MONOGRAPH

COURSE:	DENF 2703 Oral and Maxillofacial Radiology I: Introduction to X-radiation & Intraoral Techniques
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LECTURE OUTLINE

I. History of Oral Radiology

II. Radiation Physics

   A. Atomic structure

   B. Electromagnetic radiation

   C. X-ray tube

   D. X-ray production

   E. The physics of x-ray absorption

III. Radiation Biology

   A. Interaction of x-rays with matter

   B. Radiosensitivity of cells and tissues

   C. Somatic and genetic effects

IV. Health Physics

   A. Sources of radiation exposure

   B. Mechanisms of radiation thrift

   C. Radiation safety

V. Guidelines for Prescribing Radiographs

   A. Images of disease states

   B. Patient disease risks

VI. Imaging Principles and Techniques

   A. Characteristics of film images

VII. Projection Geometry

   A. Paralleling long cone technique

   B. Bisecting angle technique

   C. Image distortion

VIII. Intraoral Radiographic Examinations

   A. Film placement and beam direction

B. Recognition of technical errors

IX. Processing X-Ray Film

A. Latent Image Production

B. Photographic Characteristics of X-ray Film

C. Processing solutions

D. Processing techniques

X. Normal Radiographic Anatomy

XI. Infection Control

XII. Digital Radiography

XIII. Radiographic Quality Assurance

SECOND YEAR RADIOLOGY LABORATORIES

Laboratory A

Please review the Dentsply Rinn x-ray technique training video and the Dentsply Rinn Intraoral Radiography with XCP (e**X**tension **C**one **P**aralleling) Manual to become familiar with the XCP instruments furnished in your instrument kit, prior to attending your first lab session. This manual is available to you at no charge and it will prepare you for examination questions that will be in your first mid term examination. If you require further information, please do not hesitate to contact any of the radiology staff or faculty.

There will be a demonstration at the beginning of the lab on the use of the following: x-ray tube head, Dental X-ray Teaching and Training Replica (DXTTR), control panel, exposure factors, processors and darkroom. You will be instructed on the proper method for exposing the **RIGHT & LEFT** - **MAXILLARY** and **MANDIBULAR** anterior periapical views, including the central incisor views using F-Speed film with XCP instruments. Following this instruction you will be expected to expose the periapical views. After exposing the radiographs, you will process and mount all films.

Laboratory B

During this laboratory period you will be instructed on the proper method for exposing the **RIGHT** & **LEFT MAXILLARY** and **MANDIBULAR** premolar and molar periapical views using F-Speed film and XCP instruments. Following this instruction you will be expected to expose the periapical views. After exposing the radiographs, you will process and mount all films.

Laboratory C

During this laboratory period you will be instructed on the proper method for exposing the **RIGHT** & **LEFT** premolar and molar bitewing (BW) views using F-Speed film with XCP instruments. Following this instruction you will be expected to expose the bitewing views. After exposing the radiographs, you will process and mount all films. You will then be shown how to evaluate your radiographs. You will be expected to evaluate your first Full Mouth Survey (FMS) of intraoral radiographs and turn it in by 5:00PM.

Laboratory D

NOTE: YOU WILL BE ASSIGNED A GRADE ON THIS FMS TAKEN DURING LAB D & LAB E.

During this laboratory period, the Electronic Patient Record (EPR) and MiPACS archival imaging software will be used. You will be assigned a Pseudo-Patient file for mounting, filing and storing the digital images taken during this radiology lab.

Demonstration.

Using **P**hoto**S**timulable **P**hosphor (PSP) Plates with XCP, expose the **RIGHT** - **MAXILLARY** and **MANDIBULAR** periapical views, including central incisor and BW views. Scan and mount in MiPACS, then save in the local temporary (radiology) database / server. Obtain approval of images from a technician and save to the EPR permanent database / server. After this step images can be retrieved from the EPR.

Laboratory E

Demonstration.

Using PSP Plates with XCP, expose the **LEFT MAXILLARY** and **MANDIBULAR** periapical views and BW views. Scan and mount in MiPACS, then save in the local temporary (radiology) database / server. Obtain approval of images from a technician and save to the EPR permanent database / server. After this step images can be retrieved from the EPR. You will be expected to evaluate your second completed FMS, print and turn it in by 5:00PM. **NOTE: YOU WILL BE ASSIGNED A GRADE ON THIS FMS**

Laboratory F

During this laboratory period you will be instructed on the proper method for exposing the **RIGHT MAXILLARY** and **MANDIBULAR** anterior periapical views, including the central incisor views and premolar and molar BW views using PSP Plates with Stabe® biteblocks and BW tabs. After exposing the radiographs, you will process and mount all films.

Laboratory G

During this laboratory period you will be instructed on the proper method for exposing the **RIGHT MAXILLARY** and **MANDIBULAR** premolar and molar periapical views using PSP Plates with Snap-A-Ray® film holders and Stabe® biteblocks. After exposing the radiographs, you will process and mount all films. You will be expected to evaluate your third FMS (½ ONLY) and turn it in by 5:00PM.

Laboratory Practical Examination

This examination will consist of exposing and mounting a partial FMS taken on a DXTTR. This practical examination must be turned in no later than the end of the practical exam time period. Room and time assignments will NOT be assigned by original lab groups. Time assignment will be determined based on the time students finish the 2703 written final exam on Dec 8th and the 2562 final exam on Dec 10th. **ALL ASSIGNMENTS MUST BE COMPLETED AND TURNED IN PRIOR TO TAKING LAB PRACTICAL EXAMINATION.**

CLINIC ATTIRE MUST BE WORN AS A MANDATORY REQUISITE FOR ATTENDANCE DURING ALL LAB SESSIONS AND DURING THE LAB PRACTICAL EXAMINATION.

YOU WILL NOT BE PERMITTED TO ATTEND THE LAB SESSIONS OR THE PRACTICAL EXAM WITHOUT PROPER CLINIC ATTIRE.

RADIOGRAPHIC RECOGNITION OF ANATOMICAL LANDMARKS AND RESTORATIVE MATERIALS AS TO THEIR RADIODENSITY

In order to help you interpret the radiographic appearance of anatomical landmarks, tooth structure and common restorative materials, the following list has been prepared as to their radiodensity (radiopaque/radiolucent).

RADIOPAQUE ANATOMIC LANDMARKS

Alveolar crest
Anterior nasal spine
Border of nasal cavity
Cancellous bone
Cementum
Coronoid process
Dentin
Enamel
External oblique ridge
Genial tubercles
Hamular process
Internal oblique ridge (mylohyoid)
Lamina dura
Lower / inferior border of mandible
Maxillary sinus septa and walls
Maxillary tuberosity
Mental ridge / protuberance
Nasal conchae
Nasal membrane
Nasal septum
Nasolabial Fold
Soft tissue of lip
Soft tissue of the nose (tip and ala)
Pterygoid plate
Zygomatic arch,

- zygomatic (malar) bone
- zygomatic (malar) process of maxilla

RADIOLUCENT ANATOMIC LANDMARKS

Canine eminence / lateral fossa
Incisive canal
Incisive (nasopalatine) foramen
Lingual foramen
Mandibular canal
Maxillary sinus
Median palatal (intermaxillary) suture
Mental foramen
Mental fossa
Nasal fossa
Nutrient canals
Periodontal Ligament Space
Posterior superior alveolar (PSA) canal
Pulp
Submandibular gland fossa

RADIOPAQUE RESTORATIVE MATERIALS

Amalgam
Calcium hydroxide paste
Cements
Composite resins (microfils and hybrids)
Glass ionomers
Gold
Gutta percha
Orthodontic appliances
Porcelain
Silver points
Titanium

RADIOLUCENT RESTORATIVE MATERIALS

Acrylic resins
Composite resins (old formulations)

QUALITY CRITERIA FOR FULL-MOUTH RADIOGRAPHIC SURVEY

1. Cover the complete area of interest with the film. For periapical views at least 2 mm of bone beyond the lamina dura of the apex should be visible. If pathology is evident or suspected, an occlusal, panoramic or other extraoral view of the area may be required.

2. When taking bitewing views, the proximal surfaces should not overlap.

Accurate images are a result of proper film placement and proper cone positioning. Many factors influence the resultant radiograph including length of the cone, type of film used, intraoral technique used, exposure parameters, and film processing.

FILM HOLDING INSTRUMENTS

1. XCP (Paralleling technique or bisecting angle)
2. Precision
3. Snap-a-Ray®
4. Stabe bite blocks®
5. Tongue blade and tape
6. Hemostat

USE OF THE VARIOUS FILM-HOLDING INSTRUMENTS

1. XCP:
   a) may be used on most patients
   b) smaller bite blocks are used on pedo patients
   c) cotton rolls are used on both sides of the bite blocks for edentulous areas
   d) bitewing views, both horizontal and vertical, may be made with the special BW bite block

2. Precision:
   a) an all metal instrument collimated to the film size at the face shield.

3. Snap-a-Ray:
   a) may be used on most patients very effectively, but as a rule only on the maxillary arch when teeth are present
   b) very useful for maxillary impacted third molars
   c) may be used on completely edentulous patients with effective use of cotton rolls.

4. Stabe (styrofoam) bite blocks:
   a) disposable and easily adapted
   b) may be used on most patients except small children
   c) extended backing area for good film support
   d) may be used in any area with effective use of cotton rolls.

5. Tongue blade and tape:
   a) very effective for special problem areas, requires the patient's assistance in stabilizing
   b) useful for most endodontic views
   c) useful for gagging edentulous patients
   d) can be used for impacted third molar views and in cleft palate patients.

6. Hemostat:
   a) easy to manipulate and position
   b) best for periapical images of the anterior jaws and posterior mandible
   c) lack of back support for the film often causes image elongation from film bending

COMMON CAUSES OF UNSATISFACTORY RADIOGRAPHS

I. INCORRECT DENSITY (FILMS TOO LIGHT OR TOO DARK)

A. FILMS TOO DARK (HIGH DENSITY)

1. Overexposure
   a. excess exposure time
   b. excess kVp
   c. excess mA
   d. source-film distance too short
   e. double exposure

2. Overdevelopment
   a. developing time too long
   b. developer temperature too high
   c. overconcentrated developer

B. FILMS TOO LIGHT (LOW DENSITY)

1. Underexposure
   a. insufficient exposure time
   b. insufficient kVp
   c. insufficient mA
   d. source-film distance too long

2. Underdevelopment
   a. inadequate developing time
   b. developer temperature too low
   c. diluted, expired or contaminated developer

II. FILM FOG

A. DARKROOM ERRORS

1. Improper safelight intensity, filter color or distance to worksurface
2. Light leaks from door, vents, ceiling panels, etc.
3. Prolonged exposure to safelight

B. PROCESSING ERRORS

1. Overdevelopment (see A.2)
2. Underdevelopment (see B.2)
3. Underfixation

C. FILM ERRORS

1. Improper storage (temperature or humidity too high)
2. Use of outdated film

III. LACK OF CONTRAST

A. kVp, EITHER TOO HIGH OR TOO LOW

B. FILM FOG

C. UNDERDEVELOPMENT

D. UNDEREXPOSURE

IV. SPOTS ON RADIOGRAPHS

A. LIGHT SPOTS

1. Contamination with fixer before processing
2. Film contacting other film (or processing tank) during development
3. Oily fingerprints

B. DARK SPOTS

1. Contamination with developer before processing
2. Black paper wrapper stuck to film
3. Excessive bending
4. Contaminated fingerprints
5. Film contacting other film (or processing tank) during fixation
6. Static electricity (lines or smudges)

C. YELLOW OR BROWN SPOTS

1. Insufficient rinsing
2. Contaminated with developer or fixer after processing

D. WHITE SPOTS

1. Emulsion tears due to rough handling
2. Dirt or particles on film or rollers
3. Air bubbles on film during processing

E. GREEN SPOTS

1. Overlapped film areas in rollers of automatic processing

V. BLURRED RADIOGRAPHS

A. PATIENT MOVEMENT DURING EXPOSURE

B. MOVEMENT OF THE X-RAY TUBE DURING EXPOSURE

VI. PARTIAL IMAGES

A. CONE-CUTTING (incorrect alignment of tube and film)

B. PROCESSING ERRORS IN MANUAL TANKS

VII. OTHER

A. FADED IMAGE

1. Inadequate fixation (fog)
2. Exhausted fixer (fog)
3. Insufficient rinsing (yellow fading)

B. RETICULATION

1. Sudden or extreme temperature changes during processing
2. Frozen emulsion

C. HERRING BONE (CHEVRON) OR STIPPLED PATTERN

1. Film placed backward

COMMON OPERATOR ERRORS

The following is a list of the most common operator induced errors seen on completed radiographs. Please be aware that there are many other errors associated with the selection of exposure parameters and in film processing.

Error	Correction
Glasses left on patient	Instruct patient to remove glasses
Dental prosthesis left in mouth	Instruct patient to remove prior to exposure
Blurring due to patient movement during exposure	Instruct patient to remain immobile
Foreshortening and elongation of image due to incorrect film placement or central ray angulation	Place film parallel to long axis of teeth and central ray perpendicular to film
Overlapping of interproximal perpendicular to film	Direct central ray through interproximal surfaces and
Area in question not covered	Check film placement prior to exposure to ensure correct area of coverage (e.g. premolar view should include distal of canine)
Partial image (cone cut)	Make sure that the central ray is centered on the film, and positioning instruments (XCP) properly assembled
Apices or crowns of teeth "cut off"	Place film correctly to cover area
Identification dot appears on apex of teeth	Always place film with identification dot towards occlusal or incisal surface of tooth
Double image on film	Keep exposed and unexposed film separated
Blank film	Make sure audible tone is heard during the exposure

AMERICAN ACADEMY OF ORAL AND MAXILLOFACIAL RADIOLOGY

THE USES OF X-RAYS IN DENTISTRY

QUESTIONS AND ANSWERS

In recent years the public has been increasingly concerned about the potential risks from radiographic (x-ray) examinations.

Information provided by the news media regarding dental radiographs is generally well-intentioned but frequently fragmented and confusing. Alarming reports concerning ionizing radiation, although more anecdotal than factual, promote patient misunderstanding. As a result, dentists are confronted by patients who either have a multitude of questions about radiographs or have resolved to have no more "x-rays" under any conditions.

Although the patients' concerns are legitimate, they often cause the dentist to expend considerable appointment time justifying the need for radiographs. When the explanation of technical factors becomes difficult, the exchange may deteriorate into a situation in which the dentist feels his professional judgment is questioned. Serious damage to the patient-doctor relationship may result, sometimes causing the patient to leave the practice. This is unfortunate for both dentist and patient.

The following material presents some of the questions most frequently asked by patients with brief, direct answers. Explaining to the patient the limitations on diagnosis when radiographs are lacking is relevant to informed consent. Patients should understand that the ordering of radiographs by the dentist is based upon the reasoning that the benefit of the information gathered is greater than the risk from the minimal amount of ionization radiation received.

When patients are well informed, they can more reasonably discuss and understand the need for diagnostic radiographs the dentist prescribes.

Q: Are dental x-rays really necessary?

A: Yes. Dental radiographs (x-rays) are often essential for diagnosis and treatment of conditions that can threaten a patient's oral and general health. Many disease processes of the teeth and surrounding tissues may not be apparent in a visual examination by the dentist. Without the use of radiographs, such conditions as small as carious lesions (cavities), cysts, tumors, and bone loss from periodontal (gum) disease may go unnoticed until more obvious signs and symptoms develop. By the time these disease processes become more apparent, treatment is more time-consuming, extensive and expensive than if they were diagnosed early with the aid of radiographs. There is always the risk that undiscovered oral disease may adversely affect a patient's general health or even become life-threatening.

Q: How often are dental x-rays needed?

A: The decision to take radiographs (x-rays) must be made by the dentist after an oral examination and be based on the health needs of the individual patient. New patients may need a full-mouth series of radiographs to determine the conditions of the mouth and to establish a basis for analyzing later changes. X-rays provide the only means for the dentist to "see" inside and to evaluate conditions that require detailed investigations such as a toothache, a loose tooth, or jaw pain as the result of previous dental treatment.

Q: Could a dentist seeing a patient use x-rays taken by the previous dentist instead of ordering new ones?

A: Yes. Previous radiographs would be useful to the dentist for comparative purposes, to evaluate changes that may have taken place in the mouth and to determine how long these changes took to

occur. If the previous radiographs are of good diagnostic quality (if they show the right areas clearly), the dentist may not need to take a complete new series of radiographs when he first sees the new patient.

Q: How often should children have dental x-rays?

A: The appropriate interval between radiographs (x-rays) must be determined by a dentist for each child based on individual health conditions. In general, children will need radiographic examination more frequently than adults because they generally are more susceptible to caries (cavities), which can be detected earlier with the use of radiographs.

Q: If the patient is pregnant or thinks she might be, must dental x-rays be postponed?

A: Not necessarily. Studies have recorded no detectable radiation to the fetus from dental x-rays when a lead apron is used. However, the possibility of a minute amount of radiation being scattered internally by the patient's head must be considered. For this reason, extensive radiographs are traditionally avoided during pregnancy. Patients should understand that restricting radiographs may limit the dentist's diagnosis and subsequent treatment planning. If a diagnosis to a dental problem during pregnancy will make the pregnancy more comfortable and safer, then diagnostic radiographs are indicated.

The patient should inform the dentist if she is pregnant, or thinks she might be.

Q: Should the decision to take dental x-rays be dependent upon a patient's prior radiation history?

A: No. The decision to take radiographs (x-rays) should be determined by the dentist on the basis of the expected benefit to the patient. If the radiographs are expected to provide information essential to the patient's dental care, they should be taken regardless of prior radiation history.

Q: Should a patient who has had radiation therapy for cancer of the head and neck undergo dental x-ray examination?

A: Yes. Dental infection can be extremely serious for patients who have received radiation therapy to the head and neck, because of the reduced ability of the irradiated tissue to heal. Therefore, dental radiographs (x-rays) are especially important for these patients, because they greatly enhance early detection and control of developing infections.

Q: Do the x-rays belong to the patient or the dentist?

A: Patient records, including radiographs (x-rays), are the property of the dentist and frequently provide the basis for present or future treatment. The patient has the privilege of reasonable access to the records, such as requesting in writing that a copy be sent to another dentist.

Q: What does a full-mouth series of dental x-rays consist of?

A: A full-mouth series of radiographs (x-rays) consists of radiographs of all teeth and tooth-bearing areas of the jaws. The number of radiographs needed will depend on the technique used, the number of teeth present, the patient's age, and individual anatomic variations (shape of the mouth structures). For an adult, a full-mouth series or radiographs will usually consist of at least 14 films.

Q: When should dental x-rays be retaken?

A: Dental radiographs (x-rays) should be retaken only if necessary to accurately diagnose and treat the patient. Patients should not be subjected to retakes to achieve technical perfection rather than clinical acceptability. A full-mouth series of dental radiographs should show each tooth or tooth-bearing area clearly and accurately.

Q: What is the purpose of the dental x-ray machine that rotates around the head? How much radiation does the patient receive from it?

A: This is a panoramic type of radiographic (x-ray) unit. It produces a single large radiograph that shows both upper and lower jaws, including areas that are not seen on the full-mouth series of smaller radiographs. Since the machine rotates, the amount of exposure received is different for each part of the head and it is not possible to directly compare the exposure values of this technique and others.

Q: Is it reasonable to use a panoramic x-ray instead of a full series of regular dental x-rays?

A: Some dentists use a panoramic radiograph (x-ray) combined with bitewing radiographs (x-ray pictures of the crowns of the posterior teeth) for diagnosis, rather than the full-mouth series. Others feel the best evaluation may be derived from the complete full-mouth series because the panograph has limited applications. Panoramic radiographs may prove helpful for determining the general condition of the patient's oral health, or confirming the presence of large lesions (cysts, tumors) and fractures, but they do not reveal the fine detail required to demonstrate dental caries (cavities) or bone loss from periodontal (gum) disease making supplemental radiographs frequently necessary.

Q: Who takes the x-rays in the dental office, and what kind of training is required?

A: Dental radiographs (x-rays) are taken by dentists, dental hygienists, and dental assistants. Each position has specific qualifications and training requirements which may differ among schools and states. The dentist has the final responsibility to ensure diagnostic quality radiographs are taken with minimal patient exposure.

Q: What regulations govern safe performance of dental x-ray equipment?

A: Since 1974, Federal laws have regulated the manufacture of dental radiographic (x-ray) equipment, ensuring that it meets safety standards. After installation in the private dental office, x-ray equipment is required to be tested every three years in the state of Texas.

Q: Have recommendations been made to dentists concerning the use of x-radiation?

A: Yes. The American Academy of Oral and Maxillofacial Radiology, in conjunction with the American Dental Association, the National Council of Radiation Protection and the Bureau of Radiologic Health of the Food and Drug Administration, has developed recommendations to limit radiation exposure. The latest recommendations in radiographic practices were published in 1988. An updated draft document is currently (2001) being revised. By following these recommendations, the dentist will obtain the needed diagnostic information with the least radiation exposure to the patient.

Q: What harmful effects can x-rays have on the body?

A: Two types of effects can be caused by ionizing radiation (x-rays). They are termed "somatic effects" and "genetic effects". Somatic effects occur in tissues of the body such as the skin of the face. Genetic effects are changes in the reproductive system which alters the genetic material in the reproductive cells. Permanent changes in genetic material would only become apparent in future generations.

With modern techniques and safe equipment, the risk of either kind of harmful effect from dental x-ray exposure is extremely small.

Q: How much exposure do the reproductive organs receive from dental x-rays?

A: With currently recommended dental radiographic (x-ray) techniques and equipment, exposure to the unshielded testes for a 21-film full-mouth series of dental radiographs with “D-speed” film is 0-36 milliroentgens (mR). For the unshielded female, exposure to the ovaries is about one-fifth as

much. Using proper radiographic techniques reduces this gonadal radiation to near zero for both males and females.

Q: Are there any new techniques or equipment being developed to further reduce radiation exposure to the patient?

A: Yes. Research is constantly being conducted to decrease the exposure patients receive during a radiographic (x-ray) examination while retaining or improving the level of diagnostic information. Present research includes development of direct digital radiography, new film processing methods, image intensification techniques, fiber optic transilluminating devices and magnetic resonance imaging.

Q: How much exposure does the skin of the face receive from dental x-rays?

A: This can vary with the technique and equipment used. Using "D-speed" film the range of skin exposure will be about 150 to 500 milliroentgens (mR) per bitewing film, depending upon the kilovoltage (kVp) selected. If a long-cone, paralleling technique with high kVp is used with appropriate filtration, exposure (0.1 to 0.5 seconds) and the small diameter of the beam (2.75 inches), there is practically no possibility of damage to the skin. "E-speed" film, a faster film than the "D-speed", will further reduce the exposure by about 50% of the “D-speed” exposure. In 2000, an “F-speed” film was introduced, which reduces “E-speed” exposures by 25%.

Q: Is the risk of cancer increased by exposure to dental x-rays?

A: Not to any measurable extent. Any x-ray exposure may have the potential to damage cells. However, the radiation exposure to tissues of the head and neck during a dental radiographic (x-ray) examination is so small that the chance it will contribute to cancer is extremely low.

Q: How much radiation do the eyes and thyroid gland receive from dental x-rays?

A: Radiation exposure to the eyes and thyroid gland from dental radiographs (x-rays) varies with the technique and equipment used. Under current radiographic recommendations, the amount of radiation to these areas is not considered great enough to produce harmful effects to these tissues. Exposure to the thyroid can be further reduced by the use of a leaded thyroid shield. This shield cannot be used with a panoramic machine because it blocks out part of the jaw.

Q: Can dental x-rays cause cataracts?

A: Several studies indicate that the low doses of radiation used in diagnostic dental radiographs (x-rays) do not contribute to cataracts.

Q: What are the units of measurement for x-rays?

A: The most common terms for the measurement of x-rays are the "roentgen" (R) and the "rad". The roentgen represents the absorption of x-ray energy in air. The RAD measures the energy absorbed by tissue, this measurement indicates the likelihood of somatic and genetic changes in the body. For diagnostic dental and medical x-rays, this figure is so low it is usually expressed in millirad (mrad) units which are equal to one one-thousandth (1/1000) of a RAD. In dental radiology, the roentgen and RAD are numerically the same. The metric equivalent terms for the roentgen and the RAD are coulombs/kg and gray, respectively.

Q: What is natural background radiation?

A: Natural background radiation is the radiation we receive from natural sources surrounding us and from the food we eat. These sources include cosmic rays and radioactive substances in the earth's

surface. All people are exposed to such radiation during their lifetime. The amount of exposure varies greatly from place to place on the Earth's surface.

Q: Why do the dentist and the dental assistant leave the room when x-rays are being taken?

A: The radiation a patient receives from dental x-rays is minimal. If the dentist and the assistant did not leave the room or stand behind a barrier, they would be exposed several times a day, every day, to radiation which provides no benefit to them. Although this amount of radiation is very small, it is prudent for the dental staff to avoid any unnecessary x-ray exposure.

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