CHAPTER 2
ACCESSORIES EQUIPMENT

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At the end of the lesson, the student should be able to:-

» Discuss in brief functions and constructions/types of accessory equipment:-
  » Immobilization Devices
  » Grids
  » Beam Collimating Devices
  » Filters

» Identify the problem and troubleshoot.
1.0 Immobilization Devices

**Functions**

1. To ensure that the patient is in the same position.
2. To reduce radiation dose to the patients.
3. To reduce positioning errors and patient movement during exposure.

- Without proper immobilization, the patient is at risk for improper examinations.
- However, they will not restrain those patients who insist on moving during exposure.
- Commonly used for pediatric and geriatric patients.
Advantages

- Provide **comfortable** and improve **communication**.
- Reduce reliance on patient **cooperation** and **alertness**.
- Lessen the probability of **body motion**.
- Improve the **relationship** between superficial marks and internal structures.
- Reduce positioning time and increase diagnostic **accuracy**.
- Reduce further **injuries** and **complications**.
Example of Immobilization Devices

- Sandbags/Tapes/ Blanket/Sheet
- Sponges/Wedges/Cradles
- Straps
- Bottles
- The Pigg-o-stat (pediatric)
- The Fuller Chair (pediatric)
- Spinal collar (trauma)
- Backboard (trauma)
- Splint (trauma)
TOPIC

CHAPTER 2: Radiographic Equipment and Image Recording

The Pigg-o-stat (pediatric)

The Fuller Chair (pediatric)
CHAPTER 2: Radiographic Equipment and Image Recording

- Wedges
- Sandbags
- Sponges
Cradles

Straps
Spinal collar (trauma)

Backboard (trauma)
CHAPTER 2: Radiographic Equipment and Image Recording

Splint (trauma)
2.0 Grids

**Purposes**

- **Scattered Radiation** is inevitably produced when primary radiation passes through subject.

- Without a grid, **scattered radiation** is produced on the film which degrades the diagnostic quality.

**What is a Grid?**

- Acts as a **filter** to remove **scattered radiation** before it hits the film.
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Grid Components

- Composed of high x-ray transmitting/interspace material and high x-ray absorbing material, each aligned alternatively and regularly.

- Transmitting/Interspace material = aluminium strips

- Absorbing material = lead strips
Grid Ratio

- Height of lead strips compared to Distance between strips.

\[ R = \frac{h}{D} \]

- Typically 5:1 to 12:1
- Grid ratio will increase when the distance between lead strips (D) decreases.
Grid characteristics:

\[ t = \text{thickness of lead strips} \]
\[ h = \text{height of lead strips} \]
\[ D = \text{distance between lead strips} \]

Grid Ratio = \[ \frac{h}{D} \]
High-ratio grid are more effective in absorbing scatter radiation compared to low-ratio grid.

High-ratio grid allows less scatter radiation to pass through the inter-space material.

High-ratio grid has less angle of scatter so it can allow limited radiation to pass through. This means that more scatter radiation can be absorbed.

High-ratio grid increases radiation dose.
Grid Frequency/ Density

⇒ The grid frequency (gf) is the number of lead strips per inch or centimeter.

⇒ An increased gf involves thinner stripes.

⇒ The most used gf is 85 - 103 lines per inch.

\[
\text{Grid Frequency} = \frac{1}{t + D}
\]
Grids with higher grid frequencies have thinner lead strips.

Thinner lead strips will result in high grid ratio. Hence, increasing the x-ray absorption.

Therefore, it requires low kVp technique or high mAs technique. This will increase the patient dose.
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2.0 Grids

**Focal Range**

- Distance from tube to film (SID).
- Ideal to **match grid to SID**.
- Lower ratio grids = wider focal range
- Typically **8:1** true focal range is 100cm but can be used 86-112cm.

Focal range: determined by geometry of lead strips
Focal Range (Cont’d)

➡ Higher ratio grids eg. 12:1, range 92-102cm.

➡ Short, medium, long terms often used to describe focal range.

Focal range: determined by geometry of lead strips
Types of Grids:

1. Focused Grid
2. Parallel Grid
3. Crossed Grid
**Focussed Grid**

- **Lead strips** are tilted progressively as they move away from centre.
- **Grid focus** where perfect alignment of primary beam with lead strips.
- **Designed to minimize grid cutoff.**
- **Lead grid strips** lie on the imaginary radial lines of the circle centered at the focal spot.
- **X ray tube target** should be placed at the center of this imaginary circle.
- **More difficult** to manufacture.
- Every focused grid is marked with its intended focal distance and the side of the grid that should face the x-ray tube.
- Must take care when positioning focused grids because of their **geometric limitations**.
- Has a **sticker in one side** - this side should be placed facing the tube.
Parallel Grid

- Generally not made with grid ratio > 6.0
- Lead strips parallel to each other.
- Strips are never aligned with primary beam since all are vertical (except for strips directly under central ray).
- **Easiest** to manufacture.

- **Grid cutoff** is *most occurred* when the grid is used at a short SID or with a large-area of IR.

- Clean up scattered radiation in only one direction.
Crossed Grid (cross hatch)

- 2 grids on top of each other with lead strips of one perpendicular to other.
- **Not difficult** to manufacture and not excessively expensive.
Tube cannot be angled.

More efficient than parallel grids in cleaning up scatter radiation.

Higher contrast improvement factor.

The x-ray beam must at the center of the grid.
How to use Grids

- Most common is focussed grid.
- Read label to determine focussing distance.
- Establish tube side.
- Use high ratio if used as stationary grid to lessen obvious grid lines.
- Ensure CR is perpendicular to grid to prevent grid cut off.
- Any tube angulation is along lines of grid.
- Increase mAs by 6 steps (4x) when compared to non grid technique.
Grid Movements

TWO basic types of moving grid mechanisms are in used today:

1) Reciprocating grid

2) Oscillating grid
2.0 Grids

1) Reciprocating grid

- A moving grid that is motor-driven back and forth several times during x-ray exposures.
- The total distance of drive is approximately 2 cm.

2) Oscillating grid

- Positioned within a frame with a 2 to 3 cm tolerance on all sides between the frame and the grid.
- The grid oscillates in a circular fashion, coming rest after 20-30 seconds.
Grid Errors (Cut-Off)

- The undesirable absorption of primary x-ray by the grid.
- The attenuation of primary x-rays becomes greater as the x-rays approach the edge of IR.
- Short SID’s result in the vertical, parallel strips absorbing the “diverging” beam at the outer margins of the grid film.
Types of Grid Errors (Cut-Off)

1. Off-Level
2. Off-Centered
3. Off-Focused
4. Upside Down
**Off-Level**

- The central axis/central ray of the x-ray beam is **not perpendicular** to the grid.
- Partial cutoff occurs over the entire IR (image receptor).
- Only this is the problem to parallel, crossed and focused grids.
Off-Centered

- A focused grid that is perpendicular to the central-axis x-ray beam but is shifted laterally, resulting in a cutoff across the entire grid.

![Diagram of off-centered grid](image-url)
Off-Focused

- The center of a focused grid must be positioned directly under the x-ray tube target, so the central ray of the x-ray beam passes through the centermost inter-space of the grid.

- Any lateral shifts result in grid cutoff across the entire radiograph and producing lower OD.
Error in positioning is called Lateral De-centering

- Improper positioning of the grid that results in off-focus.

Major Problem: when radiographs are taken at SIDs unspecified for that grid (not used at the proper focal distance).
The farther the grid is from the specified focal distance, the more severe will be the grid cutoff.

Not uniform across the image receptor but is more severe at the edge.

Positioning the grid at the proper focal distance is more important with high-ratio grids.

Greater positioning latitude is possible with low-ratio grids.
**Upside Down**

- Can easily occur during mobile radiography when in not proper attention.
- Occur when using stationary grid.
- Radiographer mislead placing the grid upside-down during placing on the cassette.
The radiograph appears dark on one side and light on the other.

A radiographic image taken with an upside-down focused grid shows severe grid cutoff on either side of the central ray.
3.0 Beam Collimating Devices

- Use to control scattered radiation and reduce patient dose.
- There are **FOUR** basic types of beam-collimating devices:
  1. Aperture diaphragm.
  2. Cones/Cylinder.
  3. Collimator.
  4. Positive Beam Limitation (PBL)
Aperture Diaphragm

- The aperture diaphragm is flat sheet of metal (usually lead).
- With a hole cut in the center and attached to the x-ray tube port.
- Different diaphragm are needed to accommodate different receptor sizes and different distance.
Aperture Diaphragm (Cont’d)

- The opening can be made in any sizes or shape but most are rectangular, square or round.

- The size of the opening depends on desired
  - exposure field
  - the source to image receptor distance (SID)
  - the distance from the aperture to the focal spot.
The farther the beam restrictor is from the port, the sharper the edge of the expose area will be.
Focal Spot

Penumbra

Film
Cones/Cylinder

- Cones and cylinder are essentially circular aperture diaphragm with metal extension.

- Cones has an extension or flare
  - upper diameter smaller than the bottom flare end.

- Cylinder does not flare.
  - it has the same diameter at the bottom of the extension as it has at the top.
Cones/Cylinder (Cont’d)

The function of cones and cylinders is to expand or collapse the degree of beam restriction.

To reduce penumbra, (a geometric unsharpness around the periphery of the image).
With cone angle as above, this functions as an aperture.

Reduced Penumbra
Cones/Cylinder (Cont’d)

- Cones and cylinders are also relatively inexpensive and simple to use.
- It commonly employed in radiography of:
  - skull radiography
  - spine radiography
  - gall bladder radiography
  - breast radiography
**Collimator**

- Permit an infinite number of field size.
- Provides adjustable rectangular field.
- Provide light source as an aid in proper placing the tube and center ray.
- Collimation is the restriction of the primary beam.
- It is our best tool to reduce patient exposure.
Collimator (Cont’d)

- Collimation must be slightly less than film size OR to the area of clinical interest, which ever is smaller.

- When we go from a large film to a small film with proper collimation, the amount of radiation available to produce the image is reduced.

- The scatter radiation is reduced, improving contrast of the image and patient exposure.
Generally include filter & light

- Filter
- Focal Spot
- Mirror
- Lamp
- Shutters (only 1 set shown)
4.0 Filters

- When the x-ray beam is produced, many energies of photons exist.
- Many are of such low energies that they will offer nothing to the production of the radiograph.
- Metals such as aluminum will absorb the soft low energy rays.
- Filters acts to absorb the low photons energies from x-ray tube.
- This will improve the penetrating ability or quality of x-ray beam.
- As a result, it will reduce the patient exposure as less unnecessary radiation being absorbed by patient.
Types of Filters

1. Inherent Filtration
2. Added Filtration
3. Compensating Filters
4.0 Filters

Inherent Filtration

The leaded glass window of the tube acts as Inherent Filtration.
Added Filtration

- Aluminum is attached to the mirror in the collimator.
- This is called Added Filtration.
Compensating Filters

- Compensating Filters are used to equalize exposure when there is varying densities in the area being radiographed.
- Filters are placed in the less dense area.
- The aluminum filter will block the collimator light but will let the x-ray pass through and a reduced level based upon the thickness of the filter.
## References

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