Principles of Imaging Science II (RAD 120)

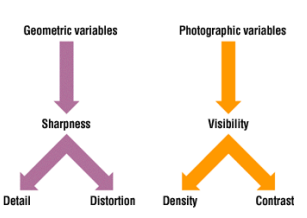
Geometric Recorded Detail

RECORDED DETAIL
(Definition, resolution or sharpness)

- Recorded detail refers to the fine anatomical details that are seen in the radiographic image
  - Refers to the degree of sharpness of structures **recorded** on the radiograph.
- What anatomical structures are best demonstrated in this image?
- What is the quality of density? Contrast?

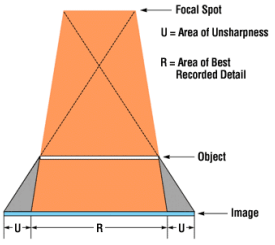
Image Quality Properties

- Separate & distinct from the photographic properties density & contrast
- The photographic properties do influence the visibility not the recording of detail
  - Good recorded detail, poor density or contrast = poor visibility of the anatomical details
  - Poor recorded detail, good density or contrast = good visibility without the anatomical details

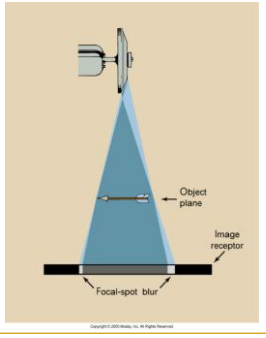


Terminology

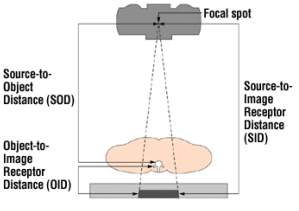
- Geometric Unsharpness (Penumbra)
  - Image blur, the area of unsharpness seen at the edges of the anatomical structures
  - Loss of recorded detail as a result of how the anatomy is projected through space toward the image receptor
  - Increased on cathode side of x-ray tube
  - Results in hazy edges



Geometric Unsharpness – Cathode End



Geometric Unsharpness

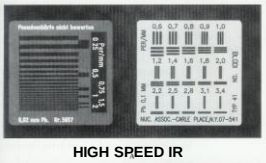


- Affected by:
  - FSS
  - SID
  - OID
  - RSS
  - Motion
- Methods employed by the radiographer to decrease unsharpness.

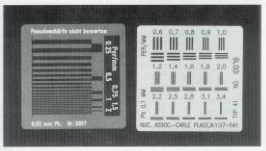
Terminology

- Geometric Sharpness (Umbra)
  - True anatomical image
  - Clinical assessment (trabecular pattern)
- Measuring recorded detail
  - Line-pair test tool with equally spaced metal strips.
  - Image obtained, #lp/mm quantified
    - Lp = single line + adjacent space

Resolution Test Tool



HIGH SPEED IR



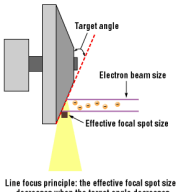
SLOW SPEED IR

A *resolution tool* is a device used to measure the detail on a radiograph. The human eye can discern up to 5 lp/mm.

Conventional screen film systems can resolve up to about 10 lp/mm, which is beyond the range of human visualization.

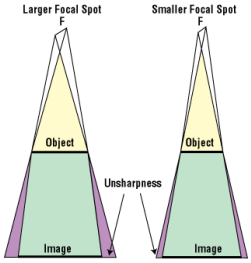
Controlling Factors

- Focal spot size (FSS) 0.5 – 1.2 mm
  - Small FSS produces > image details
    - Based on Line-Focus principle
      - Produces a smaller Effective FSS than the actual FSS
      - Effective vs Actual FSS
        - FSS Blooming - Use of high mA, low kVp
    - Comparing FSS
      - Small actual FSS represents a smaller area on anode the photons project the edges of the structures at smaller angles reducing unsharpness
      - Small FSS is desirable, yet limited in application



Line focus principle: the effective focal spot size decreases when the target angle decreases.

Focal Spot Size

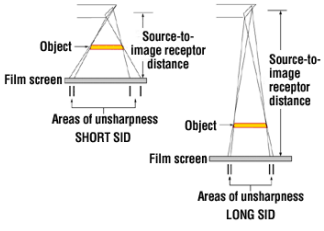


With the larger focal spot, x-rays strike the end of the object (or the edge of any structure inside the object) at more widely diverging angles because they begin farther apart at the anode. The sharp edge of the object blurs into a broader, fuzzier edge as the x-rays continue to spread out between the object and the image receptor. There is therefore more blurring of the image, resulting in less recorded detail.

Controlling Factors

- Source-Image Distance (SID) 40” – 72”
  - Longer SID produces > image details
    - At longer SIDs, the x-ray beam spreads out over a larger area
    - More collimation is needed at longer SIDs
      - More of the beam center ⊥ is used
    - mAs increases with SID increase

Source Image Distance (SID)



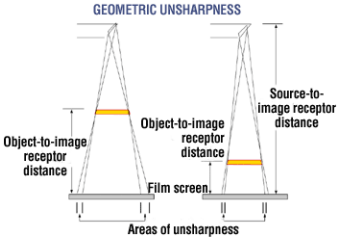
If you increase the SID while keeping the object-to-image receptor distance the same, the x-rays from the focal spot spread less after they pass the object on their way to the film.

Increasing the SID, then, cuts down on blurring and improves the recorded detail.

Controlling Factors

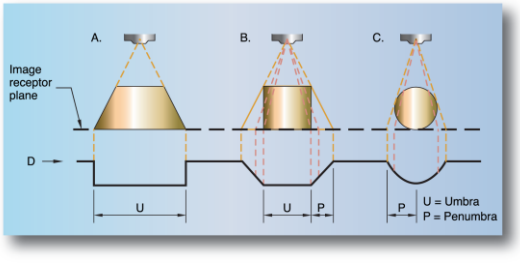
- Object-Image Distance (OID)
  - Shorter OID produces > image details
    - Object is magnified as OID increases
    - Minimize OID as possible
    - Macroradiography used in mammography
      - Magnification radiography to exaggerate small structures to improve visualization not detail
    - Bucky use increases OID, results in > contrast

Object Image Distance (OID)



Radiographers must position the anatomy close to the image receptor to improve the recorded detail and decrease magnification.

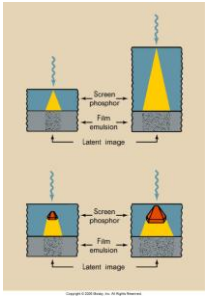
Attenuation/Absorption Unsharpness



Controlling Factors

- Image Receptor System (7 – 15 lp/mm)
  - Slower RSS > image details
    - Small phosphor crystal size
    - Thinner phosphor layer
    - Higher phosphor concentration (Packing density)
  - Good film/screen contact > image details
    - Due to cassette misuse
    - Wire mesh test
      - Demonstrates unsharpness, > density

Intensifying Screen Phosphors



- A: Reduction in spatial resolution is greater when phosphor layers are thick.
- B: Reduction is also greater when crystal size is large.
- How is the speed (RSS) connected?

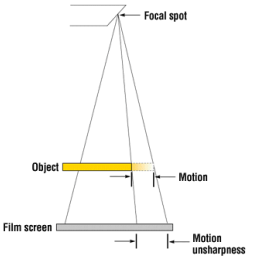
Wire Mesh Test – Film Screen Contact

A

B

Motion (Blur)

- Types
  - Involuntary motion
    - Cardiac, peristalsis, spasm, tremor
  - Voluntary motion
    - Patient movement of body
  - Equipment motion
    - Bucky activation
    - Portable X-ray tube lock failure
    - Cassette movement



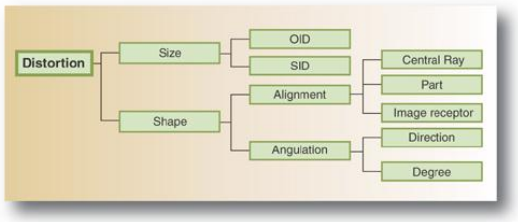
Methods to Minimize Motion

- Patient Communication
- Short Exposure Time
- Activate Locks
- Use support devices

Review: Factors Affecting Recorded Detail

- Eliminate motion
- Reduce OID
- Reduce focal spot size
- Reduce intensifying screen phosphor size, decrease phosphor layer thickness, increase packing density
- Increase SID

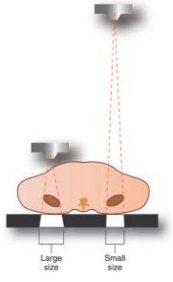
DISTORTION



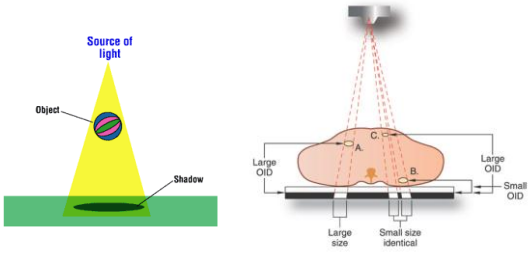
DISTORTION

- Misrepresentation of the anatomical part by size or shape
- Size distortion (Magnification)
  - Misrepresentation of the true size of the anatomical structure
  - Factors
    - OID > = increased magnification
    - SID < = increased magnification
    - Pt. thickness > = increased magnification
  - Magnification Factor (MF)
    - Relationship between SID/SOD

SIZE DISTORTION
Decreased by Increasing SID

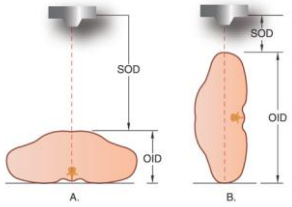


SIZE DISTORTION
Decreased by Decreasing OID



http://evolvels.elsevier.com/section/default.asp?id=0071%5Fskerr5%5F0001

SOD
Effect on entrance skin exposure



Distortion

- Shape Distortion
  - Misrepresentation of the actual shape of the anatomical structure
  - Minimize by:
    - CR perpendicular to anatomical part
    - CR perpendicular to IR
    - Anatomical part parallel to IR
  - Elongation sometimes used to advantage
    - Stretch out, open up, or demonstrate hidden parts

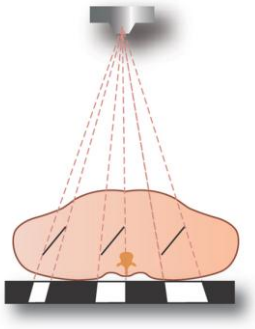
Shape Distortion

- Elongation
  - Image is longer than actual
    - Results from improper part/IR or CR/IR alignment
    - CR is perpendicular to part
- Foreshortening
  - Image is shorter than actual
    - Results from improper alignment of structure with CR or IR
    - CR is perpendicular to IR
  - Magnification results in both cases

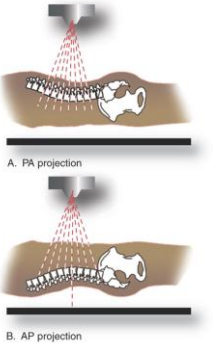
Shape Distortion

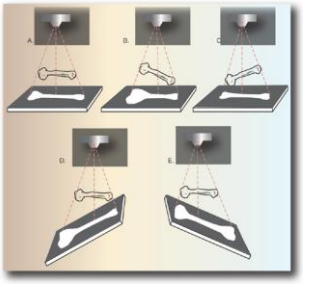
- Central Ray Alignment
  - Ensure proper alignment of CR with anatomical part and IR
  - Direct to anatomical centering point
    - > distortion beyond the CR
    - = to angling

Shape Distortion



Shape Distortion
Decreased in the PA Projection





A: Normal Relationship

B & C: Foreshortening due to anatomical part relationship
D & E: Elongation due to changes in alignment with anatomical part or central ray with image receptor

IMAGE UNSHARPNESS

- P = FSS X OID / SOD
- P = Geometric Unsharpness
- FSS = Focal Spot Size
- OID = Object Image Distance
- SOD = Source-Object Distance
- SID - OID = SOD

Magnification Factor

- $M = \frac{SID}{SOD}$

- $M = \frac{SID}{SOD} = \frac{IS}{OS}$

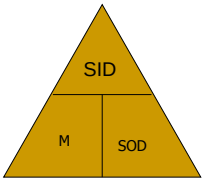


Image Quality Summation