Radiation Safety for Dental Auxiliaries

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Course Content

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8. **Introduction to Panoramics**

1. Radiation History and the Use of Radiographs

A. Outline- History

- Discovered in 1895
  - Wilhelm Roentgen
  - Recorded on photographic plates
  - Public reaction and Medical Uses

- Dangers of X-rays
  - C. Edmund Kells
  - X-ray properties

- Advances
  - Safety equipment
  - Film
  - Digital

B. Use of Radiographs

- Why?
  - Used in diagnosis, treatment planning, monitoring disease, provide information during procedures

- Intraoral radiograph- high detail, limited area

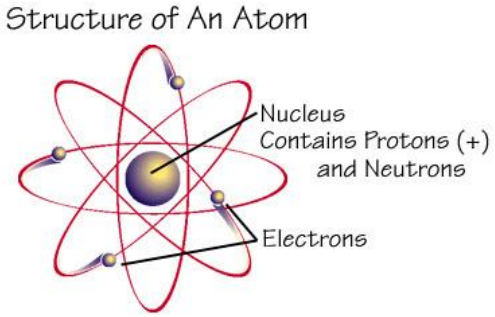
  - Periapical radiograph- "around the apex" crown, root and 3mm around apex
  - Occlusal radiograph- impacted/embedded teeth, foreign bodies, fractures, salivary stones, large tumors or lesions

- Extraoral radiograph- additional information is needed

  - Panoramic- most common
  - Cephalometric
  - PA skull, Waters, TMJ, CT

- Radiographic Selection Criteria
    - Dental Caries
    - Periodontal Disease
    - Other conditions

2. Introduction to Physics



- Atomic Structure
    - Structure of atom
    - Ionization- collision events,
    - effects of ionization
    -
- Types of Radiation
    - Electromagnetic and Particulate
    - Electromagnetic spectrum
    - Properties of Electromagnetic Spectrum
    - Specific Properties of X-Rays

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

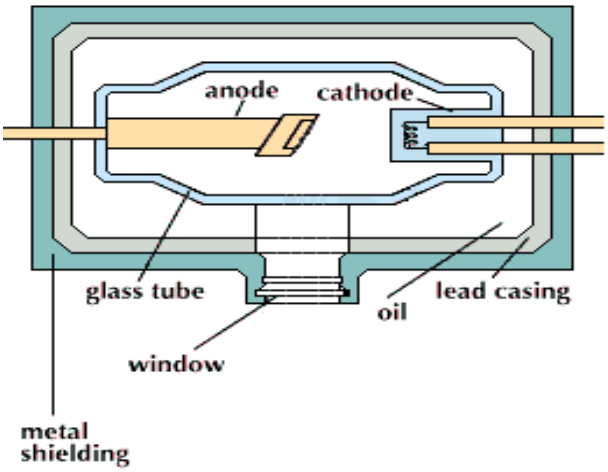
A. Components of X-Ray Equipment

- Supporting Arm
- Control Panel

1. on/off switch
2. Milliamperage selector (mA)
3. Kilovoltage selector (kVp)
4. Timer

5. Exposure switch- “dead man”
6. X-ray emission light and audible signal

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



B. Production of X-Rays

- Step by Step - 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

4. Radiographic Film and Processing

A. Image concepts

- Definitions-
  1. Image receptor- physical media affected by x-rays and produces an image- film, digital sensor
  2. Latent image- invisible image
  3. Visible image- latent image converted to visible image by chemicals

- Film

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

- Film Sizes

#0- periapical and bitewing for small children
#1 anterior periapical adult
#2 periapical and bitewing adults
Occlusal view for small children
#3 bitewings (seldom used)
#4 occlusal views

- Digital Sensors- pixel based

B. Characteristics:

- Film Sensitivity- speed- size of crystals

- Density- degree of darkening

- Contrast- differences in density

- Sharpness or definition

C. Film Handling and Storage

Radiographic film is sensitive to a number of variables

- Improper handling- pressure sensitive- fingernails, bending, dirt, chemical spills
- Heat and humidity- should not be stored at temperatures above 68 F
- Should be stored between 40% and 60% humidity
- Should be stored and handled in darkroom
- Radiation- fog from scatter radiation
- Age- expiration date- indicates maximum shelf life

D. Darkroom Chemistry and Processing

- Steps in Chemical Processing
  1. Develop
  2. Rinse
  3. Fix
  4. Wash
  5. Dry

- Developer :

  - Time/Temperature Method- brings out image
  - Softens and swells emulsion
  - Principle components- Hydroquinone- produces black tones
    Elon- produces grey tones

- Fixer:

  - removes unexposed and undeveloped silver bromide crystals
  - Stops developing action
  - Hardens emulsion to prevent damage

- Automatic processing- series of rollers, concentrated chemicals
  Shortened processing time

- 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

5. Radiation Biology

I. Basic Interactions of X-Rays:

A. No interaction

- X-rays pass through
- Radiolucent area on radiograph (dark space)
- Structures that are easily penetrated- soft tissue, pulp

B. Attenuation

1. Photoelectric Absorption- radiopaque- bone, metal

- Results in production of photoelecton and secondary radiation- both are poorly penetrating and completely absorbed
- Accounts for most interactions in dental radiology

2. Scattering

- Absorption of x-ray and re-emission of x-rays at angles
- Reaches the film and produces fog
- Majority of genetic and somatic exposure and can be hazardous to operator
- Compton scatter- x-rays are deflected and reduced in energy (long wavelength)

II. Mechanism of effects

A. Atomic level-

- energy transfer from ionizing radiation to atoms of biologic tissues
- ionization- loss of electron leaves atom with positive charge

B. Molecular level-

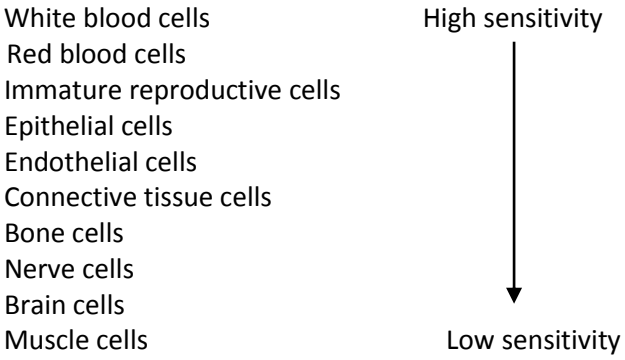
- Direct effect- occurs when molecules such as DNA, RNA, proteins, etc receive energy directly from the incident radiation
- Indirect- occurs as result of ionization of water in cell- forms toxin and damages cell

C. Cellular level-

- Somatic cells- all cells of the body except genetic
- Genetic cells- reproductive cell
- Mechanisms- direct or indirect damage
    - Cell death
    - Disruptions in cell growth
    - Permeability changes
    - Changes in cell motility

D. Tissue level

- 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



E. Organ level

- Critical Organ Concept- certain organs more susceptible to radiation

III. Factors that Determine Radiation Injury

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

IV. Sequence of Events following Radiation Exposure

A. Latent period
B. Period of injury
C. Recovery period

V. Radiation Effects in Dentistry

A. Stochastic Effects- when the dose of radiation is increased, the "probability" of the effect increases, but not its severity

- Cancer
- Genetic mutations

B. Deterministic Effects – effects that increase in severity with increasing absorbed dose

- Erythema (reddening of the skin)
- Epilation (loss of hair)
- Cataract formation

C. Short and long term effects:

1. Short term are seen minutes, days, months after exposure

- ARS- Acute Radiation Syndrome- If dose is arge enough (usually over 100 rads, whole body)
- ARS- erythema, nausea, vomiting, diarrhea, hemorrhage

2. Long term effects are seen years after exposure

- Cancer, birth defects, cataracts, genetic mutations

VI. 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

6. Radiation Safety and Protection

I. Concepts in Radiation Protection

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

II. Patient Protection

A. Prescribing radiographs

- 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

B. Proper Equipment

1. Filtration

- 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

2. Collimation

- Lead plate with a hole where x-ray beam exits the tubehead
- 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

3. 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

4. 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 extraoral exposures since it obscures information

5. 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

6. 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

7. Beam alignment devices

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

8. Exposure Factor selection

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

9. 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
    - Retakes must be avoided at all times
    - Proper film/sensor handling
    - Proper film processing/ image retrieval

III. Operator Protection

1. 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

2. Monitoring

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

3. Radiation Exposure Guidelines

    - Radiation Safety Legislation- both state and federal government
    - Maximum permissible dose- accumulated lifetime radiation dose for occupationally exposed workers

- Formula based on workers age MAD= (N-18) x 5 rems/year

IV. Patient Education

7. Intraoral Techniques

I. 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 images of incisal edges of teeth and cross-section of dental arches

II. Intraoral Radiographic Surveys

- Adult FMX-(Dentate) composed of periapical and bitewing radiographs
- Adult FMX-(Edentulous)- composed of two occlusal films and periapical films
- 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

III. Basic Principles in Intraoral Radiography

A. Long axis of teeth

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

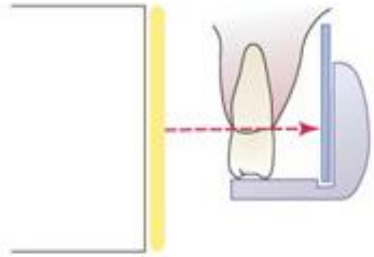
C. X-Ray beam angulations

- 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”

D. 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

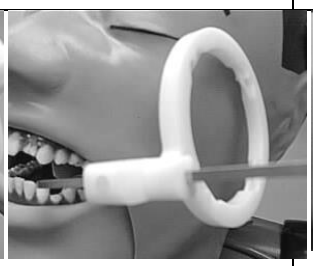
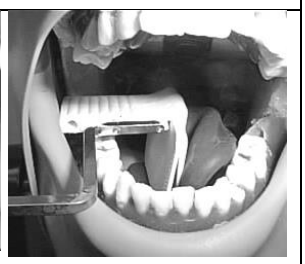
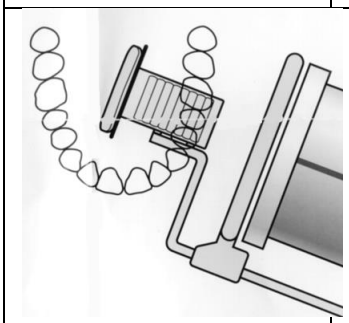
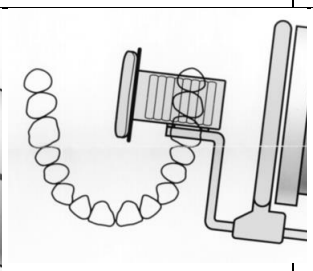
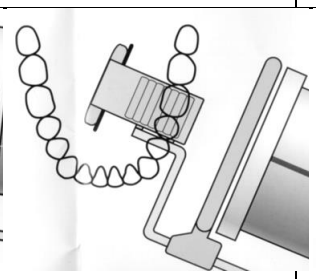
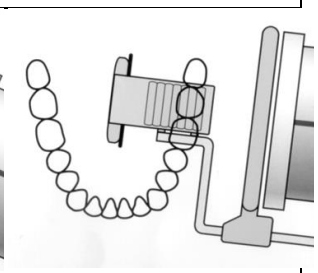


Procedure for Paralleling Technique

1. Place sensor in holder and position so it covers prescribed teeth
   - vertical plane- object sensor distance may need to be increased to be as parallel as possible
   - horizontal placement should be parallel to interproximal contacts of teeth

2. Direct patient to slowly close on biteblock
3. Slide ring to almost contact the skin
4. Align cone so it is horizontally parallel with indicator rod and center x-ray beam in ring

Paralleling Technique Using Rinn XCP Equipment

Maxillary Premolar	Maxillary Molar	Mandibular Premolar	Mandibular Molar
			
			
			

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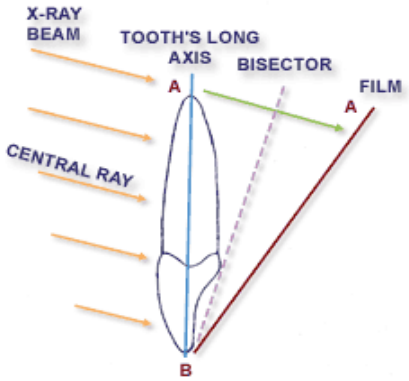
E. Bisecting Angle Technique

Fundamentals

- 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



8. Introduction to Panoramics

I. Principles- Tomography- body sectioning revealing an image layer and Slit Radiography which is a vertical slit aperture

- Wide view of upper and lower jaws
- Positioned outside of mouth
- Both film and tube head rotate around patient

II. Purposes-

A. To evaluate impacted teeth
B. To evaluate eruption patterns, growth and development
C. To detect disease, lesions and conditions of jaws
D. To examine extent of large lesions
E. To evaluate trauma

III. Advantages

A. Requires less technical expertise
B. Easily tolerated by patient
C. Minimal time requirements
D. Maxilla and mandible on single film
E. Radiation dose small

IV. Disadvantages

A. Produces an image that is less sharp- magnification, distortion and poor Definition
B. Positioning of patient is critical
C. May not reveal objects that are outside of the focal trough
D. Requires more expensive equipment

V. Operational Controls

- Time is fixed
- kVp is most common control altered

Pre-Exposure preparation

- sign on to computer and follow instructions if digital
  or
- load cassette and place into cassette holder
- use proper infection control procedures
- 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

VI. Cassettes- Screens- Film

A. Intensifying screens- emit fluorescent light which exposes the film
B. Cassettes- rigid or soft

VII. Focal Trough

A. image layer where structures are well defined
B. Sharpness location of focal trough
C. Magnification areas of focal trough

VIII. Panoramic Errors and Ghost Images

A. Characteristics of ghost images

- opposite side of actual object
- same shape as object
- larger than actual object
- projected higher on film
- less distinct (ghostlike)

B. Patient positioning errors

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

C. 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