SCATTER RADIATION

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Outline lecture(6)

- Control of scatter radiation (beam restrictors)
- The grid (characteristic of grid construction, grid ratio, grid frequency)
- Grid types (linear, crossed, focused, moving grid)
- Digital radiography CT system and mechanism

Objectives

The student should be able to do the followings;

- Describe how to ccontrol scatter radiation (beam restrictors)
- Mention the grid (characteristic of grid construction, grid ratio, grid frequency)
- Differentiate the grid types (linear, crossed, focused, moving grid)
- Explain digital radiography CT system and mechanism

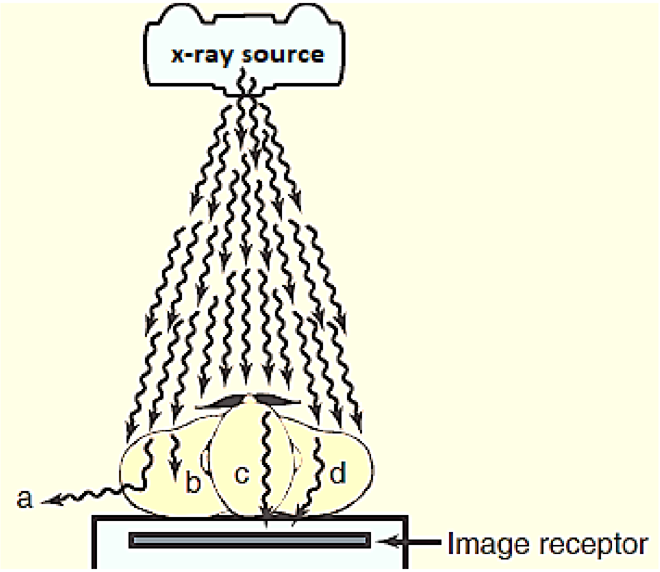
CONTROL OF SCATTER RADIATION

Scatter radiation: the secondary radiation that occurs when x-rays interact with matter, (such as the body) during an imaging procedure and deflected in different directions.

This scattered radiation can expose medical staff and others in the vicinity to unwanted radiation, posing health risks over time

Some x-rays interact with the patient and are

- (*a*): scattered away from the image receptor.
- (*b*): interact with the patient and are absorbed.
- (*c*): transmitted through the patient without interacting
- (*d*): scattered in the patient.



X-rays of types *c* and ***d* are called image-forming x-rays.**

Approximately 1% of x-rays incident on the patient reach the image receptor.

CONTROL OF SCATTER RADIATION

Reduced image contrast results from scattered x-rays.

Two types of devices reduce the amount of scatter radiation that reaches the image receptor:

1- beam restrictors : An aperture diaphragm is the simplest of all beam restricting devices. It is basically a lead or lead-lined metal diaphragm that is attached to the x-ray tube head. Collimation reduces the patient radiation dose and improves contrast resolution.

2- grids.

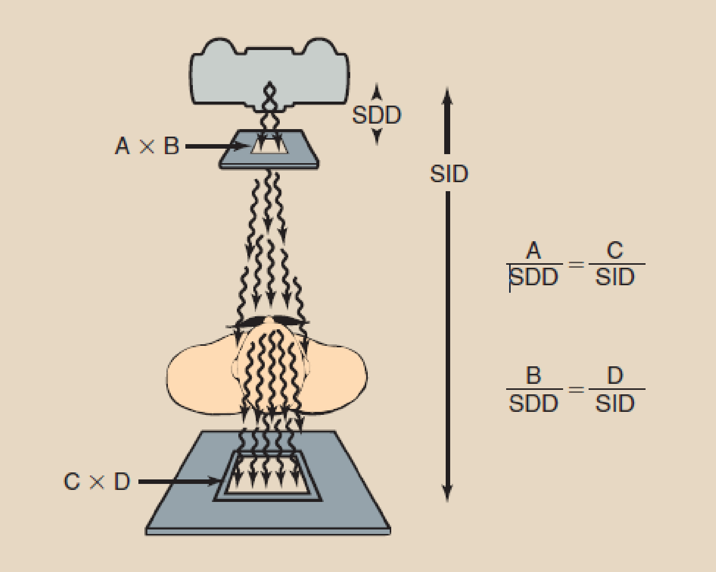


FIGURE 11-12 Aperture diaphragm is a fixed lead opening designed for a fixed image receptor size and constant source-to-image receptor distance (SID). *SDD*, source-to-diaphragm distance.

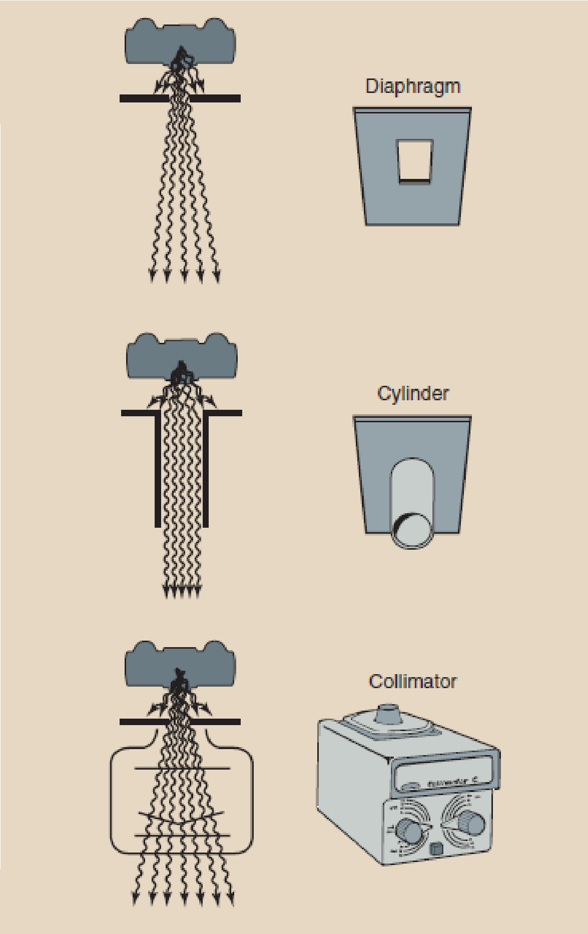


FIGURE 11-11 Three types of beam-restricting devices.

CONTROL OF SCATTER RADIATION

2- grids: The grid is designed to transmit only x-rays whose direction is on a straight line from the x-ray tube target to the image receptor.

X-rays that exit the patient and strike the radiopaque grid strips are absorbed and do not reach the image receptor.

A grid has three important dimensions: the thickness of the grid strip (T), the width of the interspace material (D), and the height of the grid (h).

- **Grid Ratio =** $\frac{h}{D}$ (High-ratio grids increase the patient radiation dose)

Question: A grid is fabricated of 30-μm lead grid strips sandwiched between interspace material that is 300 μm thick. The height of the grid is 2400 μm. What is the grid ratio?

Answer: **Grid Ratio =** $\frac{h}{D} = \frac{2400\mu m}{300\mu m} = \frac{8}{1} = 8:1$

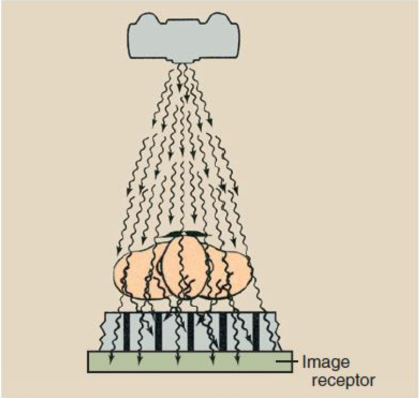


FIGURE 11-18 The only x-rays transmitted through a grid are those that travel in the direction of the interspace. X-rays scattered obliquely through the interspace are absorbed.

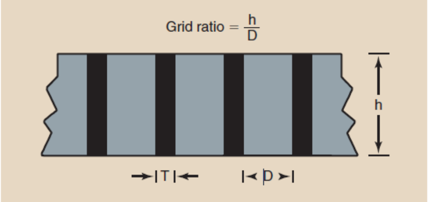


FIGURE 11-19 Grid ratio is defined as the height of the grid strip *(h)* divided by the thickness of the interspace material *(D)*. *T*, width of the grid strip.

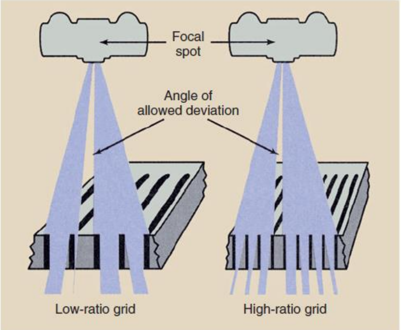


FIGURE 11-20 High-ratio grids are more effective than low-ratio grids because the angle of deviation is smaller.

Grid frequency

The grid frequency: is the number of grid strips per centimetre.

The use of high-frequency grids requires high radiographic technique and results in a higher patient radiation dose.

Most grids have frequencies in the range of 25 to 45 lines per centimetre. Grid frequency can be calculated if the widths of the grid strip and of the interspace are known. Grid frequency is computed by dividing the thickness of one line pair (T + D), expressed in μm, into 1 cm:

$$\boldsymbol{Grid\ frequency = \frac{10000 \mu m/cm}{(T+D)\ \mu m\ /linepair}}$$

Question: What is the grid frequency of a grid that has a grid strip width of 30 μm and an interspace width of 300 μm?

$$Grid\ frequency = \frac{10000}{(T+D)} = \frac{10000}{(30+300)} = 30.3\ lines/cm$$

Grid types (linear, crossed, focused, moving grid)

1- Parallel grid (linear) is constructed with parallel grid strips. At a short source-to-image receptor distance (SID), some grid cutoff may occur.

2- Crossed Grids: are fabricated by sandwiching two parallel grids together so their grid strips are perpendicular.

3- Focused grid: is fabricated so that grid strips are parallel to the primary x-ray path across the entire image receptor.

4- Moving Grid: moving the grids while the x-ray exposure is being made. The grid lines disappear at little cost of increased radiographic technique.

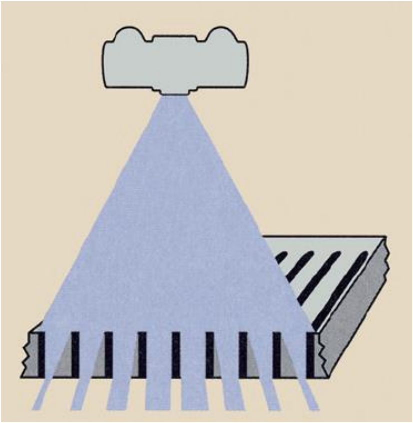
- Focused grids usually are moving grids.

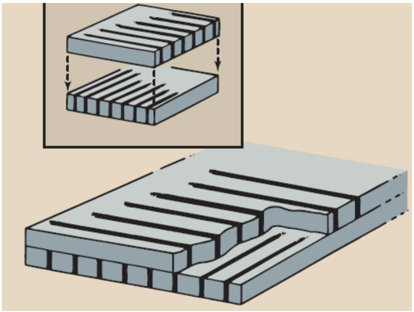
◦ **GRID SELECTION FACTORS**

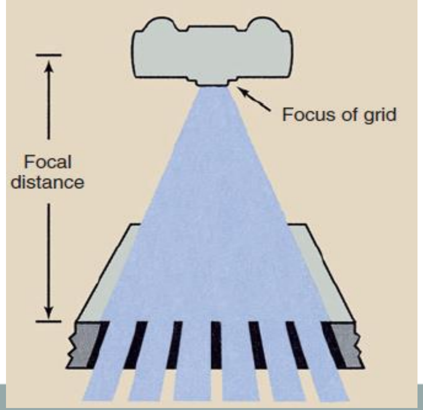
1. Patient radiation dose increases with increasing grid ratio.

2. High-ratio grids are used for high-kVp examinations.

3. The patient radiation dose at high kVp is less than that at low kVp.







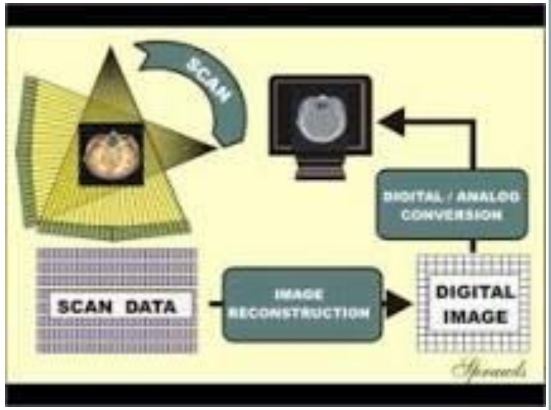
Digital radiography (DR), CT system and mechanism

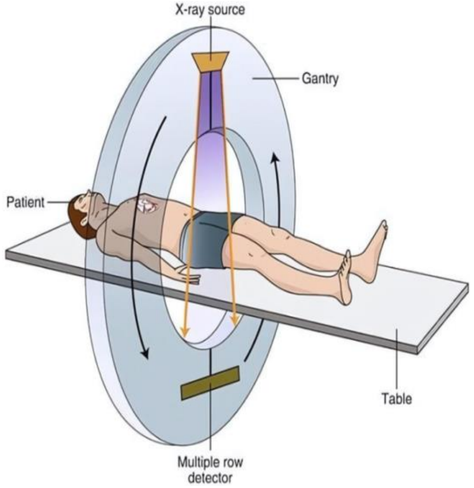
- Computed radiography is a form of digital radiography.
- CT scanners are composed of three important elements: an X-ray tube, a gantry with a ring of x-ray sensitive detectors, and a computer.
- The formation of a CT image is a distinct **three phase process**:

1- The scanning phase produces data, but not an image.

2- The reconstruction phase processes the acquired data and forms a digital image.

3- The visible and displayed analogue image (shades of grey) is produced by the digital-to analogue conversion phase





Digital radiography (DR), CT system and mechanism

- In CT, the x-ray beam moves in a circle around the body. This allows many different views of the same organ or structure and provides much greater detail. The x-ray information is sent to a computer that interprets the X-ray data and displays it in two-dimensional form on a monitor.

Mechanism of CT

- As the x-rays leave the patient, they are picked up by the detectors and transmitted to a computer. Each time the x-ray source completes one full rotation, the CT computer uses sophisticated mathematical techniques to construct a two-dimensional image slice of the patient. It depends on the amount of the x-ray attenuation which is determined by the density of the imaged tissue, and they are individually assigned a Hounsfield Unit or CT Number.
- High density tissue (such as bone) absorbs the radiation to a greater degree, and a reduced amount is detected by the scanner on the opposite side of the body
- Low density tissue (such as the lungs), absorbs the radiation to a lesser degree, and there is a greater signal detected by the scanner.

References

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- Hendee W., and Ritenour E.,. (2002). *Medical Imaging Physics*. Willy-Liss,Inc