APPH 226: Grids

Objectives: 5.3, 5.4, 9.3

MRT Program

Grid History

- Invented in 1913 by Gustave Bucky
- Is the most effective means for limiting scatter radiation that reaches the IR
- Improvements have been made to it, but the basic principle has not changed
- Consists of a radiopaque material alternating with radiolucent material

Grid

- Approximately ¼ inch thick and ranges from 8x10 inches to 17x17 inches
- Has very thin lead strips inside with radiolucent interspaces
- Purpose is to absorb scatter from the patient
- Goes in between the patient and IR to improve image contrast

Grids

- As scatter leaves the patient, much of it is directed towards the IR
  - Not great for image quality – image fog
- Ideally a grid would absorb (clean up) all scatter photons and only allow transmitted photons to pass to the IR
- This does not happen, but with proper use, the image contrast can be greatly improved

Grid Construction - Strips

- Grid strips (lines) have a precise height, thickness and space between them
  - Typically made of lead because:
    - Inexpensive
    - Easy to shape
    - High atomic number and mass density

Grid Construction – Interspace

- Purpose: to maintain precise separation between the lead strips
- Aluminum is commonly used for interspace material
  - Nonhygroscopic - does not absorb/retain moisture
  - Easier to manufacture
- Plastic fiber also used
  - However, there is less absorption of the beam at low kVps
- Lead lines and interspace material are then covered with an aluminum front and back panel

Grid Construction

- Grids are described by grid frequency and grid ratio
- Grid Frequency
  - Number of lead lines per unit length (inches/cm/both)
  - Commonly in the 25-45 line/cm range
- Grid Ratio
  - Ratio of the height of the lead strips to the distance between them

Grid Frequency

- When using a stationary high frequency grid, the resultant images will show less distinct grid lines
- Grids with higher frequency have thinner lead strips

Grid Ratio

- Defined as:
- **Ratio of the height of the lead strips to the distance between them**

Grid Ratio = h/d

h= lead strip height D= interspace width

Grid ratio plays a major part in the ability of a grid to improve image contrast

Grid Ratio

- Ratios range from 4:1 to 16:1
  - In general x-ray, typically 8:1 or 10:1 used
- High ratio grids remove/clean up more scatter than lower ratio grids
  - Increase radiographic contrast

Grid Ratio

- The higher the grid ratio, the straighter the scatter must be in order to pass through to the IR
- Scatter must have alignment very close to primary to be able to pass through interspaces
- Meaning higher ratio grids:
  - Remove more scatter
  - Require more accurate positioning of tube
  - Prone to increased grid errors

Grid Cut Off

- What is it?
  - Absorption of the primary beam (transmitted x-rays) by the lead strips
    - 'cut off' from reaching IR
  - Undesirable
  - Loss of radiographic density
  - Can be partial/complete
  - Can occur with any type of grid
  - Causes 'grid errors'

Grid Patterns

- Refers to the pattern of the lead lines of a grid
- Two types of patterns
- Linear
  - Grid lines run in one direction
  - Most popular
- Crossed or Cross hatched
  - Grid lines run in two directions

Crossed or Cross Hatched Pattern

- Lead lines at right angles to each other
- Removes more scatter than linear because there are more lead strips oriented in two directions
- Limited application as the tube cannot be angled
- Very precise positioning required

Crossed Grids

Advantages

- Much more efficient at cleaning up scatter

Disadvantages

- Positioning of grid is critical and CR is critical, must be perfectly centered
- Exposure technique is substantial, higher patient dose

Linear Pattern

- Most commonly used because it allows for angulation along the length of the lines
- Can be:
  - Parallel
  - Focused

Parallel Grid

- Simplest type of grid
- Has lead strips that run parallel to one another
- Easiest to manufacture
- Main disadvantage: cannot avoid grid cut off on image

Parallel Grid

- More attenuation occurs as the x-rays approach the edge of the image receptor (IR)
- Would notice greater radiographic density along center line of IR, but decreasing density towards the sides
- Greater grid cut off will occur with shorter SID

Focused Grid

- Designed to minimize grid cut off
- Lead strips are angled to approximately match the angles of the divergent x-ray beam
- Allows more transmitted photons to reach IR

Focused Grid

- Transmitted photons are more likely to pass through a focused grid to reach the IR than they are to pass through a parallel grid
- Less grid cut off
- Uniform density throughout image when positioned correctly

Focused Grids

- Clearly marked with its intended focal distance and the side that should face the x-ray tube
- If used outside of the intended focal range, grid cut off will occur

Focal Range

- Focal Range
  - Recommended range of SIDs that can be used with a focused grid

Moving Grids

- With stationary grids, grid lines will be produced on the images
- Grid lines
  - Primary x-rays absorbed within the lead strips
  - Although the grid strips are very small, can still see them on an image
  - Can be shown by taking an x-ray of a grid
  - Usually, a high frequency grid has less obvious lines as compared with low frequency grids
    - Not always, the visibility of grid lines is directly related to the width of the grid strips

Moving Grids

- Grid lines appearing on the image is not ideal
  - Adds additional artifact
- Hollis Potter came up with the idea to move the grid during the exposure
  - This would make the grid lines ‘disappear’ without adding to the radiographic technique
- Called a moving grid or Potter-Bucky diaphragm (bucky)

Moving Grids

- Two types of moving grids
- Reciprocating
  - Motor driven
  - Moves back and forth several times during exposure
    - About 2 cm distance for movement
- Oscillating
  - Uses spring like mechanisms with an electromagnet
  - Circular motion

Moving Grids

- Disadvantages:
  - Requires a bulky mechanism that can fail
  - Increased OID due to size of mechanism
    - Increases magnification of image and image blur
  - Motion can be transferred to the cassette holding device, which can result in motion artifacts
- Advantages far outweigh disadvantages, so moving grids are usually the technique of choice and widely implemented

Grid Problems

- Moving grids
  - Incorrect grid installation
  - If grid movement is in the same direction as the grid lines, will be ineffective and grid lines will show on the image
- Stationary grids
  - Most frequent error with focused grids is improper positioning
    - Off level – beam angled across the grid
    - Off focus – wrong SID
    - Off center – not centered to CR (central ray), lateral decentering
    - Upside down

Off Level Grid Error

- Most common grid error
- Occurs when x-ray beam is angled across the grid
  - Can be either tube or grid being angled
  - More commonly with x-ray tube position
- Incident x-rays will be angled across the grid and grid cut off will occur across entire image
- Seen as loss of density over entire IR
- Occurs with both focused and parallel grids

Off Focus Grid Error (wrong SID)

- Using SID outside of focal range for grid
- Will occur if SID is greater or less than the focal range
- More grid cut off will occur with higher ratio grid
- The further the grid is away from the specified focal distance, the more severe the grid cut off will be
- Appears as loss of density along edges of image

Off Center Grid Error

- Also called lateral decentering
- Central Ray is not aligned from side to side with the center of a focused grid
- Because of how the lead lines in the focused grid lay, the divergence of the x-ray beam does not match the angle of these strips
- Appears as overall loss of density over IR

Upside Down Grid Error

- Grid is used upside down
- Most obvious grid error
- Photons will pass easily through the center of the grid as the lines are perpendicular to the IR
- As the lines moving towards the sides are more angled, more photon absorption will occur
- Severe grid cut off on the edges of the image, photons are completely absorbed

Grids and Exposure Factors

- As grid usage decreases the scatter reaching the IR, it also decreases the radiographic density
  - Remember, some of the primary beam is also being absorbed
- As such, when using a grid, the technical factors must be increased to compensate
- Usually mAs is adjusted
- Depends on the grid ratio, we use the grid conversion formula to determine the new technique, mAs

Grid (Bucky) Conversion Factor

Grid Ratio	Grid Factor
No grid	1
5:1	2
8:1	4
12:1	5
16:1	6

Grid Conversion Factor (GCF)

- When converting from one grid to another grid with different ratios, use the grid conversion formula.

$$\frac{\text{mAs1(original)}}{\text{mAs2 (new)}} = \frac{\text{GCF1(original grid)}}{\text{GCF2 (new grid)}}$$

Carlton & Adler 4th edition pg. 547

Grid Conversion Factor

- A technique of 70 kVp and 5 mAs was set for a non-grid exposure. The technologist will use a 5:1 grid for the new exposure, what should the new mAs be?

$$\frac{\text{mAs1 (original)}}{\text{mAs2 (new)}} = \frac{\text{GCF1 (original grid)}}{\text{GCF2 (new grid)}}$$

$$\frac{5\ (\text{mAs1})}{\text{mAs2}} = \frac{1}{2} \qquad \text{mAs2 (new)} = 10$$

Grid Performance Evaluation

- Ability of a grid to improve contrast is specified by:
  - Contrast Improvement Factor
    - Depends on amount of scatter produced
    - Given values for contrast

$$K = \frac{\text{image contrast with grid}}{\text{image contrast without grid}}$$

Contrast Improvement Factor

- If k is 1, then no improvement is seen
- Most grids will have k of 1.5 – 2.5
- This means that the radiographic contrast is increased by 1.5 - 2.5 times
- The higher the k factor, the greater the contrast improvement

Air Gap Technique

- Method to reduce scatter without using grids
  - Helps to increase image contrast
- IR is moved 10-15 cm away from part
- Portion of the scatter will be scattered away from IR and not contribute to the image

Air Gap Technique

- Limitations:
  - Would have to increase technique to maintain radiographic density
  - Magnification of part on image
  - Increased image blur
  - Not as effective with higher kVp settings as more of the scattered x-rays will travel in a forward direction

Readings

- Bushong: Radiologic Science for Technologists 11th Edition:
  - Pg 194-205