. Scattered by the object. (change direction and loss energy)

Radiography Process

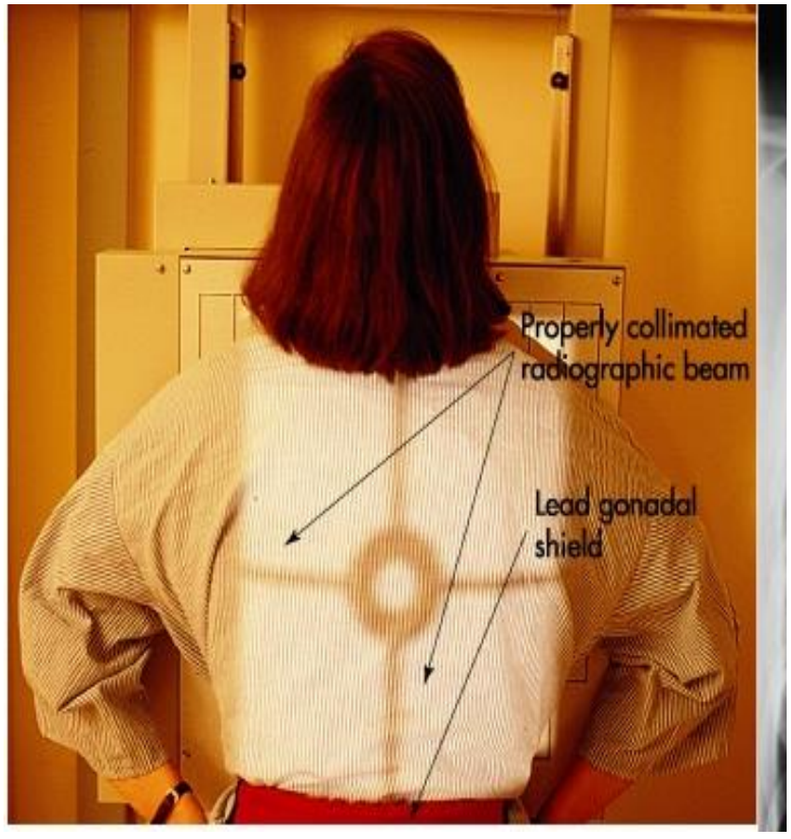
Transmit vs. Absorb vs. Scatter





Radiography Process

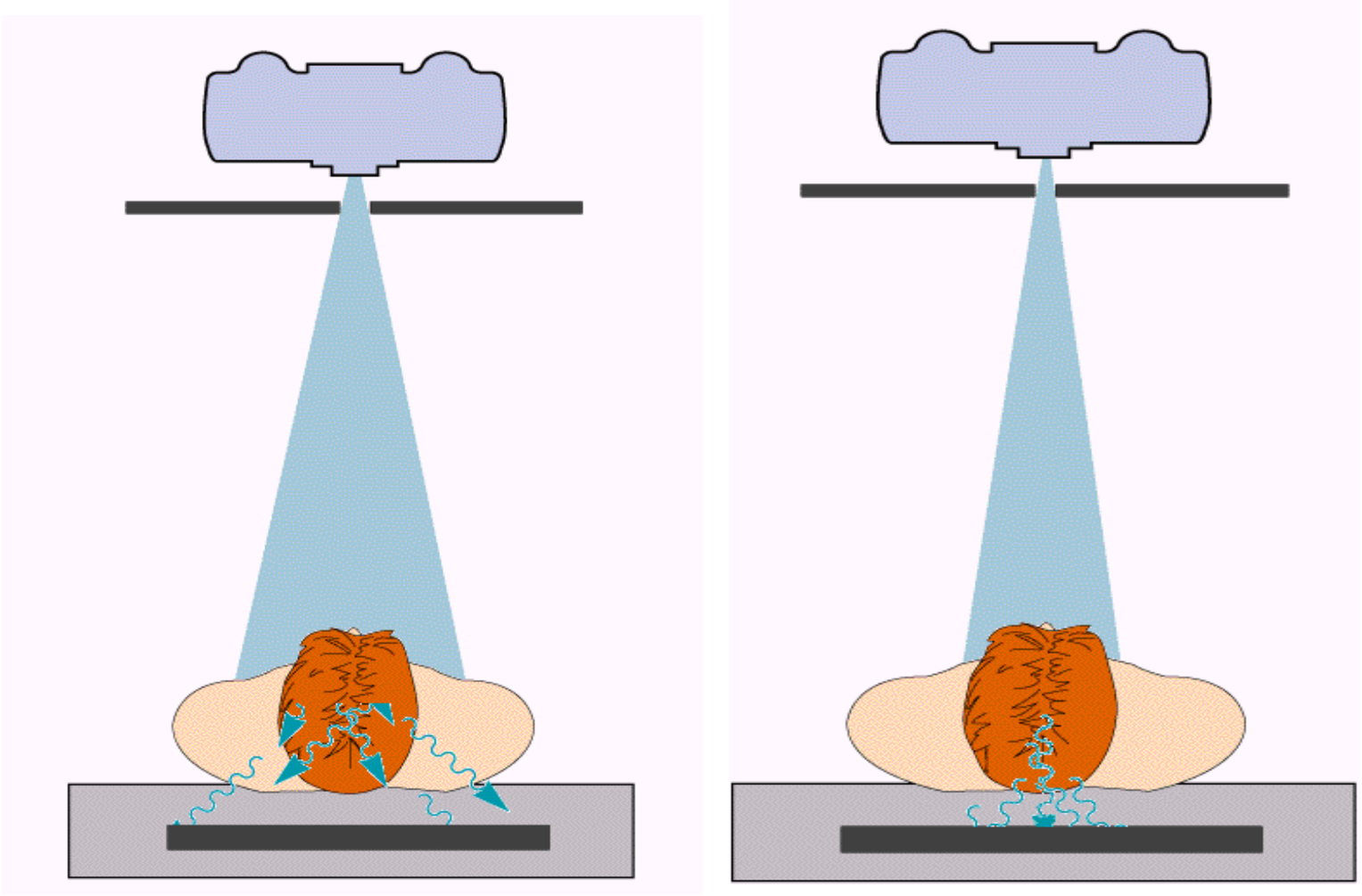
- **Scatter has negative impact causing**
  - Creates fog in image.
  - Unsharpness
  - Lowers contrast (more grays)
  - Greatest cause of occupational exposure
- **Increases as**
  - kV increases
  - Field size increases
  - Thickness of part increases



- Collimate to area of interest reduces scatter and radiation dose to the patient.

Radiography Process

Effects of collimation on scatter



Radiography Process

- Image detector (sensors or film) records X RAYS that penetrate object.
- Image based on the differences between the transmitted & absorbed x rays.
- Image processed to make it visible
  - detector– digital processing
  - Film – chemical processing

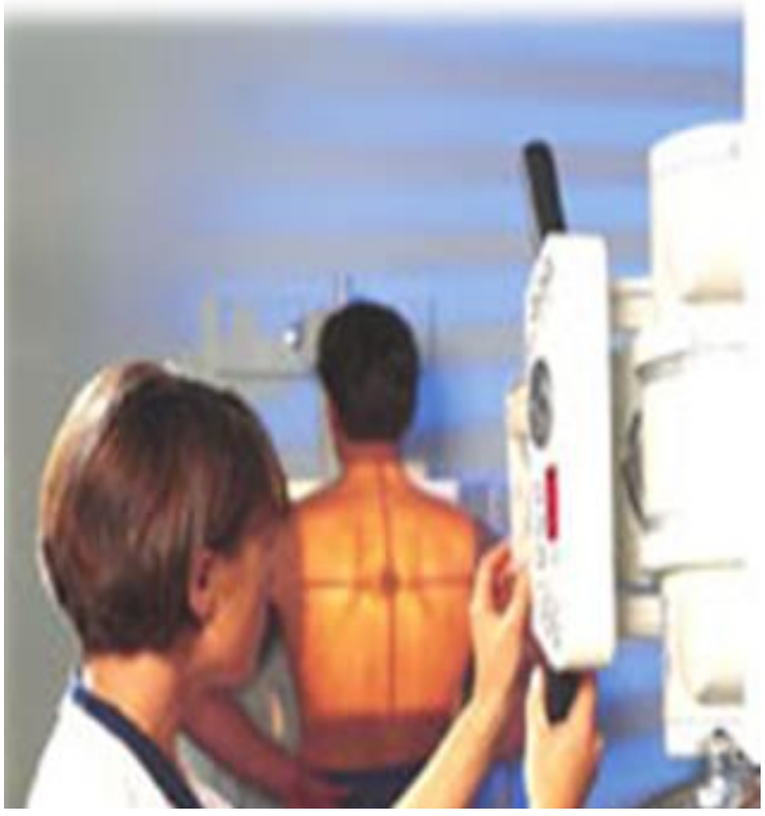


Image Quality

- **FILM = BLACK-GRAY-WHITE IMAGE OF THE OBJECT**

photographic characteristics

-Visibility (density & contrast)

- Sharpness (detail & distortion)

Image Quality

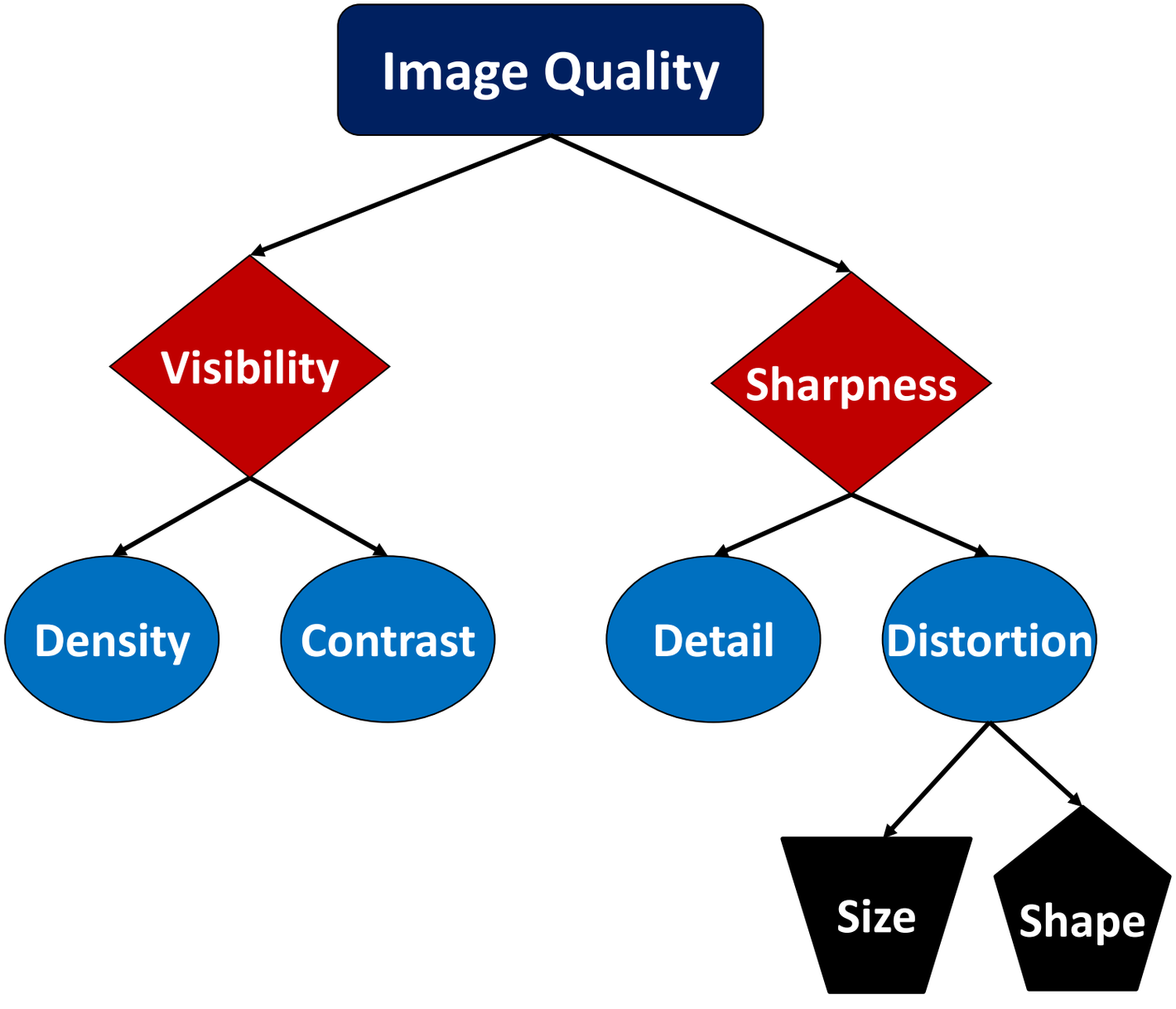
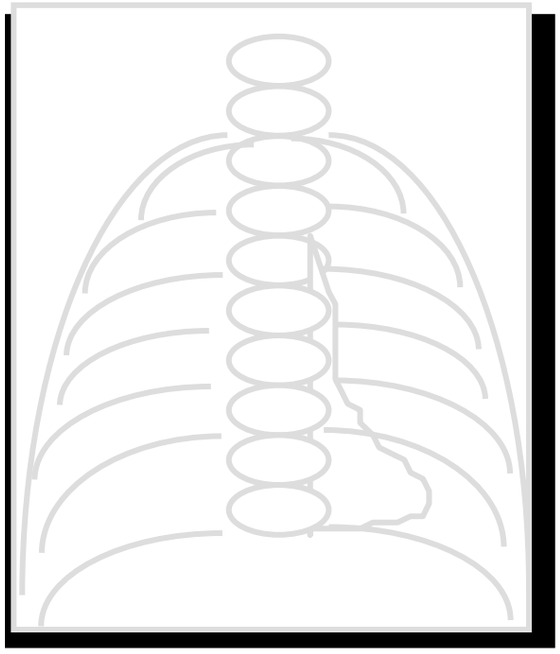


Image Quality

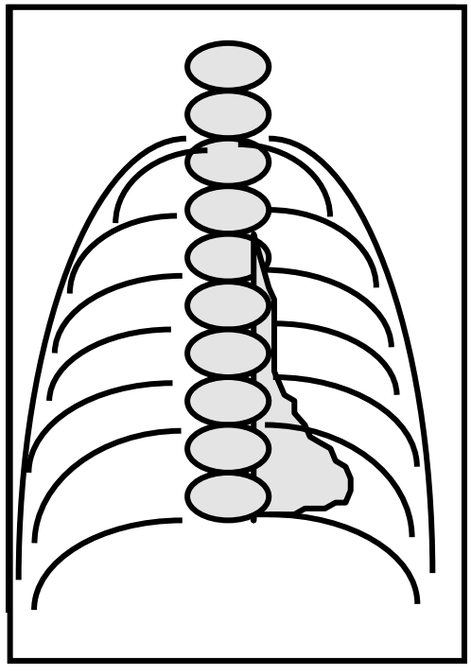
QUALITY--VISIBILITY OF STRUCTURES

1. DENSITY

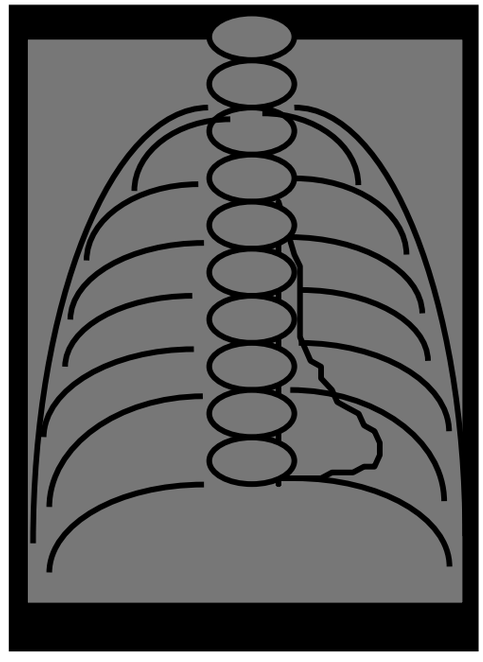
- AMOUNT OF BLACKENING ON IMAGE
- ▲ FILM BLACKNESS = ▲ X RAYS



LIGHT
Too few x rays



OPTIMAL



DARK
Too many x rays

Image Quality

Density Changes

Light
Low density

Optimal

Dark
High density

Image Quality

QUALITY--VISIBILITY OF STRUCTURES

2. CONTRAST

- The difference in density on adjacent areas on the image.
- Range of Black-Gray-and White on the image.
- Desirable contrast level varies by anatomical area.

Image Quality

SCALE OF CONTRAST

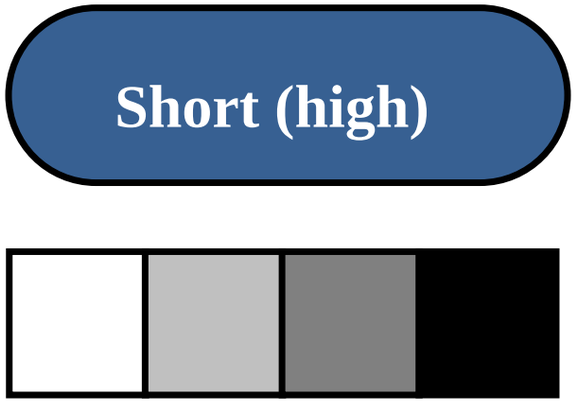
RELATIVE MEASURE OF CONTRAST

SHORT SCALE (HIGH CONTRAST)

- BLACK & WHITE IMAGE
- MAJOR DIFFERENCES

LONG SCALE(LOW CONTRAST)

- GRAY IMAGE
- SLIGHT DIFFERENCES



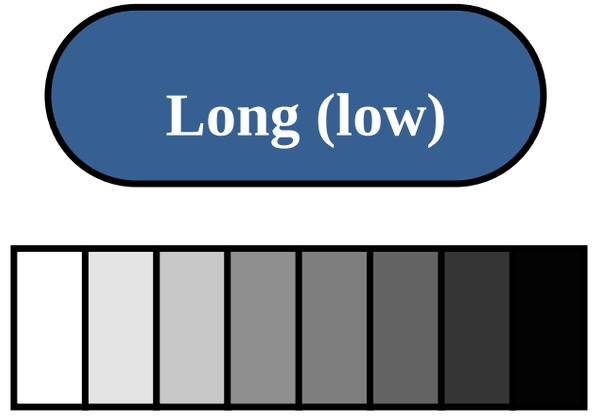


Image Quality

SCALE OF CONTRAST

High

Optimal

Low

Image Quality

♦ **mAs** determine the quantity (amount)of x-ray.
♦ **KVp** determine the penetration power of x-ray.
♦ **Density** is the amount of blackening on the image(overall blackness of film)
♦ **Density** is primarily controlled by mAs.(Directly proportional)
- **Too little** density present on the processed film means underexposed (bright)
- **Too much** density present on the processed film means overexposed (dark)
♦ **Contrast** The difference between densities on the image
♦ **Contrast** is primarily controlled by KV. (Inversely proportional as the KV is increased, the number of grays increases, thereby producing a longer scale of contrast)
-Greater difference in density **means** higher contrast.
- Less difference in density **means** lower contrast.

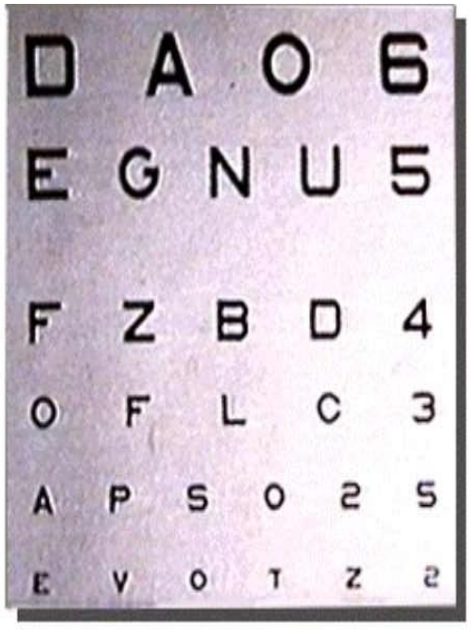
Image Quality

QUALITY—SHARPNESS OF IMAGE

1. RECORDED DETAILS

- Smallest details that can be seen on the image

A A A A A A A A A A A A A A



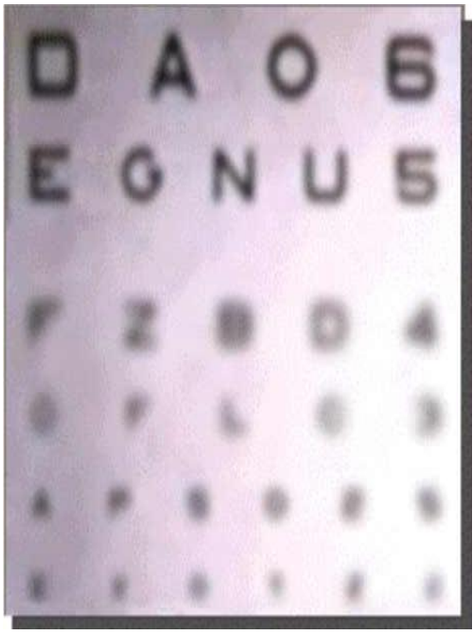


Image Quality

QUALITY—SHARPNESS OF IMAGE

2. DISTORTION (GEOMETRIC)

- A change in the appearance of a structure (size or shape) on an image that differs from the actual appearance

TYPES:

1. SIZE - **MAGNIFICATION**

2. SHAPE - **ELONGATED**

SHORTENED

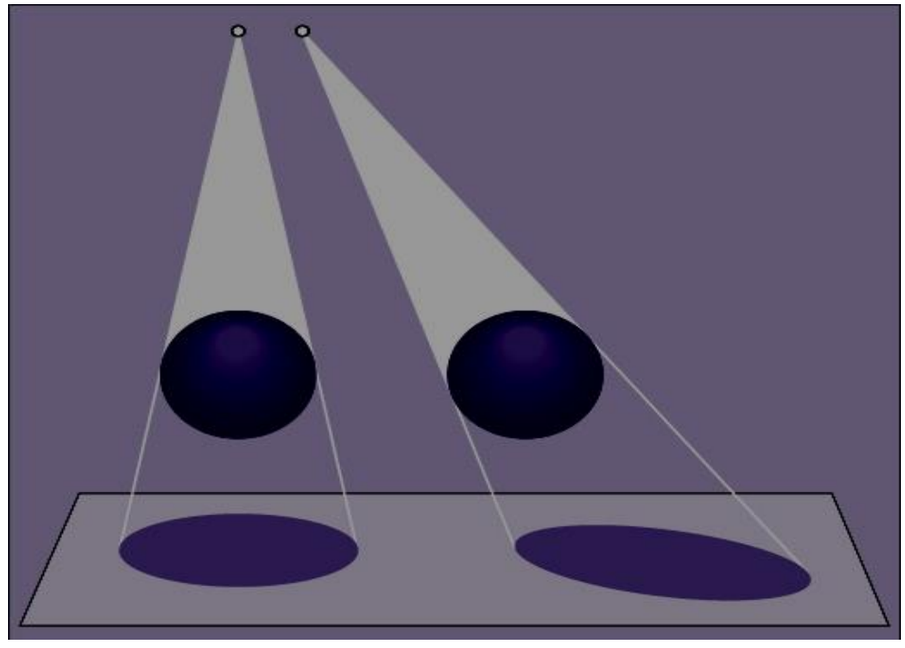
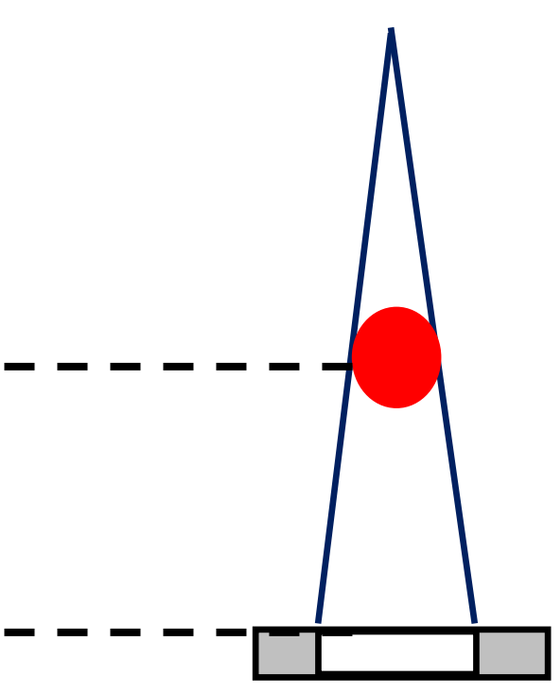


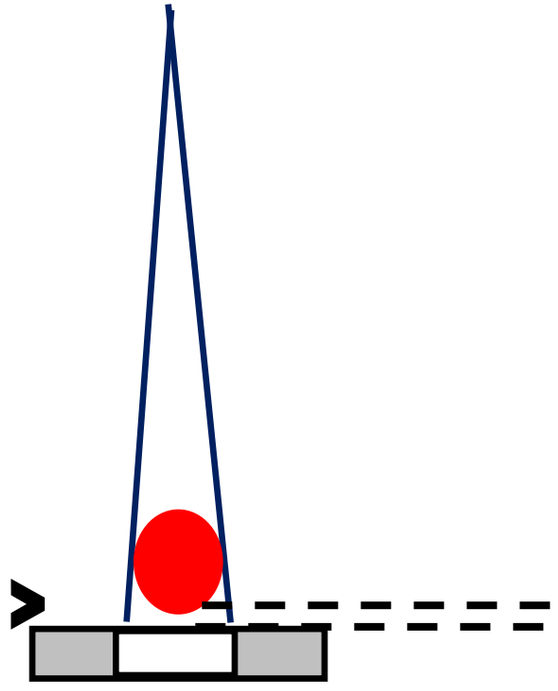
Image Quality

Size Distortion

1. DISTANCE BETWEEN OBJECT & IMAGE (OID or OFD)
   - Use short OID to obtain truest size
   - ▲ OID = ▲ OBJECT SIZE = ▼ SHARPNESS = ▼ DETAILS



LONG OID
Greater mag=decrease sharpness



SHORT OID
Less mag = increase sharpness

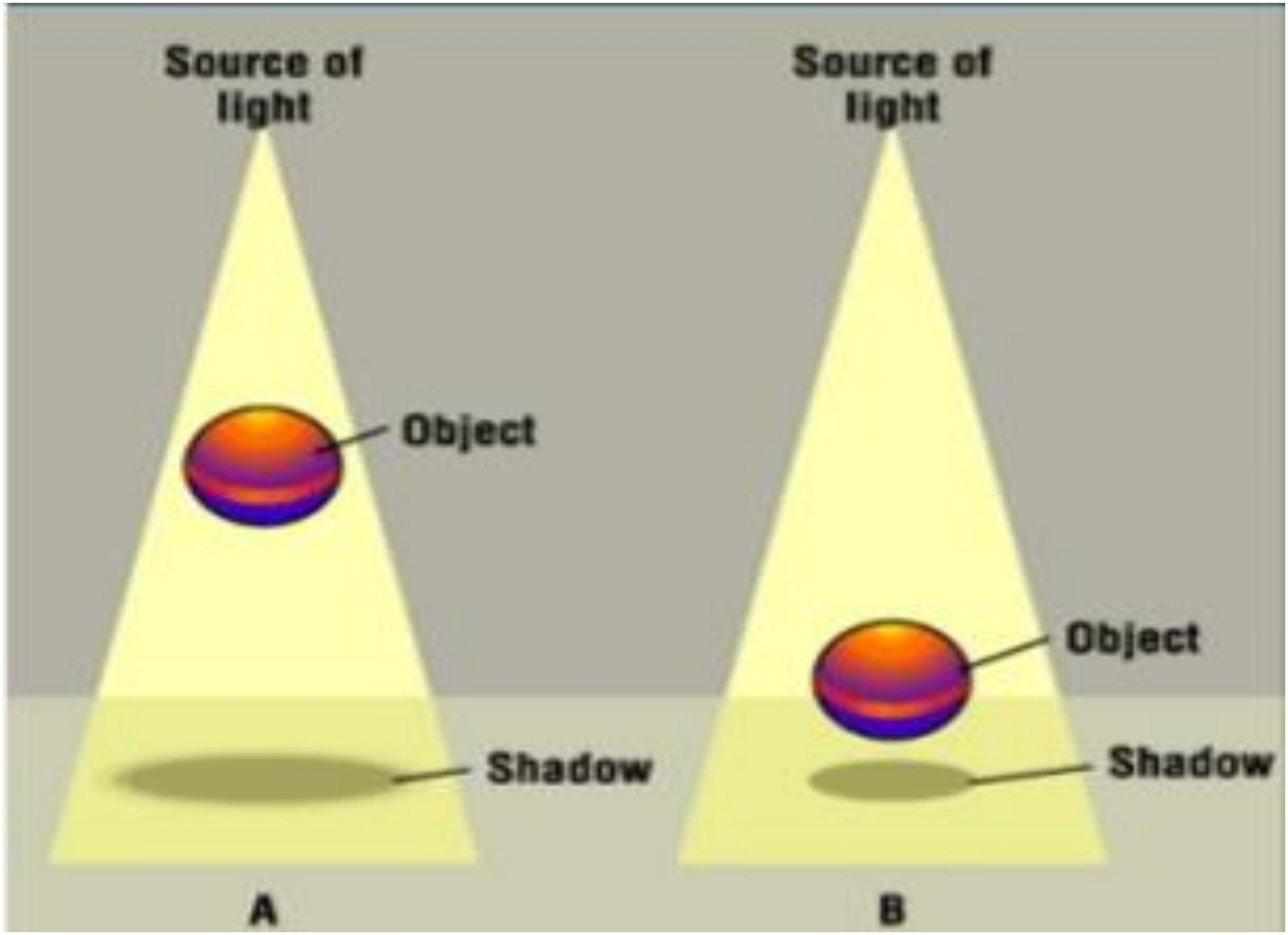
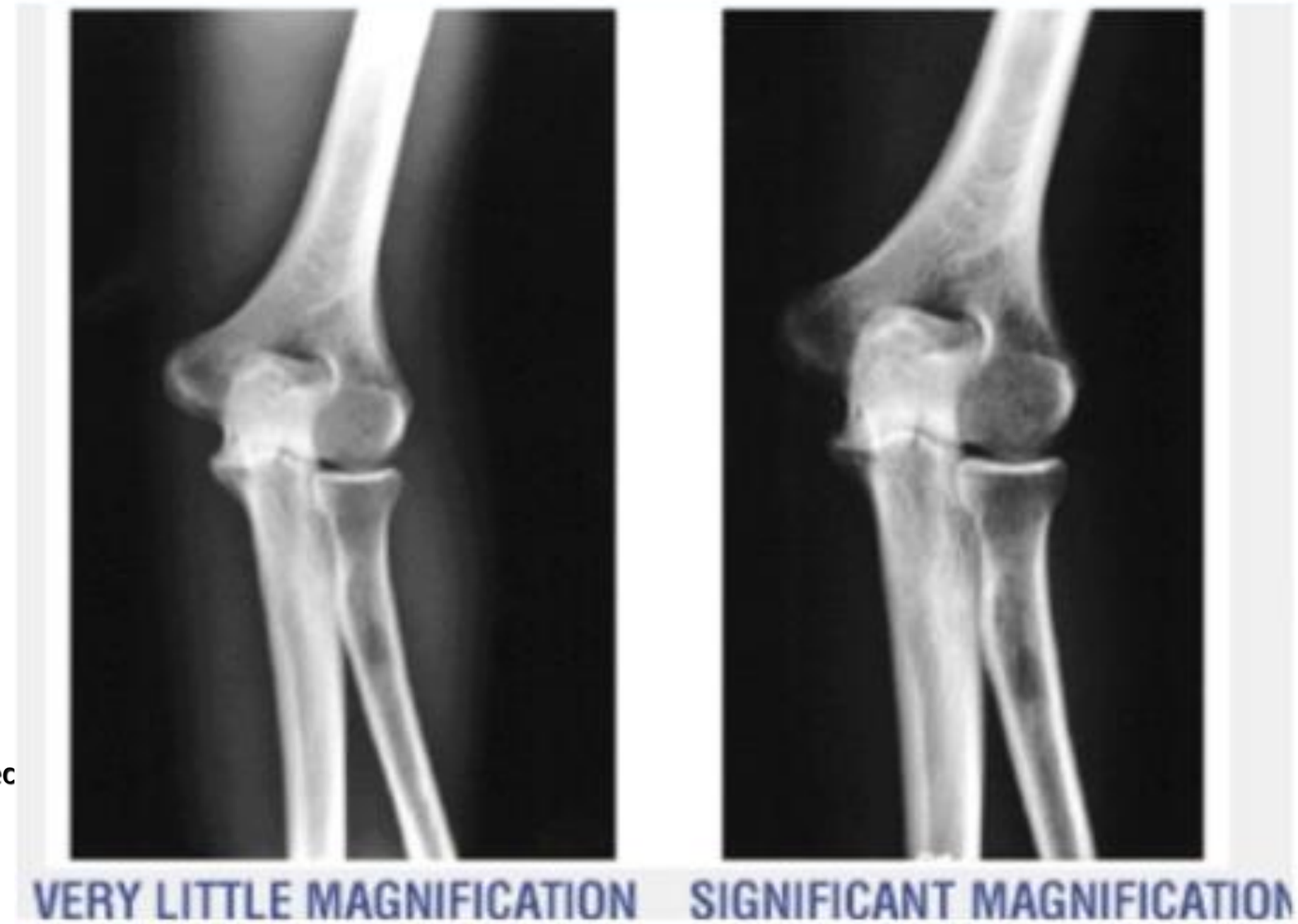

Source of light
Object
Shadow
A
Source of light
Object
Shadow
B

Image Quality



Dec

Image Quality

Minimizing Size Distortion

- keep part as close to film as possible (less OID)
  - Select body position that will put object of interest closest to the film.
- Control SID
  - Use long distance between tube & film
  - Standard SID for specific exams
    - Results in constant level of magnification

Image Quality

Shape Distortion

1. **Alignment of beam and part of interest**
   - ANGLE OF BEAM
     ⊥ (true) vs. ∠(with angle)
2. **Placement of part of interest relative to film**
   - PARALLEL (true) vs. TURNED [oblique] (with angle)

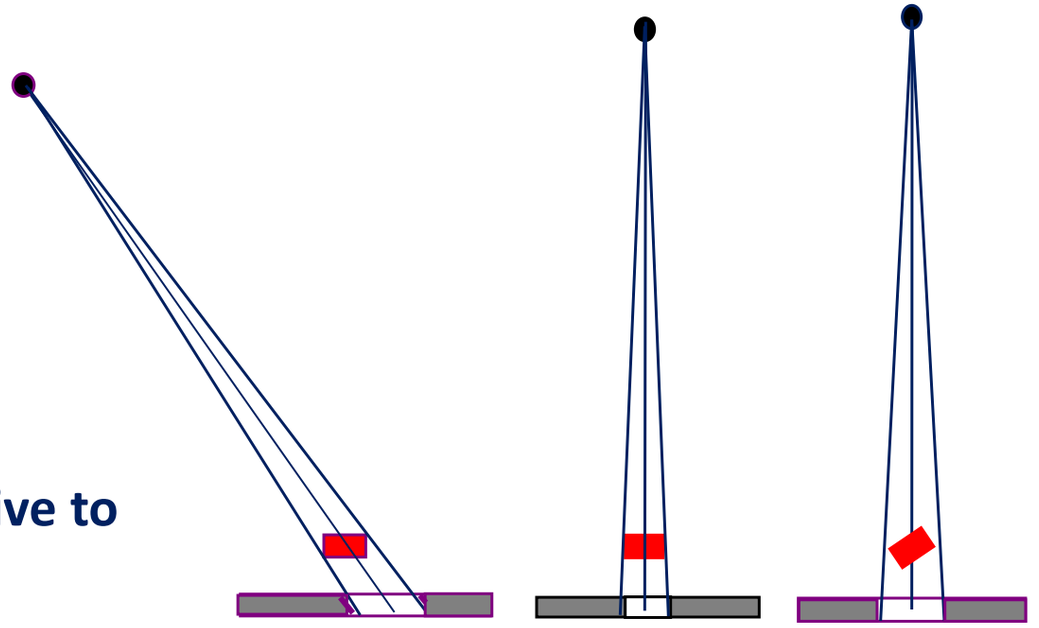
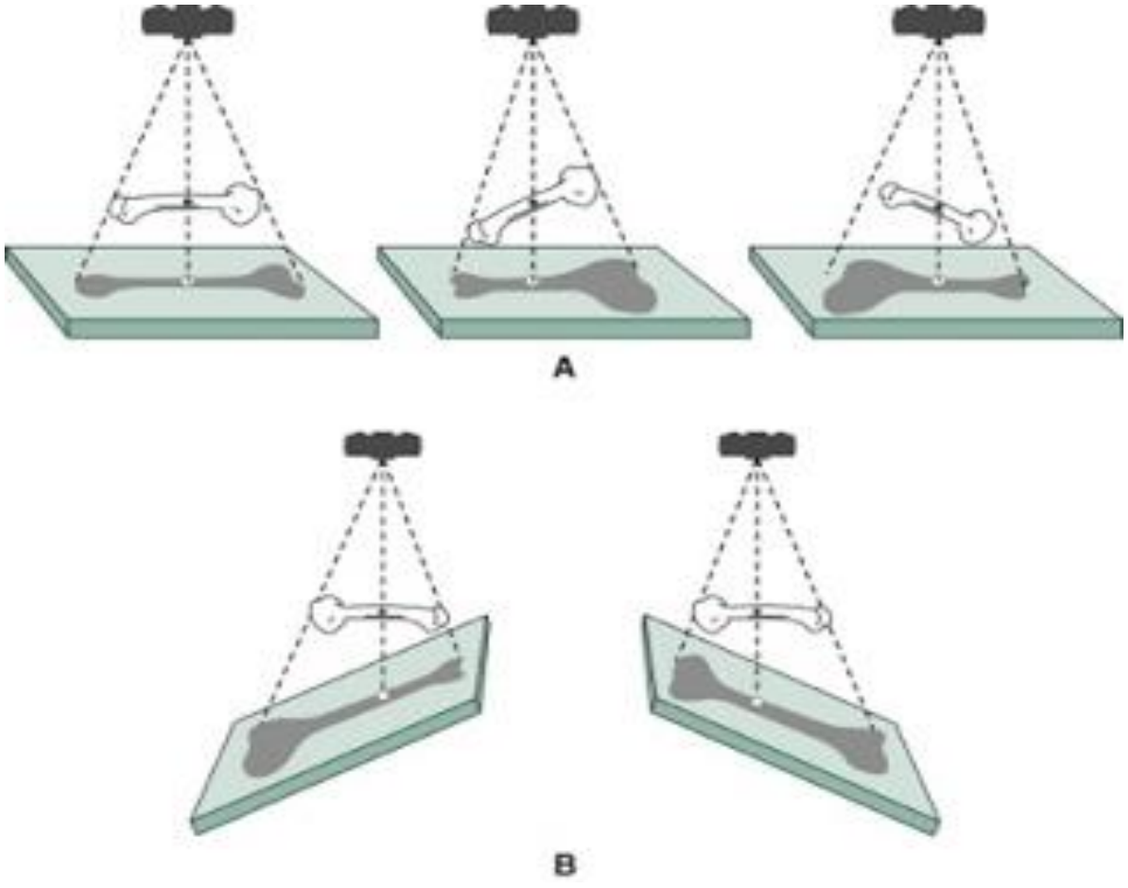


Image Quality



A. Foreshortening
B. Elongation

A. No distortion
B. Foreshortening
C. Elongation

Image Quality

Motion

-Controlled by:

Voluntary

- Careful instructions to the patient.
- Suspension of respiration
- Immobilization

Involuntary

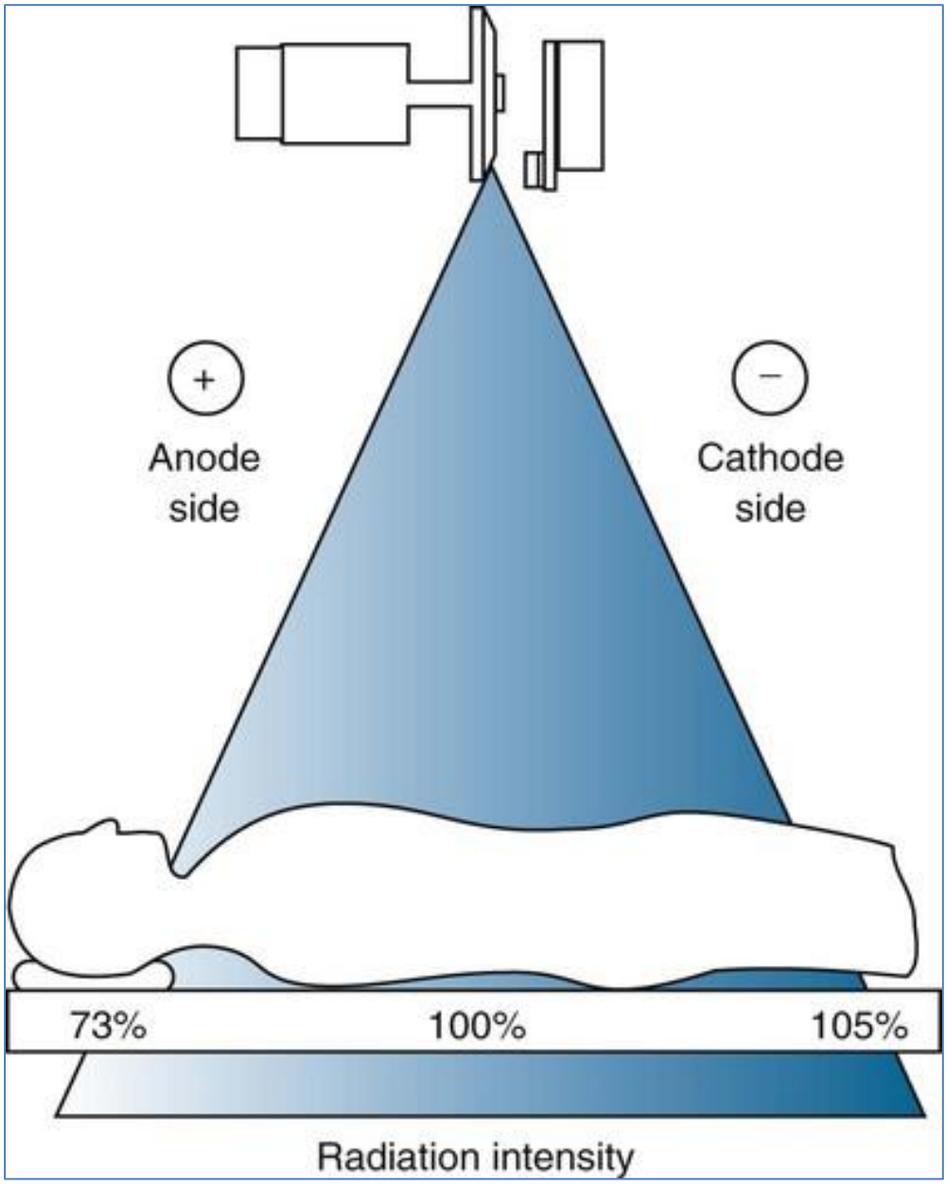
- Best controlled by short exposure times

Image Quality

Anode Heel Effect

- Anode heel effect describe the intensity of the radiation emitted from the x-ray tube.

- The intensity at **the cathode(-)** end of the x-ray field is greater than that at the **anode end(+)**. The thicker body part under (-) to create a uniform densities



SUMMARY

Factors affecting Radiographic image quality

1/ Subject contrast
- Absorption differences
- Thickness
- Atomic Number

2/ Radiation Quality
- Target material
- Kilovoltage
- Filtration

3/ Scattered Radiation
- Selection of Exposure factors (KV)
- Beam collimation
- Compression
- Air gab
- Grid

4/ Processing
-Chemical film process
-Digital image

SUMMARY

Factors affecting Radiographic image quality

5/ Film fogging(conventional X-ray)

- Storage
- Light leaks (cassette/film type)
- handling

6/ Technique

- Patient positioning
- Patient immobilization
- Exposure time
- SID
- OID