Dental Radiation Safety: Guidelines for Prescribing Radiographs and Limiting Radiation Exposure

Lynn Marsh, RDH, EdD
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ABSTRACT

Dental radiation safety is a critical component of patient care. Responsibilities of the healthcare provider include reducing patient exposure to radiation by utilizing appropriate procedures during patient assessment. Exposure to radiation must follow the ALARA principle, meaning that it is “As Low As Reasonably Achievable.” The principles involved include the use of as small an X-ray beam as possible, lead aprons and collars, the fastest film available or digital radiography, and the use of proper processing. Guidelines for prescribing radiographs and limiting radiation exposure have been recommended by professional societies, and should be utilized by the oral health care provider. Dental radiation safety and guidelines for prescribing radiographs and limiting radiation exposure are essential safety measures for patient protection.

EDUCATIONAL OBJECTIVES

The overall goal of this course is to provide the reader with information on dental radiation safety. On completion of this course, participants will be able to:

1. Describe the responsibilities of the healthcare provider in reducing patient exposure to radiation;
2. Review the use and effect of collimation;
3. List and describe the elements involved in ALARA; and
4. Discuss the guidelines for prescribing radiographs.

Dental radiographs are valuable in helping the oral health care provider evaluate and treat oral health problems at an early stage. Since many oral diseases cannot be detected during a clinical examination alone, dental radiographs are an important adjunctive aid in assessing a patient’s overall oral health. Dental radiographs help the oral health care provider identify diseases and developmental problems before they become serious health issues. Early detection can limit, or prevent, further progression of infections and diseases in the oral cavity. Dental Radiation Protection Standards are basic requirements that ensure patient safety. These standards contain requirements regarded as necessary for best practices in radiation protection; they include fundamental quantitative requirements, such as exposure limits to protect both the oral health care provider and the patient.

ABOUT THE AUTHOR

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Lynn Marsh is an associate professor in the Department of Dental Hygiene at Farmingdale State College, Farmingdale, NY, and a member of the National Dental Hygiene Honor Society, Sigma Phi Alpha. Her teaching responsibilities include radiology laboratory, current issues in dental hygiene, practice management for quality assurance, pain management laboratory, and clinical instruction. She practiced dental hygiene for more than 20 years.
State laws and regulations set specific requirements for the use of ionizing radiation, which includes X-rays. Radiographic training requirements for dental office personnel frequently differ from, and are less rigorous than, those of medical personnel who expose X-rays. Training requirements for dental office personnel are typically found in state dental practice acts or dental board regulations.1

It is the responsibility of the oral health care provider to be cognizant in reducing patient exposure to radiation by utilizing appropriate procedures during patient assessment. This includes providing radiographic images with maximum diagnostic information, while at the same time minimizing unnecessary patient exposure to radiation. Dental radiation safety guidelines include the use of lead aprons and thyroid collars, particularly for patients younger than 20 years, to protect the radiosensitive thyroid gland and reproductive system (Fig. 1).2

Collimation

Other dental radiation safety guideline recommendations include the use of rectangular collimation. This will reduce patient exposure to radiation to less than half of the exposure associated with the use of traditional round collimation (Figs. 2, 3).3

A collimator, housed within the X-ray tube head, is a metallic barrier with an opening in the center used to decrease the size and shape of the X-ray beam. The collimator reduces the amount of irradiated tissue exposure for the patient. Filtration and collimation of the X-ray beam are vital safety measures. The filter and collimator block the majority of the unwanted X-ray photons.4 Rectangular collimators restrict the size of the X-ray beam to just larger than that of the number 2 size traditional film. To lessen excessive patient exposure to radiation, the size of the X-ray beam should be restricted to the size of the film being exposed. Use of a rectangular collimator instead of a round collimator also decreases scatter radiation and film fog, and improves image quality. Furthermore, the reduction in the size of the X-ray beam enhances image definition and sharpness.4

High-speed film and digital radiography

The use of higher speed film (F-speed film) or digital radiography will further reduce patient exposure to radiation considerably, when compared with the use of slower speed film (D-speed film).2 On the other hand, the ease-of-use of direct digital radiographic imaging systems increases the likelihood of an unwarranted number of radiographs, in an attempt to attain a diagnostically acceptable image. Consequently, the use of fast film/screen combinations for extraoral radiography, or digital alternatives, will considerably reduce patient exposure to radiation only provided care is taken to avoid unnecessary radiographs.

The speed of traditional film is related to the size of the silver bromide crystals. These are very sensitive to light, and contained in the emulsion of the film. The larger the crystals, the faster the speed of the film. Given that the crystals in high speed film are larger and more sensitive to light, less exposure time is required to record the radiographic image. Exposure settings on the X-ray machine vary, depending on the speed of the film, the length of the position indicating device, KvP, and mA. It should be noted that to obtain the advantages of reduced patient radiation exposure, intraoral or extraoral digital radiograph systems should use the minimum radiation necessary for the generation of a diagnosti-
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A diagnostically acceptable image. Any benefits derived from using a digital radiographic imaging system can be negated by an overexposed radiograph that is digitally enhanced to have acceptable brightness and contrast.2

Other considerations

Additional factors regarding dental radiation safety apply in the darkroom used to process traditional film. Proper film processing procedures are essential to ensure the production of a diagnostically acceptable film. The darkroom must be free of any light leaks, as this can cause film fog. An appropriate safelight, placed at a minimum of 4 feet from the working area, must be used in the darkroom, to allow the oral health care provider to handle films in the dark without producing film fog during processing.

Processing solutions should be changed regularly, and not subjected to high temperatures. Quality control checks should be performed to ensure optimal processing and quality radiographs. Depleted or contaminated processing chemicals also can result in nondiagnostic radiographic images that would necessitate a retake, thus re-exposing the patient to unnecessary radiation.5 In addition, to produce diagnostically acceptable films and limit radiation exposure, the rollers and tanks must be cleaned. When utilizing an automatic processor, the operator should use separate sponges to clean each roller. This prevents potential cross-contamination of the chemicals; for example, a drop of fixer later entering the developer due to prior use of a sponge for the fixer’s roller. Such contamination can compromise the quality of the radiograph, fixer, developer, and water. Warm running water or the manufacturer’s spray also may be used while rotating the gears in each roller, and a soft brush can be used to loosen and remove debris build-up on the rollers. Detergent, soap, or household cleaners should not be used on film processing rollers. ALARA

Oral health care providers must follow the ALARA principle, which stands for “As Low As Reasonably Achievable,” when exposing radiographs. This radiation safety principle limits patient exposure by incorporating the following techniques:2

- Use of the fastest image receptor (the fastest traditional film speed or digital sensor).
- Reduction in the size of the X-ray beam to the size of the image receptor whenever possible (Figs 2, 3).3 The position indicating device should have rectangular collimation to reduce the size of the X-ray beam to the size of the image receptor whenever possible.
- Use of proper exposure and processing techniques.
- Use of leaded aprons, including thyroid collars.

It is important that oral health care providers have copies of any existing radiographs, to avoid re-exposing the patient to radiation.
Table 1. Guidelines for prescribing radiographs

<table>
<thead>
<tr>
<th>TYPE OF ENCOUNTER</th>
<th>PATIENT AGE AND DENTAL DEVELOPMENTAL STAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child with Primary Dentition (prior to eruption of first permanent tooth)</td>
<td>Child with Transitional Dentition (after eruption of first permanent tooth)</td>
</tr>
<tr>
<td>Adult, Dentate or Partially Edentulous</td>
<td>Adult, Edentulous</td>
</tr>
<tr>
<td>New Patient* being evaluated for oral diseases</td>
<td>Individualized radiographic exam: Selected periapical/occlusal views and/or posterior bitewings if proximal surfaces cannot be visualized or probed. Patients without evidence of disease and with open proximal contacts may not require a radiographic exam at this time.</td>
</tr>
<tr>
<td>Recall Patient* with clinical caries or at increased risk for caries**</td>
<td>Posterior bitewing exam at 6-12 month intervals if proximal surfaces cannot be examined visually or with a probe</td>
</tr>
<tr>
<td>Recall Patient* with no clinical caries and not at increased risk for caries**</td>
<td>Posterior bitewing exam at 12-24 month intervals if proximal surfaces cannot be examined visually or with a probe</td>
</tr>
<tr>
<td>Recall Patient* with periodontal disease</td>
<td>Clinical judgment as to the need for and type of radiographic images for the evaluation of periodontal disease. Imaging may consist of, but is not limited to, selected bitewing and/or periapical images of areas where periodontal disease (other than nonspecific gingivitis) can be demonstrated clinically.</td>
</tr>
<tr>
<td>Patient (New and Recall) for monitoring of dentofacial growth and development, and/or assessment of dental/skeletal relationships</td>
<td>Clinical judgment on need for and type of radiographic images for evaluation and/or monitoring of dentofacial growth and development or assessment of dental and skeletal relationships</td>
</tr>
<tr>
<td>Patient with other circumstances including, but not limited to, proposed or existing implants, other dental and craniofacial pathoses, restorative/endodontic needs, treated periodontal disease and caries remineralization</td>
<td>Clinical judgment as to need for and type of radiographic images for evaluation and/or monitoring of these conditions</td>
</tr>
</tbody>
</table>

*Clinical situations for which radiographs may be indicated can be found in “The Selection of Patients for Dental Radiographic Examinations.”

**Factors increasing risk for caries may be assessed using the ADA Caries Risk Assessment forms.

Table courtesy of The Food & Drug Administration. Radiation-Emitting Products: The Selection of Patients for Dental Radiographic Examinations.
Oral health care providers should decide when radiographs are needed, based on each patient’s individual oral examination findings, any symptoms reported, a review of the health history, risk of experiencing oral disease, patient’s age, or any combination of these.7

Guidelines for prescribing radiographs and limiting radiation exposure

The American Dental Association, in collaboration with the Food and Drug Administration, developed recommendations for dental radiographic examinations, to serve as an adjunct to the oral health care provider’s professional judgment on how to best use diagnostic imaging.1 While dental radiographs are important in assessing and diagnosing oral diseases and conditions, the oral health care provider must consider the benefits of dental radiographs and weigh this against the risk of exposing a patient to radiation, the effects of which are cumulative over time. Each individual patient’s health history, need, and susceptibility to oral disease should be taken into consideration. For this reason, the recommendations are intended to serve as a resource and are not projected to be standards of care, or requirements or regulations, for prescribing radiographs.

How often the patient should be exposed to dental radiographs also depends on the patient’s oral health condition, age, risk for disease, and any signs and symptoms of oral disease that the patient might be experiencing. The recommendations are subject to clinical judgment and may not apply to every patient. They are to be used by the oral health care provider only after reviewing the patient’s health history and completing a clinical examination. Although radiation exposure from dental radiographs is low, once a decision to take radiographs has been made, it is the oral health care provider’s responsibility to follow the ALARA principle to minimize the patient’s exposure to radiation (Table 1).6

Summary

Dental radiation safety, radiograph selection, and optimization of exposure limitations, should be implemented for every patient in the dental practice. Guidelines for prescribing radiographs and limiting radiation exposure have been recommended by professional societies, and should be utilized by the oral health care provider. Dental radiation safety and guidelines for prescribing radiographs and limiting radiation exposure are essential safety measures for patient protection.

References


Webliography

1. ___________ set(s) specific requirements for the use of ionizing radiation, which includes X-rays.
   a. OSAP
   b. The ADA
   c. State laws and regulations
   d. all of the above

2. Dental radiation safety guidelines include the use of lead aprons and thyroid collars to protect the radiosensitive ___________.
   a. parotid gland
   b. thyroid gland
   c. tibia
   d. all of the above

3. The American Dental Association, in collaboration with the ____________, developed recommendations for dental radiographic examinations.
   a. Environmental Protection Agency
   b. American Radiation Association
   c. Food and Drug Administration
   d. all of the above

4. ALARA stands for ____________.
   a. “As Little As Requirements Allow”
   b. “As Low As Radiation Allows”
   c. “As Low As Reasonably Achievable”
   d. none of the above

5. Proper film processing procedures are necessary to ensure the production of ____________.
   a. minimal chemical vaporization
   b. a diagnostically acceptable film
   c. light
   d. extra films

6. Using a rectangular collimator instead of a round collimator _________.
   a. decreases scatter radiation
   b. decreases film fog
   c. improves image quality
   d. all of the above

7. An appropriate safelight, placed at a minimum of ____________ from the working area, must be used in the darkroom.
   a. 2 feet
   b. 3 feet
   c. 4 feet
   d. 5 feet

8. A collimator is ____________.
   a. housed within the X-ray tube head
   b. used to decrease the size and shape of the X-ray beam
   c. used to reduce the amount of irradiated tissue exposure for the patient
   d. all of the above

9. Oral health care providers must follow the ALARA principle, when exposing radiographs, to ____________.
   a. increase film accuracy
   b. limit patient radiation exposure
   c. protect the operator
   d. increase film brightness

10. When deciding whether to take radiographs, each individual patient’s ____________ should be taken into consideration.
    a. health history
    b. need
    c. susceptibility to oral disease
    d. all of the above
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EDUCATIONAL OBJECTIVES
- Describe the responsibilities of the healthcare provider in reducing patient exposure to radiation.
- Review the use and effect of collimation.
- List and describe the elements involved in ‘ALARA’
- Review the guidelines for prescribing radiographs.

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3. Benefit to your clinical practice: ...................... 3 2 1
4. Usefulness of the references: ......................... 3 2 1
5. Quality of written presentation: ...................... 3 2 1
6. Quality of illustrations: ................................. 3 2 1
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8. Relevance of quiz questions: .......................... 3 2 1
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3. A     B     C     D
4. A     B     C     D
5. A     B     C     D
6. A     B     C     D
7. A     B     C     D
8. A     B     C     D
9. A     B     C     D
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