APPH 226: Contrast

Objectives: 5.1, 5.2, 5.3, 5.6

MRT Program

Radiographic Contrast

- Can be described as the difference in optical density (OD) between adjacent structures (density differences)
- Variation of OD on an image
- Function:
  - Makes the anatomy visible
  - Differences in density

Levels of Contrast

- High contrast
  - Also referred to as short scale contrast
  - Few densities, but great differences between them
  - 'black and white'
- Low Contrast
  - Also referred to as long scale contrast
  - Large number of densities, but small differences between them
  - 'more shades of grey'

Radiographic Contrast

- Is a product of both image receptor contrast and subject contrast
- Image Receptor contrast
  - Determined by the properties that are manufactured into the image receptor
  - Technologist has no control over this, but can be influenced by processing and exposure
- Subject contrast
  - Determined by absorption characteristics of tissues in the area being imaged, and kVp used
    - Thickness of part, density of tissue, atomic number

Image Receptor Contrast

- Determined by the manufacturer
- Simplest way to work with this is to standardize it
  - Digital IR
    - Ensure appropriate exposure is used every time
      - Optimal OD for images (between 0.25-2.5)
    - Maximize the exposed area of the image receptor

Digital Imaging – Contrast Resolution

- Contrast Resolution
- This is the ability of a digital system to display subtle changes in shades of grey
- High contrast resolution means that the difference between adjacent densities is enhanced – greater difference
  - Can be manipulated with software
  - Allows the user to enhance the difference between similar densities
  - Contrast resolution in digital imaging is related to pixel bit depth
    - kVp does not control contrast in digital imaging (kVp controlled contrast for film/screen IR)

Digital Imaging – Contrast Resolution

- With digital imaging, higher kVp values can be used without impact to the contrast that would have occurred with old technology when using film/screen as the IR
  - This results in lower patient dose
- Scatter is still a major concern
  - Digital systems are sensitive to scatter
  - All efforts to decrease scatter should be routinely applied
- kVp is still an important factor for providing adequate penetration of all tissues
  - If contrast is too low, the system cannot correct for this, there needs to be enough grey shades for the system to differentiate signals

Contrast Evaluation

- Contrast is more complex than density
- Subjective to the viewer
- Determined by the subject/area being imaged
  - Amount of information needed to visualize tissue for optimum accuracy of diagnosis
  - Personal preference

Body Part Composition

- What is the anatomy being imaged?
- What is optimal visualization?
  - i.e. soft tissue vs bony extremities
- When selecting technical factors, need to consider the composition of anatomy (bone, muscle, fat, soft tissue, air)
- Ideal contrast – for the part – will maximize the amount of information visible for diagnosis

Density and Contrast

- Density, in most situations, has no effect on contrast
- The occasions where it does affect contrast are:
  - Density too high
  - Density too low
    - Cannot assess radiographic contrast
    - Must be at an acceptable level
    - Unless specified, assume that the density is within the ideal range

Scatter – What factors can affect it?

- Based on your knowledge thus far, can you think of what factors would affect the amount of scatter that reaches the IR?
  - Grids
  - Collimation
  - OID
  - Filtration
    - Why do these factors seem familiar?
      - Density – scatter contributes to density, and also affects contrast

Grids

- Review: What is the purpose of using a grid?
- To absorb scatter that leaves the patient before it reaches the IR
- If there is less scatter on an image, contrast is increased
- If the grid ratio (efficiency) is increased, the result is a greater effect on contrast (increased contrast)

Collimation

- When the field size is changed, this affects the amount of tissue being irradiated
- More matter, more scatter
- With more collimation, the field size is smaller, less scatter is produced
- With less collimation, this results in a larger field size, more scatter is produced

OID

- If OID is increased intentionally, it is the air gap technique.
- If this technique is utilized, what happens to the radiographic density and why?
  - Decreased radiographic density as some scatter will miss the IR
  - May require compensation with mAs (increase)
- What happens to the scatter?
  - It is decreased, which then effectively increases the contrast on the image

Filtration

- Review: What happens to the x-ray beam when it is filtered?
  - Low energy photons are filtered out
  - Average energy of the photons will be increased
  - Results in a more penetrating beam
- Due to the increased x-ray energy, scatter is increased, why?
  - Fewer interactions with matter, but increased proportion of Compton interactions vs photoelectric effect (PE)
  - Scatter is increased, contrast is decreased

Subject Factors – the Patient

- This group of factors involve the patient
  - Subject contrast
  - Patient's body part thickness
  - Tissue mass density
  - Atomic number
  - Object shape

Subject Contrast – the Patient

- Results from how body tissues attenuate the beam differently
- Description of the anatomic part
  - Thickness , composition
    - Within the anatomy, how is the tissue attenuating differently? (bone, soft tissue, fat, muscle, air)
    - Similar thickness
      - Low subject contrast – similar composition
      - High subject contrast – greater variance in composition

Patient's Body Part Thickness

- As the thickness increases, the amount of scatter produced also increases
- If scatter interactions increase, the contrast decreases
- Patient thickness has an additional effect on subject contrast, due to attenuation
- A thick part will attenuate more than a thin part, so if the area that is being imaged has areas of differing thickness, subject contrast will increase

Patient's Body Part Thickness

- Compression devices and positioning can help create a more uniform thickness
- Compression devices
  - Paddles, bands
- Positioning
  - PA vs AP
- Decreased thickness will:
  - Decrease patient dose
  - Increase contrast

Tissue Mass Density

- Sections of the body may have equal thicknesses, but different mass densities
- Examples: Fat vs Air vs Bone vs Soft tissue vs Muscle
- Chest and abdomen have similar thickness, but very different tissue mass densities
- The effects of different mass densities on subject contrast can be demonstrated

Atomic Number (tissue)

- This factor also affects subject contrast
- Compton scattering is independent of atomic number, but photoelectric (PE) interactions vary in proportion to atomic number
- If the atomic number of adjacent tissues is very different, subject contrast is high

Contrast Media

- Used to image anatomy with low subject contrast
  - Soft tissue structures most commonly
- PE interactions vary with atomic #
  - With larger differences in atomic #, subject contrast will increase
- Changes absorption characteristics of tissue
  - Increase/decrease attenuation of beam

Contrast Media

- Positive Contrast Agent
  - High atomic number
  - Absorbs more x-rays than surrounding tissues
  - Barium, iodine
- Negative Contrast Agent
  - Low atomic number
  - Decreased attenuation – more transmission
  - Air

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Readings

- Bushong: Radiographic Science for Technologists, 11th ed

Pg 179-181 (Stop before Motion Blur)

Pg 182-183 (Selection of Technique Factors)

Pg 187-191 (Stop before Beam Restrictors)

Pg 204-205 (Air Gap Technique)

Pg 248-251 (Stop before Image Detail)