Radiation Safety for Dental Auxiliaries

Susan W. Grammer, RDH, M.Ed.

Course Content

A. Radiation History and the Use of Radiographs

B. Introduction to Physics

C. X-ray Machine and Production of X-Rays

D. Radiographic Imaging

E. Radiation Biology

F. Radiation Safety

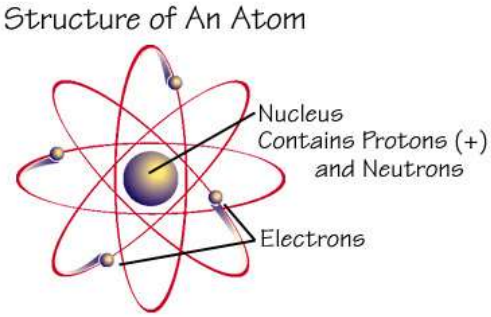
G. Intra-Oral Radiographic Techniques

H. Introduction to Panoramics

A. History and Use of Radiographs

- Wilhelm Roentgen
- Otto Walkhoff, C. Edmund Kells, William Rollins
- Radiographs
  -used in diagnosis, treatment planning, monitoring disease, provide information during procedures
  - Radiograph- Intraoral- high detail, limited area
  - Periapical radiograph- "around the apex" crown, root and 3mm around apex
  - Occlusal radiograph- impacted/embedded teeth, foreign bodies, fractures, salivary stones, large tumors or lesions
  -Extraoral- panoramic, cephalometric

B. Introduction to Physics



- Ionization- collision events,
- effects of ionization

Electromagnetic spectrum

- Properties

Mini- Quiz

1. Who discovered the x-ray?

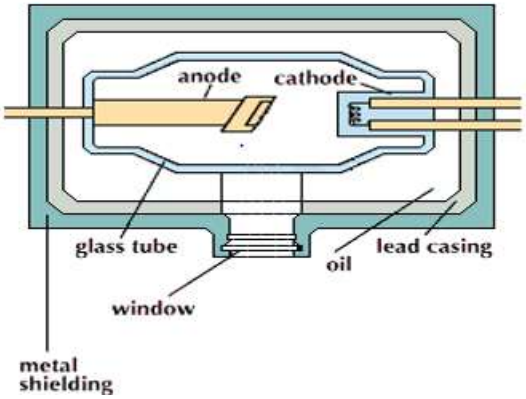
2. Why are we concerned about ionizing radiation?

3. Name a type of electromagnetic radiation:

C. X-Ray Machine and Production of X-Rays

1. **Supporting Arm**
2. **Control Panel**

    a. Milliamperage selector (mA)
    b. Kilovoltage selector (kVp)
    c. Timer
    d. Exposure switch- “dead man”
    e. X-ray emission light and audible signal



3. **Tube Head**

- Cathode-(-) tungsten filament
- Anode- (+) tungsten target, copper sheath
- Transformers
- Oil
- Tube housing- metal
- Filtration- inherent and added
- Collimation

Step by Step – What happens in the tube head:

1. Operator turns on machine and sets exposure factors (mA, time, kVp)
2. Operator holds down exposure button
3. Step-down transformer reduces 110 or 220 volts to 3 to 5 volts
4. Filament heats up- mA tells how many electrons to produce- thermionic emission
5. Step-up transformer (65 to 90 kVp) accelerates electrons to anode target
6. X-rays leave the glass tube – filtered to remove long wavelength, collimated to reduce size of beam, guided through PID (cone)
7. Produces 1% radiation

Types of Radiation

a. Leakage Radiation

b. Primary Radiation

c. Scatter Radiation

d. Remnant Radiation

e. Secondary Radiation

 **Mini Quiz**
1. Name the x-ray tube part that heats up to give off electrons
2. What does the mA (milliamperage) control in the x-ray tube?
3. What does the kVp (kilovoltage) control in the x-ray tube?

D. Radiographic Imaging

- Film and Film Sizes

  -transparent plastic base
  - radiation sensitive silver bromide emulsion
  - lead foil- protects film from "backscatter radiation"
  - black paper
  - embossed dot- tells right from left

#0- periapical and bitewing for small children
#1 anterior periapical adult
#2 periapical and bitewing adults, Occlusal view for small children
#4 occlusal views

- Darkroom Chemistry and Processing- Steps in Chemical Processing
  a. Develop
  b. Rinse
  c. Fix
  d. wash
  e. dry

Automatic processing- series of rollers, concentrated chemical

Safe Light-safe illumination

- Safelight and distance- 4 feet from working area
- Safelight and time- limited working time
- Safelight and filter- manufacture recommendation
- Safelight and wattage- recommended is 15 watts

- Coin test for: safelight problems, light leaks

 **Mini- Quiz**
1. What is the correct sequence for manually developing film?
2. What is found in x-ray film packet?
3. What is the coin test used for?

Imaging Characteristics:

- Film Sensitivity- speed- size of crystals

- Density- degree of darkening

- Contrast- differences in density

- Sharpness or definition

 **Mini- Quiz**
1. What is film speed is determined by?
2. Using the paralleling technique, the central ray makes a right angle with:

E. Radiation Biology

Types of Radiation- ionizing and non-ionizing

Basic Interactions of X-Rays:

-No interaction- 9%
- Absorption- 23%
- Scatter- 56%

Theories of biological effects

- Direct effect- occurs when molecules such as DNA, RNA, proteins, etc receive energy directly from the incident radiation
- Indirect- occurs as result of ionization of water in cell- forms toxin and damages cell

Radiosensitivity of Cells

- Law of Bergonie and Tribondeau
- Cell sensitivity
  - Actively dividing cells are more sensitive than slowly dividing cells
  - Cell is most sensitive during mitosis (cell division)
  - Immature cells are more sensitive than mature cells

Radiation sensitive

- Blood forming
- Small lymphocytes
- Reproductive tissues
- Lens of eye and oral mucosa

Intermediate sensitivity

- Blood vessels
- Connective tissue
- Bone (young)

Radiation resistant

- Mature bone
- Muscle
- nerves

Factors that Determine Radiation Injury

- Total Dose
- Dose Rate
- Area exposed
- Cell sensitivity
- Age

Patient concerns about Radiation- Risk

A. Biological risks in dental radiation are low compared to medical, but patients may be concerned

B. Risks compared to: Background radiation- sources of background radiation

Area of exposure:

- Whole body – High dose
- Whole body- Low dose
- Limited area- High dose
- Limited area- Low dose

F. Radiation Safety and Protection

A. ALARA principle- As Low As Reasonably Achievable
B. Risk vs Benefit

Patient Protection

- ADA and FDA guidelines- recommendations for prescribing dental radiographs
- Every patient is evaluated for radiographs on an individual basis
- Every exposure must be clinically indicated
- No radiograph should be taken unless used for diagnostic purposes

Proper Equipment

- Added filtration- Aluminum filters to remove long wavelength, low energy radiation
- Inherent filtration- glass window, insulating oil, tubehead seal
- Total filtration- State and Federal laws require total filtration (added +inherent) to have 1.5 mm aluminum for x-ray machines operating at or below 70 kVp and 2.5 mm of aluminum for all machines operating above 70 kVp

- Collimation

- Used to restrict the size and shape of the x-ray beam
- May be round or rectangular depending on shape of the opening of the cone
- Beam must be no larger than 2.75 inches at patient's face

- Position Indicating Device (PID) or cone

- Extension of x-ray tubehead used to direct the beam
- 3 types- conical, round and rectangular
    - Conical – no longer used in dentistry because of production of scatter radiation
    - Rectangular- most effective in reducing patient exposure

- Thyroid collar

- lead shield used to protect thyroid gland from scatter radiation
- is recommended (not mandated) for all intraoral exposures- esp in small children and adults with thyroid disorders
- not recommended for extra oral exposures since it obscures information

- Lead apron

- flexible shield placed over chest and lap to protect reproductive organs from scatter radiation
- recommended for intraoral and extra oral –placed on back during panoramic exposures)
- lead free with alloy sheeting are available

- Fast film

- most effective method of reducing patient exposure to radiation
- F-speed film is the fastest intraoral film available
- Digital imaging is 50 to 90% less exposure to patients than intraoral film

- Beam alignment devices

- Film or Sensor holders- helps stabilize receptor in the mouth and reduces chance of movement

- Exposure Factor selection

  - Limits the amount of x-radiation exposure a patient receives
  - Adjusting the kilovoltage, milliamperage and exposure time

- Proper technique

  - Helps ensure diagnostic quality and reduce amount of radiation to patient
  - Images that are non-diagnostic must be retaken which results in additional exposure to patient
  - Proper film/sensor handling/Proper film processing

Operator Protection

- Distance, Positioning and Shielding

- must stand at least 6 feet away from the tube head during exposure
- position at a 90 degree angle from primary beam (travels in straight line)
- protective barriers – (several thicknesses of drywall, cinderblock walls, etc)

  - NEVER hold a film in place during exposure
  - NEVER hold the tube head during exposure
  - NEVER hold the patient

- Monitoring

  -Equipment monitoring- quality control
  -Personnel monitoring- film badge

- Radiation Exposure Guidelines

  - Radiation Safety Legislation- both state and federal government
  -Maximum permissible dose- accumulated lifetime radiation dose for occupationally exposed worker
  -Formula based on workers age MAD= (N-18) x 5 rems/year

 **Mini- Quiz**
1. What does ALARA stand for?
2. On a day-to-day basis what type of radiation are we exposed to the most?
3. What is the purpose of the lead collimator?
4. What is the purpose of the aluminum filter?
5. Where should you stand when operating an x-ray unit?
6. How do we protect the patient from unnecessary radiation?
7. Who can take radiographs in the state of Kentucky?

G. Intra oral Techniques

Types of Intraoral radiographs

- Periapical- records images of full length of teeth and at least 2mm of surrounding bone
- Bitewing- recomrds crowns and coronal 1/3rd of interproximal bone
- Occlusal- records cross-section of dental arches

Intraoral Radiographic Surveys

- Adult FMX-(Dentate) composed of periapical and bitewing radiographs
- Child- Preschool- composed of 4 molar periapicals, 2 bitewings, and 2 occlusal
- Child- Mixed Dentition- identical to adult FMX, but deleting molar periapicals and molar bitewings

Basic Principles in Intraoral Radiography

A. Head position- occlusal plane should be parallel to floor

B. X-Ray beam angulations

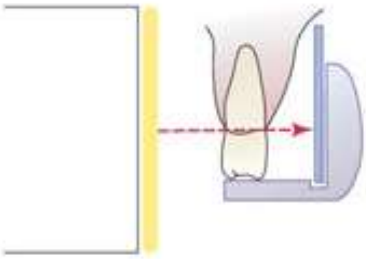
- Central ray- imaginary center of x-ray beam
- Long axis- vertical orientation of teeth
- Angulation- direction the x-rays are directed toward the teeth and film
    - Vertical- up and down
    - Horizontal- movement of tube head around patient

- Point of entry- need to cover the film with the x-ray beam or resulting image will be “cone cut”

Paralleling Technique

- Preferred technique- anatomic accuracy- less distortion
- Fundamentals-

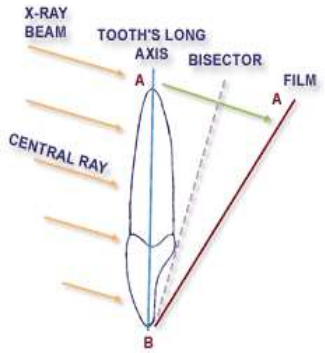
  - Must use film/sensor holder
  - Sensor is placed parallel as possible to long axis of tooth
  - Central ray is perpendicular to tooth and sensor
  - Increase object-sensor distance



Procedure for Paralleling Technique

1. Place sensor in holder and position so it covers prescribed teeth
   - Vertical plane- object sensor should be as parallel as possible
   - Horizontal placement should be parallel to interproximal contacts of teeth
   - Direct patient to slowly close on biteblock
   - Slide ring close to skin and align cone parallel with rod- center cone with ring

Bisecting Angle Technique



- Film is positioned at angle to tooth
- Imaginary line bisects the angle
- Align end of cone parallel to imaginary bisecting line

Procedure for Bisecting Angle Technique

1. Align patient’s head so occlusal plane is parallel to floor and mid-sagittal plane is perpendicular to floor
2. Use film holder and center film behind center of teeth
3. Direct central ray in vertical position so end of cone is parallel to imaginary bisecting line

4. Direct horizontal angulation so central ray does not overlap interproximal areas
5. Look to make sure central ray is completely covering sensor

	**Mini- Quiz**
1. A periapical radiograph should show:	
2. What part of tooth would not be visible on a bitewing radiograph?	

F. Introduction to Panoramics

1. To evaluate impacted teeth
2. To evaluate eruption patterns, growth and development
3 To detect disease, lesions and conditions of jaws
4. To examine extent of large lesions
5. To evaluate trauma

Advantages

1. Requires less technical expertise
2. Easily tolerated by patient
3. Minimal time requirements
4. Maxilla and mandible on single film
5. Radiation dose small

Disadvantages

1. Produces an image that is less sharp- magnification, distortion and poor definition
2. Positioning of patient is critical
3. May not reveal objects that are outside of the focal trough
4. Requires more expensive equipment

Operational Controls

- Time is fixed
- kVp is most common control altered

Pre-Exposure preparation

- load cassette and place into cassette holder (unless digital)
- have patient remove all metallic objects from head
- place lead apron on back and front of patient (do not use thyroid collar)
- explain procedure to patient and talk to them during exposure

Positioning for patient

- stand or sits with spine erect
- anterior teeth placed in bite piece groove
- Head planes:
    - Mid-sagittal- horizontal parallel to floor
    - Occlusal- vertical- parallel to floor
    - Anterior posterior (forward backward) aligned
        - Tongue pressed against palate
        - Lips closed

Panoramic Errors

Patient positioning errors

- Too far forward
- Too far back
- Slumped spine
- Mid sagittal plane rotated or tilted
- Chin too high
- Chin too low

Patient preparation errors

- Metallic objects left in place- earrings, necklace
- Movement of tongue not raised
- Clothing not removed- hats, hoodie sweatshirts
- Processing errors- static electricity, film handling