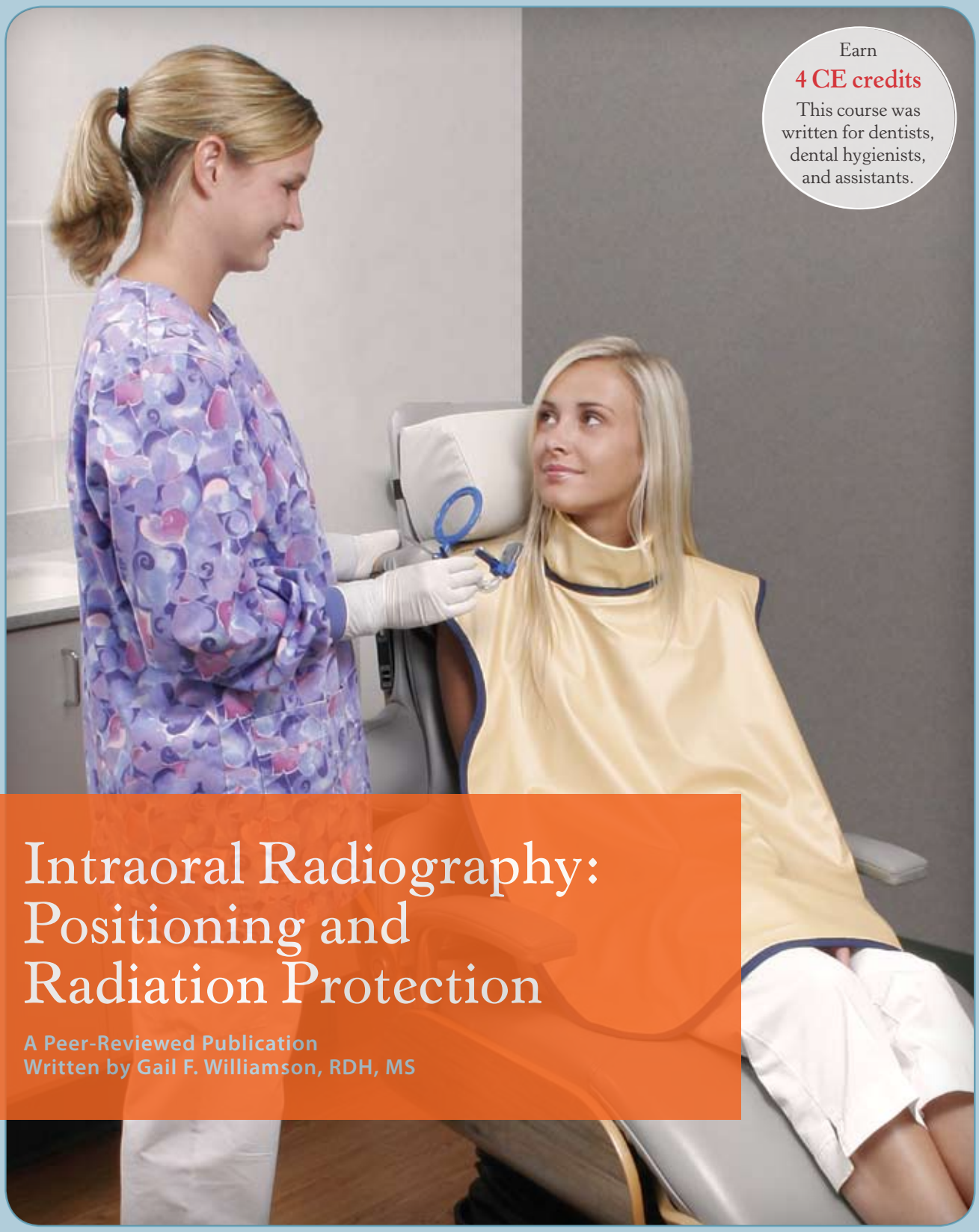

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Intraoral Radiography: Positioning and Radiation Protection

A Peer-Reviewed Publication
Written by Gail F. Williamson, RDH, MS

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Educational Objectives

Upon completion of this course, the clinician will be able to do the following:

1. Understand the various types of intraoral radiographs that can be taken and what these are used for
2. Know how to correctly use the paralleling and bisecting techniques to take intraoral radiographs
3. Know common errors that occur when taking intra-oral radiographs and how to avoid these
4. Know how to minimize radiation exposure for patients and the operator

Abstract

Several types of intraoral radiographs can be taken. An understanding of both the paralleling and bisecting techniques and when to use these is necessary. Avoiding common errors when taking intraoral radiographs reduces the need for retakes. Minimizing radiation exposure for patients and the operator is an essential component of intraoral radiography.

Introduction

X-rays were discovered in 1895 by Professor Wilhelm Conrad Roentgen, and Dr. Otto Walkhoff is credited with the first dental radiograph. Until the 1980s, dental radiographs were typically captured using film. Dr. Frances Mouyens invented direct digital radiography to take intraoral dental radiographs in 1984, and this technology was introduced into the U.S. in 1989. While the use of digital radiography in dentistry continues to gain strength, film-based radiographs are still more common. The complete transition to digital radiography is just a matter time.

Intraoral dental radiographs fall into two main categories: bite-wings and periapicals. Bite-wing radiographs are the best diagnostic tool available for the detection of interproximal caries and assessment of alveolar bone levels. Bite-wings are usually taken in the posterior regions of the mouth. However, size 1 bite-wings can be taken of the anterior teeth to assess anterior bone levels. Periapical radiographs record the entire tooth and supporting bone and are used to evaluate the extent of caries and periodontal bone loss and aid in the diagnosis and treatment of root and bony pathoses. Periapicals and bite-wings can be combined to form surveys of varying configurations, for a comprehensive view of the entire dentition. Intraoral radiographs can be captured using film or digital receptors. Digital receptors are available as wired and wireless rigid sensors (CCD — charge-coupled device; CMOS — complementary metal oxide semiconductor) and photostimulable phosphor plates. Both systems are computer-based technologies that require specific hardware and software components for operation. Digital receptors are available in sizes comparable to film, mostly typically sizes 0, 1, and 2.

It has been estimated that in 1999 a total of 384 million sets of radiographs were taken, of which 170 million were a complete series.[1] This demonstrates the importance and value of radiography in the diagnosis and treatment of oral disease.

	Number taken (in millions)
Full-mouth series	170.20
Periapical	80.30
Bite-wing	112.80
Panoramic	20.80

Source: ADA. The 1999 Survey of Dental Services Rendered.

Dental radiographs should be prescribed according to selection criteria guidelines and taken only for diagnostic and treatment purposes. Selection criteria guidelines are based on evidence of disease patterns and take into consideration the patient's medical and dental history, clinical signs and symptoms of disease, risk factors, age and dentition, and new or recall patient status. Only bite-wing radiographs have time-based intervals that are determined according to risk factors for caries. For a complete review of these recommendations, refer to "The Selection of Patients for Dental Radiographic Examination, Revised 2004."[2]

Dental radiographs are valuable diagnostic tools when the image quality is adequate for proper interpretation. Film-based and digital dental radiographs both require the use of careful technique and precautions to maximize the diagnostic and interpretative value of the radiograph while at the same time minimizing patient exposure to radiation.

Key Objectives

- Maximize diagnostic value of X-rays
- Minimize patient exposure to radiation

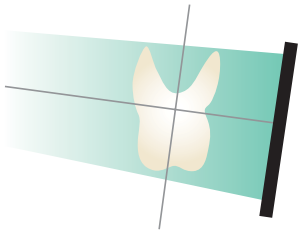
Maximizing the diagnostic value of radiographs starts with having the correct receptor (film, plate, or sensor) position, ensuring that the X-ray beam is centered and aligned at the correct vertical and horizontal angulations and exposed at the correct time.

Positioning Guidelines for Intraoral Radiographs

Accurate positioning is key for diagnostic radiographs and helps avoid retakes. Intraoral radiographs are taken using paralleling, bisecting, and bite-wing techniques. Devices used to accomplish this include receptor instruments with ring guides, standard biteblocks, and bite-wing tabs.

Paralleling Technique

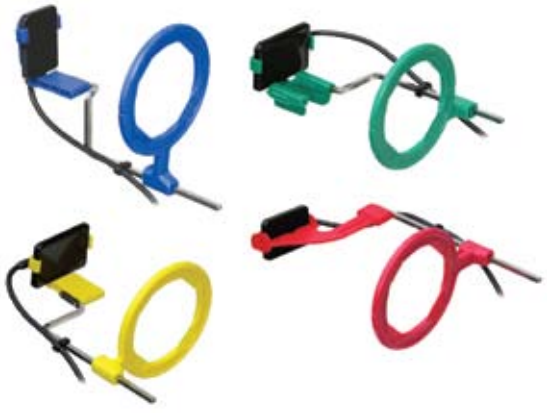
The paralleling technique is used for both periapical and bite-wing radiographs and is the most accurate technique for taking these projections. For film or digital radiographs, the receptor should be placed vertically and horizontally parallel with the teeth that are being radiographed. The X-ray beam should be directed at right angles to the teeth and receptor.



In the case of periapical radiographs, the film or digital receptor should be placed parallel to the full length of the crown and root of the teeth being imaged. The paralleling technique for bite-wing radiographs is simpler in the sense that the radiograph is more easily placed in the patient's mouth even if the palate is shallow or the patient gags easily.

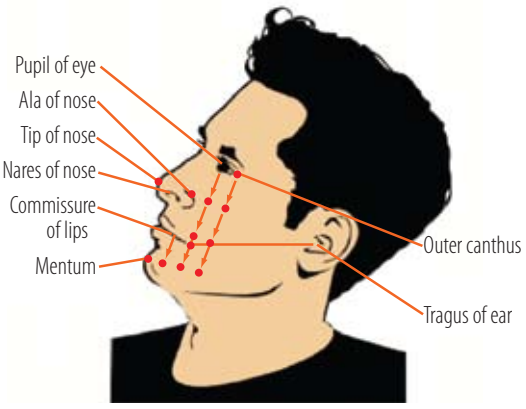
Film and Digital Receptor Instruments

Receptor instruments with X-ray beam ring guides improve the accuracy of the PID (Position indicating device, or X-ray cone) alignment to ensure correct beam angulation and beam centering. Receptor instruments combine a receptor holder with an arm that has an attached ring indicating the position for the PID. This helps the operator avoid common errors by specifically directing the X-ray beam toward the receptor. Regardless of the instrument used, the placement of the receptor relative to the teeth must be correct. Instruments are available for paralleling, bisecting, and bite-wing techniques, as well as for endodontic imaging where endodontic files and instruments may otherwise impede proper positioning of the receptor behind the tooth.



Great care is necessary when placing the X-ray beam at right angles to the receptor, to avoid common errors. Incorrectly directing the beam in the horizontal plane will result in overlapping proximal contacts on bite-wing or periapical radiographs, making them diagnostically useless and resulting in a retake. Similarly, if the X-ray beam is not correctly centered over the receptor, cone cuts can occur on the image, with a clear zone where the X-rays did not expose the receptor. Central ray entry points help to identify the center of the receptor by using an external landmark. In the case of periapical radiographs, improper vertical angulation can produce image foreshortening and elongation that misrepresents the actual length of all structures including the teeth.

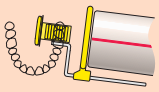
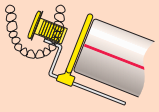
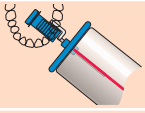
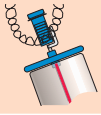
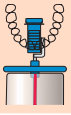
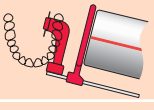
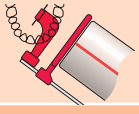
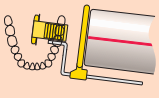
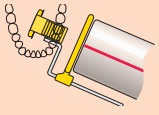
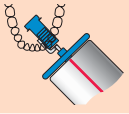
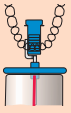
Central Ray Entry Points



Common Errors

Rigid digital receptors are more difficult to use initially, may result in more errors for both periapical and bite-wing radiographs compared to traditional film, and can cause more discomfort for the patient. To avoid these problems, rigid receptors should be placed close to the midline to aid proper placement and to reduce discomfort. It is particularly important if a patient has a shallow palate or floor of mouth to employ this method, both to avoid discomfort and to avoid distortion of the image. The rigid sensors have a slightly smaller surface area for recording the image than traditional film does. Therefore, accurate positioning of the receptor and X-ray beam is even more critical to avoid cone cuts and crown or apical cut-offs. Due to the sensor's rigidity, more errors have been found than with the use of traditional film; more horizontal placement errors occur posteriorly, and more vertical angulation errors anteriorly.[3] This can be overcome with experience and understanding of the differences between rigid receptors and film. Phosphor plate receptors are more flexible and thinner than the other digital sensors but have the same dimensions as film, thus making the transition from film to digital radiography somewhat easier. However, the plates must be handled carefully, scanned to digitize the image, and exposed to intense light before they can be reused.

Projection Or View	Receptor Placement	Teeth Recorded	Central Ray Entry Point
MAXILLARY PERIAPICALS			
Molar periapical	Place the receptor toward the midline and the biteblock under the 2nd molar crown, and align the mesial edge of the biteblock between the 1st and 2nd molar contact point	1st, 2nd, 3rd molar teeth crowns and apices	Point down from the outer canthus (corner) of the eye to midcheek area
Premolar periapical	Place the receptor toward the midline and the biteblock under the 2nd premolar crown, and align the mesial edge of the biteblock between the 1st and 2nd premolar contact point	Distal of the canine, 1st and 2nd premolar, 1st molar crowns and apices	Point down from the pupil of the eye to mid-cheek area
Canine periapical	Place the receptor lingual to the canine, with the biteblock centered with the cusp tip	Mesial and apex of the canine	Ala (corner) of the nose
Lateral incisor periapical	Place the receptor lingual to the lateral incisor and the biteblock under the lateral incisor crown	Mesial, distal, and apex of the lateral incisor	Nares (nostril) of the nose
Central incisor periapical	Place the receptor lingual to the central incisors, and center the biteblock with the central incisor contact point	Mesial, distal, and apices of the central incisors	Tip of the nose
OPTION			
Canine-lateral periapical	Place the receptor lingual to the canine and lateral; center the biteblock with the lateral-canine contact point	Mesial and apex of the canine, mesial, distal, and apex of the lateral incisor	Ala (corner) of the nose
BITE-WINGS			
Molar bite-wing	Align the mesial edge of the tab between the 1st and 2nd molar contact on the mandible	Maxillary and mandibular molar crowns in occlusion	Point down from the outer corner of the eye to the occusal plane
Premolar bite-wing	Align the mesial edge of the biteblock between the 1st and 2nd premolar contact on the mandible	Distal of the maxillary and mandibular canine, premolar and 1st molar crowns in occlusion	Point down from the pupil of the eye to the occusal plane
MANDIBULAR MOLAR PERIAPICALS			
Molar periapical	Place the receptor toward the tongue, place the biteblock on the 2nd molar crown, and align the mesial edge of the biteblock between the 1st and 2nd molar contact point	1st, 2nd, 3rd molar teeth crowns and apices	Point down from the outer canthus (corner) of the eye to the mid-mandible area
Premolar periapical	Place the receptor toward the tongue, place the biteblock on the 2nd premolar, and align the mesial edge of the biteblock between the 1st and 2nd pre-molar contact point	Distal of the canine, 1st and 2nd premolar, 1st molar teeth crowns and apices	Point down from the pupil of the eye to mid-mandible area
Canine-lateral periapical	Place the receptor lingual to the canine and lateral with biteblock centered with the contact point	Distal of the lateral and mesial of the canine and apices	Point down from the ala (corner) of the nose to the chin corner
Central incisor periapical	Place the receptor lingual to the central incisors, and center the biteblock with the central incisor contact point	Mesial and distal of the central incisors and mesial of the lateral incisors and apices	Point down from the tip of the nose to the chin center

Receptor Orientation	Receptor Size	Image
Horizontal placement; dot toward crown	Size 2	
Horizontal placement; dot toward crown	Size 2	
Vertical placement; dot toward crown	Size 1	
Vertical placement; dot toward crown	Size 1	
Vertical placement	Size 1 or 2	
Vertical placement	Size 2	
Horizontal or vertical placement; dot toward mandible	Size 2	
Horizontal or vertical placement; dot toward mandible	Size 2	
Horizontal placement; dot toward crown	Size 2	
Horizontal placement; dot toward crown	Size 2	
Vertical placement	Size 1 or 2	
Vertical placement	Size 1 or 2	

Rough handling may produce plate scars, result in image artifacts, and necessitate plate replacement, making them less user-friendly in these instances.

Bite-wing Tabs

For patients who gag easily or children, tab bite-wings are less cumbersome and more comfortable for the patient than instrument holders.

Correct Bite-wing Positioning

Position the receptor parallel to the interproximal spaces, not to the teeth being radiographed; otherwise, overlapping will occur.

Bite-wing tabs hold the digital receptors or traditional film in position intraorally. Neither has any directional capability for PID positioning and beam direction. However, careful placement and beam alignment will produce good results. The vertical angulation is typically set +5° with the beam centered to the tab. The tab should be aligned with the teeth contacts, which will indicate the correct horizontal angulation. Central ray entry points will help with X-ray beam centering, as will using the lines on the PID that indicate the direction of the X-rays. Universal holders are available that can be used for rigid digital sensors.

Bisecting Technique

The bisecting technique may also be used for periapical radiographs. In this case, the receptor is placed diagonal to the teeth. The beam is then directed at a right angle to a plane that is midway between (bisects) the receptor and the teeth. This technique produces less optimal images because the receptor and teeth are not in the same vertical plane. However, it is a useful alternative technique when ideal receptor placement cannot be achieved due to patient trauma or anatomic obstacles such as tori, shallow palate or shallow floor of the mouth, short frenum, or narrow arch widths.

This technique is more operator-sensitive. If the angle is not correctly bisected, elongation or foreshortening will occur. A variety of film holders can be used for different locations in the mouth for accurate positioning of the receptor. One approach the clinician can use is to align the PID parallel to the receptor initially and then reduce the vertical angle about ≈10°, which will approach the bisecting plane. Also, starting angles can be used that will get the operator close to the bisecting plane in each area of the mouth. These angles can be aligned using the angle meter on the side of the X-ray head.

Arch	Molar	Pre-molar	Canine	Incisor
Maxilla	+15° to +25°	+25° to +35°	+40° to +50°	+40° to +50°
Mandible	+5° to −5°	−10° to −15°	−10° to −15°	−10° to −15°

Long PIDs include 12- to 16-inch lengths, but the standard 8 inch length PIDs can be used for paralleling as well. The longer PID length collimators reduce image magnification and improve sharpness and result in less image distortion. Right-angle entry of the X-ray beam improves anatomic accuracy and correct image length.

Special Conditions While Positioning

Gagging

Gagging patients can be challenging and require patience and reassurance from the clinician. It is important to be organized, pre-set the exposure time, pre-align the PID, and be ready to act quickly. The most common area to elicit the gag reflex is the maxillary molar periapical view. Placement of the receptor toward the midline and away from the soft palate will reduce the tendency for gagging. There are a variety of strategies that will help manage the gagging patient: breathing through the nose, salt on the tongue, distraction techniques (lifting one leg in the air, bending the toes toward the body, humming), use of topical anesthetics, and tissue cushions on the receptor. Similar approaches can be useful when the patient experiences discomfort from the receptor, particularly the use of topical anesthetic agents and receptor cushions.

Radiation Considerations

It is incumbent upon dental professionals to ensure that in the process of taking dental radiographs, both the patient and the operator are protected as much as possible from the harmful effects of radiation. It has been known since shortly after their discovery that X-rays can result in biological damage.[4] Short-term effects of radiation result from a high dose over a short period of time — for example, the severe illness and rapid onset of death following a nuclear bomb explosion. Long-term effects result from the cumulative effect of low doses of radiation over an extended period of time and can include cancer and genetic abnormalities.

The risk of dental radiograph-induced idiopathic disease is extremely low. To put this in perspective, full-mouth radiographs (20 films) using F speed film and rectangular collimation equal one to two days of background radiation.[5] The risk of fatal cancers as a result of exposure to full-mouth dental X-rays using E+ speed film has been estimated to be 2.4 per million patients.[6] Nonetheless, dental professionals must protect their patients and themselves by minimizing exposure and risk.

Anatomical Variations

Shallow Palates	• Move receptor towards midline • Consider using bisecting technique instead of paralleling technique
Presence of tori	• Ensure maxillary tori are between the teeth and receptor • Try to avoid mandibular tori • Place receptor deeper in mouth if there are mandibular tori, avoid tipping of receptor • Consider using bisecting technique instead of paralleling technique
Narrow arches	• Place receptor as far lingually as possible • For mandibular anterior region, place receptor on dorsum of tongue • Use compact size holders with rounded edges • Consider using bisecting technique instead of paralleling technique
Edentulous situations	• Place receptor deeper in mouth
Endo	• Place receptor deeper in mouth if necessary to avoid endodontic instruments

IV. Minimizing Radiation Exposure

There are numerous methods that can be employed to minimize patients' exposure to radiation. Together these methods can significantly reduce patients' exposure.

Number of Radiographs Taken

Since radiation exposure has a lifetime cumulative effect, only essential dental radiographs should be taken. Keeping the total number of radiographs to a minimum requires an assessment of their necessity on a patient-by-patient basis. This is the purpose and goal of selection criteria.

Retakes contribute to an increased number of radiographs and as a result increased radiation exposure. Operator technique must be optimal to avoid retakes. Critical factors include accurate receptor placement,

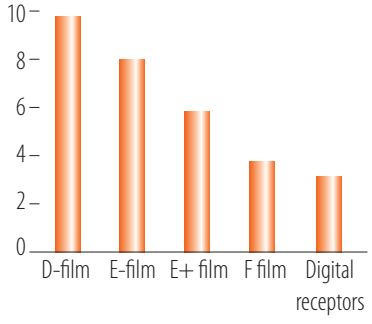
proper angulation and beam centering, effective patient management, use of the correct exposure time, and careful processing for film-based imaging.

Processing errors occur only with film and result in the greatest number of retakes, exposing patients to needless radiation.[7,8] To avoid these, the developer and fixer solutions must be used according to correct time-temperature regimens and renewed and replenished regularly along with provision of regular processing maintenance and optimal darkroom conditions.

Receptor Selection

For film-based radiography, F speed film is recommended. The speed of the film depends upon the sensitivity of the emulsion to the X-ray beam. The faster the film, the shorter the exposure time and the less the total radiation delivered to the patient. F speed film requires 60% less exposure time than D speed film does. Digital receptors are faster than film and are 60% faster than E speed film.[9] The table below shows the relative radiation exposure for different types of film on a scale of 1–10.

Film Speed and Relative Radiation Exposure



Source: Frederiksen NL. Health Physics. In: Pharoah MJ, White SC, eds. Oral Radiology: Principles and Interpretation. 4th ed. St. Louis: Mosby; 2001.

Digital radiographs expose patients to less radiation on a per-radiograph basis. Additionally, digital radiographs are in general quicker to take and view than radiographs using film. However, this ease-of-use, particularly for rigid receptor systems, has been found to be a factor in a higher number of radiographs taken when digital radiography is used.[10] As a result, while the individual radiograph exposes the patient to less radiation, cumulatively this may not be the case if extra radiographs are taken. The same study found that the ease-of-use also resulted in offices being more likely to take more radiographs.

Studies have found that digital radiographs in general are as useful as film radiographs for diagnostic purposes.[11,12] Computerized image enhancement of digital radiographs allows the viewer to change brightness and contrast and to invert, color, measure, or magnify the image. The ability to view the image in different formats may aid in diagnosis and, in some cases, compensate for otherwise less-than-ideal radiographs, making them usable;[13] as such, image enhancement may contribute to a reduced absolute number of retakes.

Limiting the Number of Radiographs

- Individual patient assessment of necessity and number required
- Operator technique to minimize retakes
- Avoiding the temptation to take extra digital radiographs because of ease-of-use
- Consideration of alternative diagnostic tools

X-ray Beam Filtration and Collimation

X-ray beams contain both high-energy and low-energy photons. Low-energy photons would be absorbed by the patient; to minimize this exposure, beam filtration is used. It is important to use a machine with a kilovoltage between 60 and 90 kV to reduce radiation doses to the patient, optimally in the range of 60 to 70 kV.[14]

Beam collimation limits the diameter of the beam at the patient's face, which should not exceed 7 cm, or 2.75 inches. Both round and rectangular collimators are available; the rectangular collimator reduces the beam's diameter more and exposes 60% less tissue compared to round collimators.[15]

Several options are available for rectangular collimation: semi-permanent rectangular PIDs from the x-ray machine manufacturer or a secondary removable rectangular collimator that is affixed to the standard round PID.

Radiation Protection

Patient Protection

Patients rely upon dental professionals to provide safe and effective treatment. Patient protection includes the use of lead collars and may include the use of lead aprons. Lead collars are designed to protect the thyroid, and they fit around the patient's neck. They have been found to substantially reduce radiation to the thyroid during dental radiographic examinations.[16]

Lead aprons are considered optional by the American Association of Oral and Maxillofacial Radiology unless legally mandated.[17] However, considering the fact that dental professionals are to comply with the ALARA (As Low As Reasonably Achievable) principle and patients should be protected as much as possible, providing patients with added protection through the use of lead aprons is appropriate. Selection criteria guidelines recommend patient shielding as an extra precaution during dental exposures, in particular children, women of childbearing age, and pregnant women.[18] Lead aprons are available in child and adult sizes. Lead aprons are available with a built-in thyroid collar, in which case a stand-alone lead collar is not required.

The lead contained in lead aprons and collars is thin and malleable, and if the apron or collar is folded or left in a heap, the lead can be bent and damaged, resulting in areas of the collar or apron being lead-deficient. Collars and aprons should be hung up to avoid damage.

Annual inspection of lead aprons for defects is mandatory, and test results must be recorded.[19] Inspection should occur immediately if cracks or other damage are suspected. Testing of lead aprons involves the use of a radiographic examination (or fluoroscopic examination) of the apron. If the apron is damaged, it must be appropriately discarded and a new replacement apron used.

Operator Protection

Primary radiation is that which is generated at the anode target, collimated, and directed toward the patient to take the radiograph. To avoid this, the operator must never stand directly in the X-ray beam directed at the patient, even though it may be tempting to hold a film in position for a patient having difficulty cooperating or to help a patient sit still in the correct position. Patient or film-holding must never be done and on a repeated basis would have a cumulative effect upon the operator.

Patient and Operator Protection from Radiation Exposure

Primary Radiation	• Provide patient with lead collar and apron • Minimize total exposure • Operator must not stand directly in the primary beam
Scatter Radiation	• Operator must stand behind a barrier or stand a minimum of 6 feet from the X-ray source and at an angle of 90°–135° from the beam
Leakage Radiation	• Same operator precautions as for scatter radiation • Regular maintenance for X-ray unit

Scatter radiation results from the beam interacting with the surface of the patient, causing radiation to bounce as scatter in different directions. The third type of radiation is leakage that emanates from the X-ray tube head. To avoid scatter and leakage radiation, the operator must either stand behind a barrier or stand at a minimum 6 feet away from the radiation source and at an angle of 90°–135° to the X-ray beam. Barriers need not be lead-lined. Dental office operatory walls constructed of drywall are found to be adequate.[20]

Operators should comply with the MPD (maximum permissible dose), to limit their occupational exposure, to the lesser of either a total effective dose of 5 rems/year (0.05 Sv); or, the sum of the deep-dose and committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rems (0.5 Sv). The limit for pregnant radiation workers is 0.5 rems (5 mSv).

The best method to avoid occupational exposure is to consistently practice safety rules as described above.

Regular X-ray machine inspection and maintenance is necessary to ensure not only that the machine is delivering the appropriate radiation to patients, but also to check for sources of leakage radiation and proper filtration and collimation and if necessary to correct inadequacies.

Summary

Dental radiographs are valuable diagnostic tools and expose the patient to minimal amounts of radiation. Nonetheless, dental professionals must ensure that both they and patients are protected from the harmful effects of cumulative exposure to radiation. Patients can be protected through the use of lead collars and aprons and by ensuring that only necessary radiographs are taken and that radiation exposure is kept low. Operator protection involves standing behind barriers, avoiding standing in or near the primary beam,

and regularly maintaining X-ray equipment. One of the critical factors in minimizing the number of radiographs is to ensure that retakes are not required due to improper technique or processing problems. Receptor instruments are valuable tools that guide the X-ray beam, thereby helping to increase the accuracy of dental radiography.

Endnotes

1 American Dental Association. 1999 Survey of Services Rendered.
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Author Profile

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Professor Gail F. Williamson is a professor of Dental Diagnostic Sciences in the Department of Oral Pathology, Medicine, and Radiology at Indiana University School of Dentistry. She serves as Director of Allied Dental Radiology and Couse Director for Dental Assisting and Dental Hygiene Radiology Courses. Professor Williamson serves on the Council of Sections Administrative Board of the American Dental Education Association.

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Cone cut and overlap images from ADTS course, *Successful Intraoral Radiography* by William S. Moore, DDS, MS

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Questions

1. _____ is credited with the first dental radiograph.
   a. Professor Roentgen
   b. Dr. Hans Blitter
   c. Dr. Otto Walkhoff
   d. None of the above

2. Only digital radiographs are currently used in dentistry.
   a. True
   b. False

3. Intraoral radiographs fall into two main categories: _____.
   a. Bite-wings and periapicals
   b. Bite-wings and laterals
   c. Panoramic and lateral radiographs
   d. All of the above

4. In 1999, an estimated _____ sets of radiographs were taken.
   a. 282 million
   b. 384 million
   c. 462 million
   d. 575 million

5. Only _____ radiographs have time-based intervals that are determined according to risk factors for caries.
   a. Periapical
   b. Panoramic
   c. Cephalograph
   d. Bite-wing

6. The paralleling technique is used for _____ .
   a. Periapical radiographs
   b. Bite-wing radiographs
   c. Panoramic radiographs
   d. a and b

7. In the paralleling technique, the X-ray beam should be directed at _____ to the teeth and receptor.
   a. 45 degrees
   b. 90 degrees
   c. 180 degrees
   d. None of the above

8. Receptor instruments combine _____.
   a. A receptor display with an arm that has an attached rectangle
   b. A receptor holder with an arm that has an attached rectangle
   c. A receptor holder with an arm that has an attached ring
   d. None of the above

9. Receptor instruments help the operator avoid common errors by _____.
   a. Specifically directing the X-ray beam towards the receptor
   b. Reducing the intensity of the X-ray beam
   c. Allowing the operator to rotate the film
   d. None of the above

10. Common errors in intraoral radiographs include _____.
    a. Overlapping contacts on bite-wing radiographs
    b. Elongation and foreshortening on periapical radiographs
    c. Cone cuts
    d. All of the above

11. Phosphor plate receptors are _____ than other digital sensors.
    a. More flexible
    b. Thinner
    c. Sturdier
    d. a and b

12. Molar periapicals are taken to record the _____.
    a. 1st, 2nd and 3rd molar teeth crowns and apices
    b. 1st, 2nd and 3rd molar teeth crowns only
    c. Only the surrounding bone
    d. None of the above

13. The receptor orientation for a bite-wing radiograph of the premolar teeth should be _____.
    a. Horizontal or vertical with the dot towards the maxilla
    b. Diagonal with the dot towards the mandible
    c. Horizontal or vertical with the dot towards the mandible
    d. None of the above

14. The receptor orientation for a periapical radiograph of the mandibular central incisors should be _____.
    a. Horizontal
    b. Diagonal
    c. Vertical
    d. Any of the above

15. The receptor orientation for a periapical radiograph of the maxillary premolars should be _____.
    a. Horizontal placement with the dot towards the crown
    b. Vertical placement with the dot towards the crown
    c. Vertical placement with the dot towards the root
    d. None of the above

16. The bisecting technique is _____ compared to the paralleling technique.
    a. Less operator-sensitive
    b. More operator-sensitive
    c. Easier
    d. None of the above

17. The bisecting technique is a useful alternative to the paralleling technique if the patient has _____.
    a. Tori
    b. A shallow palate or floor of mouth
    c. Narrow arch width
    d. All of the above

18. The most common area to elicit a gag reflex is _____.
    a. The maxillary molar periapical view
    b. The mandibular molar periapical view
    c. The molar bite-wing view
    d. None of the above

19. If a patient has a shallow palate, it can help when taking a radiograph to_____.
    a. Consider using the bisecting technique
    b. Use a bent film
    c. a and b
    d. None of the above

20. If a patient has a narrow arch, it can help when taking a radiograph to _____.
    a. Use compact size holders
    b. Avoid taking a radiograph
    c. Consider using the bisecting technique
    d. a and c

21. Full mouth radiographs expose the patient to the same amount of radiation as _____ of background radiation.
    a. One to two days
    b. Three to four days
    c. 5 days
    d. 10 days

22. A patient's radiation exposure can be minimized by _____.
    a. Taking only essential radiographs
    b. Using a high-speed film or digital radiograph
    c. Avoiding errors that would result in retakes
    d. All of the above

23. The greatest number of retakes in intraoral radiography is a result of _____.
    a. Faulty X-ray equipment
    b. Processing errors with film radiographs
    c. The patient moving while the radiograph is being taken
    d. None of the above

24. Digital radiographs _____.
    a. Expose patients to less radiation per radiograph
    b. Are quicker to take than traditional film radiographs
    c. Have a greater ease-of-use than traditional film radiographs
    d. All of the above

25. Beam collimation limits the diameter of the X-ray beam at the patient's face, which should not exceed _____.
    a. 3 cm or 1.50 inches
    b. 4 cm or 1.75 inches
    c. 7 cm or 2.75 inches
    d. 9 cm or 2.95 inches

26. Lead collars are designed to protect _____.
    a. The esophagus
    b. The thyroid
    c. The hypothalamus
    d. All of the above

27. The ALARA principle stands for _____.
    a. As Likely As Routinely Assessed
    b. As Low As Reasonably Applicable
    c. As Low As Reasonably Achievable
    d. None of the above

28. _____ inspection of lead aprons is mandatory.
    a. Monthly
    b. Annual
    c. Bi-annual
    d. None of the above

29. Operator protection against primary radiation is achieved by _____.
    a. Not standing directly in the primary beam
    b. Holding the film or sensor at an angle in the patient's mouth
    c. Wearing a lead collar
    d. None of the above

30. _____ can be minimized by regularly maintaining X-ray equipment.
    a. Leakage radiation
    b. Seizures
    c. Scratches on sensors
    d. None of the above

ANSWER SHEET

Intraoral Radiography: Positioning and Radiation Protection

Name: Title: Specialty:

Address: E-mail:

City: State: ZIP:

Telephone: Home ( ) Office ( )

Requirements for successful completion of the course and to obtain dental continuing education credits: 1) Read the entire course. 2) Complete all information above. 3) Complete answer sheets in either pen or pencil. 4) Mark only one answer for each question. 5) A score of 70% on this test will earn you 4 CE credits. 6) Complete the Course Evaluation below. 7) Make check payable to PennWell Corp.

Educational Objectives

1. Understand the various types of intraoral radiographs that can be taken and what these are used for
2. Know how to correctly use the paralleling and bisecting techniques to take intraoral radiographs
3. Know common errors that occur when taking intra-oral radiographs and how to avoid these
4. Know how to minimize radiation exposure for patients and the operator

Course Evaluation

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

1. Were the individual course objectives met?	Objective #1: Yes No		Objective #3: Yes No			
	Objective #2: Yes No		Objective #4: Yes No			
2. To what extent were the course objectives accomplished overall?	5	4	3	2	1	0
3. Please rate your personal mastery of the course objectives.	5	4	3	2	1	0
4. How would you rate the objectives and educational methods?	5	4	3	2	1	0
5. How do you rate the author's grasp of the topic?	5	4	3	2	1	0
6. Please rate the instructor's effectiveness.	5	4	3	2	1	0
7. Was the overall administration of the course effective?	5	4	3	2	1	0
8. Do you feel that the references were adequate?		Yes		No		
9. Would you participate in a similar program on a different topic?		Yes		No		

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_____

11. Was there any subject matter you found confusing? Please describe.

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4.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		19.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		21.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		22.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		23.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		24.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		25.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		26.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		27.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
13.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		28.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
14.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		29.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
15.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		30.	Ⓐ	Ⓑ	Ⓒ	Ⓓ

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PLEASE PHOTOCOPY ANSWER SHEET FOR ADDITIONAL PARTICIPANTS.

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