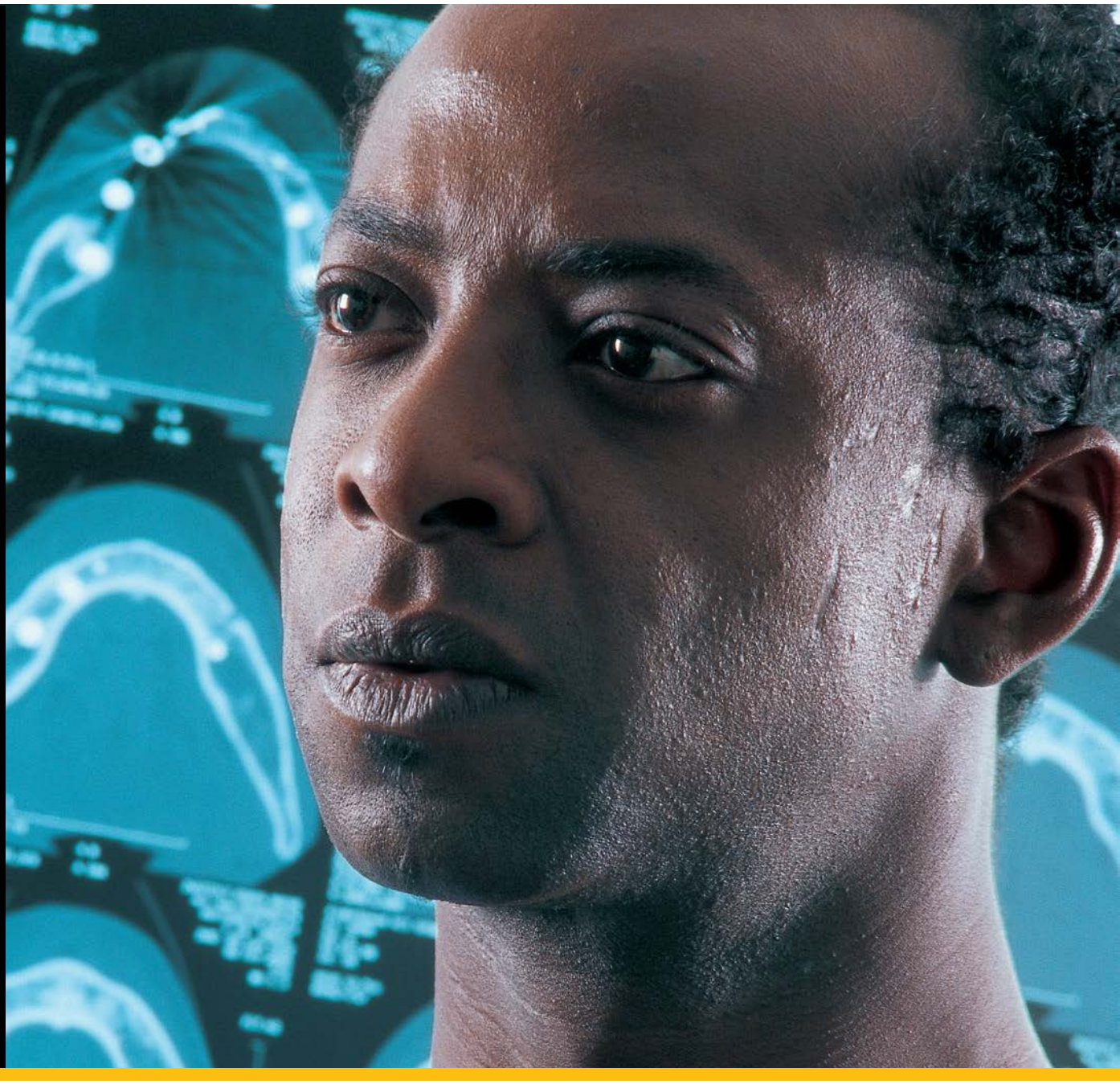
Carestream DENTAL

Dental Radiography Series



Radiation Safety
in dental radiography.

The goal of dental radiography is to obtain diagnostic information while keeping the exposure to the patient and dental staff at minimum levels.

While some exposure to radiation is acceptable in medical practice, it should be understood that levels of radiation exposure to patients, dental staff, and other nearby occupants should be kept to As Low As Reasonably Achievable (ALARA) to reduce health risks from ionizing radiation.

Any methods that can reduce patient and area radiation exposures without major difficulty, great expense or inconvenience, should be practiced. Practitioners must always consider the risk of patient exposure with the benefit of diagnosis.

Radiograph Guidelines

4 Radiation safety considerations

4 Exposure

5 Patient selection

5 Film

6 Rectangular Collimation

7 Image Density

7 Film Cassettes

7 Minimal Exposure

8 Exposure Protection

Basic principals of radiation safety
Additional radiation safety controls commonly utilized for dental facilities
Engineering controls

9 Summary

9 References

Radiograph Guidelines

One way to do this is with the use of radiographic patient selection criteria.

Guidelines for the prescription of dental radiographs have been developed by an expert panel of dentists sponsored by the public health service.

A free brochure is available from Carestream Dental (see last page for ordering information) publication 8616 "Guidelines for prescribing dental radiographs." The guidelines are voluntary and are intended only as a decision-making aid for the dental practitioner. They are used only in conjunction with a carefully taken medical and dental history and a clinical examination.

Radiation safety considerations

In any case, once the decision has been made to prescribe x-rays, every reasonable effort must be made to minimize exposure to the patient and dental office personnel.

Interestingly, the same safety procedures that minimize exposure for both patient and operator can also increase the quality of the radiographic images.

There are many factors that determine the level of radiation received by the patient during a radiographic examination. These include:

- The selection of the x-ray machine
- The use of technique factors that result in low patient exposure
- The use of fast films and screen/film combinations
- Adherence to correct film processing methods
- The use of collimators and filtration
- The use of lead aprons and thyroid collars to protect the patient from unnecessary radiation exposure

All x-ray equipment, regardless of date of manufacture, is subject to state and federal x-ray equipment regulations.

Although proper filtration is not usually a problem with modern equipment, older x-ray machines should be tested by a radiation physicist or qualified technician to verify the presence of the correct amount of filtration.

The kilovoltage or kVp setting is one of the most important factors that determines the image contrast, as well as dosage to the patient. In the 60-80 kVp range, biological risk esti mates from dental radiology are essentially the same and, therefore, the diagnostic need should be the determining factor for which kVp setting to use. Settings below 60 kVp are not recommended for routine dental radiography because of higher patient exposures.

Exposure

Typical Radiation skin entry exposures and effective dose equivalents are outlined in the table below:

Typical patient doses from dental x-ray exams

Exam	Skin Dose (mR)	Effective Dose F-Speed Film (mrem)
Full mouth (18 exposures)	2,300-3,100	1.5
Bite-wing	200	0.4
Panoramic	700-950	1.1

To keep the effective dose equivalent in perspective; in 1991, a research team at the Academic Center for Dentistry in Amsterdam made an elaborate series of measurements of dose to all areas of the head and neck during bite-wing radiography using a plastic "head phantom." They found an effective dose for the bite-wing of 0.4 mrem. To put this in perspective, background radiation from naturally occurring radionuclides in our environment and from cosmic rays delivers almost a thousand times as much radiation every year (approximately 300 mrem).

The benefits of the use of x-rays in dentistry outweigh the risks when proper safety procedures and considerations are followed.

The dentist or registrant of the x-ray producing equipment is responsible for all aspects of radiation safety in the dental office.

Patient selection

The dentist selects the patient who needs radiographs, determines which radiographs are needed, takes or supervises the exposure of the films and interprets the images.

An important method for keeping patient exposure as low as reasonably achievable is the appropriate prescription of radiographs.

Pediatric concerns and dental radiographs

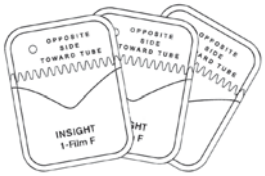
With children the major reasons for taking dental radiographs of baby teeth are to detect dental cavities and to evaluate growth and development so that abnormalities can be treated before they become serious problems. An example of a developmental problem that can occur is the lack of formation of one or more permanent teeth. If this is detected early, efforts can be made to keep the primary tooth in place as long as possible so that more complex (and expensive) treatment can be avoided.

The guidelines recommend bitewing radiographs on young children at the first dental visit if the proximal surfaces (sides of the teeth) cannot be seen well or explored with a dental instrument. X-ray radiographs for the purposes of determining tooth growth and development depend on the patient's stage of tooth eruption. The frequency of radiographs should depend on the child's risk for decay. Situations that make a child at higher risk for decay include lack of fluoride in the drinking water, high sugar diet, history of cavities, poor oral hygiene, and many others. Although some children will not have cavities, the majority will develop one or more some time in the future. It is much easier and less expensive to treat cavities while they are still small, before they can lead to pain and infection. While children are more sensitive to x-rays than adults because they are rapidly growing, the amount of radiation from needed dental radiographs is extremely small, essentially from a few hours of natural background radiation, which we have around us all the time. It is significantly less radiation than they would receive if they flew in an airplane (from increased cosmic radiation at flight levels) in a cross country flight. The minimal risk of the radiographs needs to be compared with the information obtainable that may be very important for a child's health.

While the radiation dose to the patient is very low, techniques to keep radiation dose As Low As Reasonably Achievable (ALARA) for the patient and nearby persons should be practiced. Guardians, parents and siblings, etc. should be asked to wait outside the operatory during x-ray exams. Young patients should be carefully instructed on the importance of remaining still and cooperating during exams to reduce the need for re-examination. In addition, the overall childhood frequency of X-ray examinations depends significantly on the progression of dental caries risk. Therefore a direct relationship between oral hygiene and overall childhood exposure can be established. A child's accumulated radiation exposure from dental exams can be reduced by adhering to good oral hygiene practices.

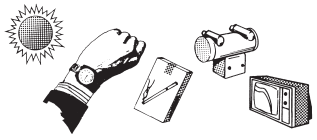
Film

With proper use of film, required diagnostic information can be obtained from dental x-rays at a minimal radiation dose. The two speeds used for intraoral radiography are group D and group F. Converting from D-speed to F-speed film alone can reduce exposure by 60%. And when combined with the use of rectangular collimation, F-speed film, such as INSIGHT, delivers a radiation dose that's less than one-fifth the amount of D-speed, such as Ultra-speed, and round collimators. The right high-quality film can help dentists adhere to the ALARA (as low as reasonably achievable) principle to protect patients and staff alike.

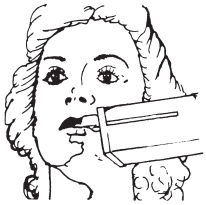


Rectangular Collimation

Collimators, when installed properly, serve to limit the size and shape of the useful x-ray beam reaching the patient. This will not only reduce dose, but may also improve image quality.



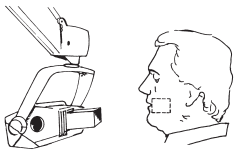
The American Dental Association (A.D.A.) and the American Academy of Oral and Maxillofacial Radiology recommend the use of a shielded, open-ended, position-indicating device, or PID, preferably with rectangular collimation.



This is an example of a rectangular collimator that restricts the beam to the size and shape of the dental film. Round collimators can be converted to a rectangular shaped opening by using an insert avail able through a manufacturer of dental radiographic products (see last page for suggested resource). This technique significantly reduces the volume of tissue exposed during intraoral radiography.

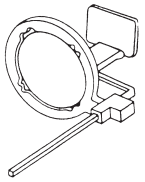
Rectangular collimators reduce patient exposure by restricting the beam size to that of the film used. These devices will increase subject contrast by reducing excessive scatter radiation.

The area and volume of tissue exposed to the primary x-ray beam should not exceed the minimum coverage required to image the anatomical area in question. Periapical radiographs should, in general, demonstrate 1/4- in of alveolar bone beyond the apex of each tooth, 1/8- to 1/4-in margin between the crowns of the teeth and the edge of the film; the occlusal plane should be straight or slightly curved upward toward the distal.



In bite-wing views, the occlusal plane should be straight or slightly curved upward toward the distal. There should be equal distribution of maxillary and mandibular crowns and maxillary and mandibular alveolus, and the interproximal spaces should be open. These criteria can be met successfully by careful execution of correct periapical and bite-wing techniques.

Film holding devices are recommended for intraoral radiography to eliminate the need for the film to be held in place by the patient's finger. These film holding devices also provide for the film to be placed parallel to the teeth, resulting in a less distorted image. The holders recommended today incorporate beam guiding devices which make PID alignment a simpler task.



The A.D.A. and the Academy discourage the use of short, closed, pointed plastic cones because of the increased scatter radiation and unnecessary radiation close to the face and surrounding areas of the patient. As shown in the drawing, the rectangular collimator restricts the x-ray beam to an area just slightly larger than the intraoral film itself.

It is estimated that the radiation dosage from use of both F-speed film and rectangular collimation is minimal, less than one-fifth that from D-speed film and round beams. On the other hand, beam energy ranging from 60 to 80 kVp, and short cone (20cm or 8 inches) versus long cone (40cm or 16 inches) make little difference in patient exposure.

Image Density

A significant factor contributing to image density is the quantity of x-rays reaching the film. This is controlled by combining milliamperage and exposure time as milliampere-seconds or mAs. Correct mA and timer settings are established using a technique chart such as the exposure guidelines for Carestream Dental intraoral films (publication 8641).

Unnecessary radiation exposure to patients results when films need to be retaken due to faulty radiographic or processing techniques.

Film Cassettes

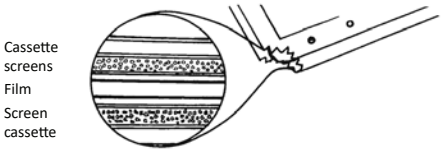
Film cassettes are used for extraoral techniques such as panoramic and cephalometric radiography.

Cassettes serve as lighttight film holders and are equipped with two intensifying screens that convert x-ray energy to light energy. This feature enables image formation to occur with less exposure than is possible with direct x-rays alone. Patient exposure can be reduced by up to 100 times when compared to direct exposure film techniques.

To minimize the needs for retakes, it is important to utilize the proper film/screen combination with a cassette that provides pressure uniformity and lighttight integrity.

Film/screen combinations are used to image the mandible, the maxilla, the temporomandibular joint and the orofacial complex.

Since different film/screen combinations result in various speed systems, the practitioner can choose the speed system that will allow the patient to be exposed to the least amount of radiation while still providing the diagnostic information required.



Minimal Exposure

LANEX Regular Screens are used with a green sensitive film, such as T-MAT G/RA. Exposures are usually one quarter to one half those needed with the earlier generation of blue-light emitting phosphors. Beside dose reduction, the newer phosphors maintain excellent image detail, help eliminate motion blur by the use of shorter exposure times, and produce less wear on the x-ray tube.

EVG extraoral imaging system also provides a similar exposure reduction, while providing a further increase in sharpness resulting from Enhanced Visualization due to low crossover film and screen technology.

Proper exposure and processing of film is another factor in keeping exposure as low as reasonably achievable. Errors can result in the need for additional radiographs and increased exposure.

Quality assurance is any systematic action to ensure that a dental office will produce consistently high-quality images with minimal exposure to patients and personnel. When operators are presented with clear guidelines for quality assurance, patient exposure is dramatically reduced.

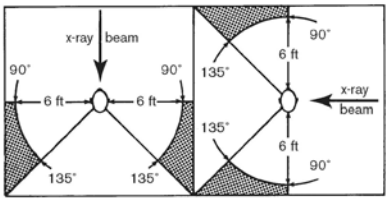
Besides diagnosis, films are used for insurance claims, teaching, patient referrals and legal purposes. The use of duplicate radiographs reduces patient x-ray exposure because the need to re-expose patients is eliminated. When duplicate radiographs are needed, there are several methods available to produce them. We offer duplicating film in a variety of film sizes that range from size 2 to an 8 x 10-in size.

We also offer two-film dental packets that contain two separate intraoral dental films together for producing two identical radiographs with one exposure. The two-film packet requires no adjusting or resetting of equipment or additional exposure to the patient. The same double loading technique can be done with extraoral film by using a combination of T-MAT H/RA and LANEX Regular Screens.

Exposure Protection

Even though the thyroid gland may be out of the primary beam path when rectangular collimation is used, exposure of that gland may be significant when the round positioning device is used. Lap aprons are available with thyroid collars attached. Separate thyroid collars are also available.

The most commonly used leaded aprons cover the entire chest and lap, effectively reducing scatter radiation reaching underlying tissues. Lap aprons and thyroid collars should be used for all dental radiographic procedures.



The best way of limiting the possibility of occupational exposure is the establishment of radiation safety procedures that apply the basic principles of radiation safety.

Basic principals of radiation safety

The goal of radiation safety is to keep all radiation exposures As Low As Reasonably Achievable (ALARA). This means that even if exposures are acceptable, if there is a reasonable way to reduce the exposure even further, those controls should be utilized. While there are many components to an effective radiation safety program, there are consistently three basic principals to minimize radiation exposure:

- Time – minimize time duration working with x-ray sources
- Distance – increase distance between the source of radiation and yourself
- Shielding – shielding of a suitable density to attenuate ray

Additional radiation safety controls commonly utilized for dental facilities

Administrative controls

- Warning signs and postings
- Safety procedures
- Radiation badge dosimeter

Engineering controls

- Shielding (lead, thick drywall, concrete, barriers, etc.)
- Operating controls placed outside of or at an increased distance from patient area

Perhaps the most important factor in reducing personnel exposure to radiation is for the operator to stand behind a radiation barrier during the exposure. This is usually accomplished by installing the exposure button in a location outside the dental operatory.

If a protective barrier is not available, the operator should be positioned at least six feet from the x-ray tube head at an angle from 90 degrees to 135 degrees to the central ray of the x-ray beam. Six feet (2 m) is considered safe as long as the operator is not positioned in the path of the primary x-ray beam.

The proper installation of x-ray equipment and safety of operational procedures can be certified by a radiation physicist. Some states require a plan for review of an office before the installation of any x-ray equipment. This plan would include the location of x-ray equipment, the exposure button and composition of wall materials for radiation barriers.

The operator or patient should never hold films in the mouth during radio graphic procedures. Unnecessary health risk and injuries may occur. Film holders used in modern dental radiography preclude the need for dental personnel or patients to hold films with their fingers.

Depending on the radiation levels of the clinical setting, practitioners may elect to use radiation dosimeters (personal monitoring dosimeter) to monitor long-term radiation doses to employees working with x-ray units. The use of the personal monitoring dosimeter may also be required by local regulations. Even when not required by regulation, occupational dose monitoring with personal monitoring dosimeters may be beneficial to the clinic to ensure safe practices and proper risk management.

Radiation dosimeters should be used properly in accordance with the dosimetry providers and all regulatory requirements. Use only dosimeters accredited by the National Voluntary Laboratory Accreditation Program (NVLAP).

Neither the operator nor the patient should stabilize the x-ray tube head during the procedure; rather the operator should make any adjustments prior to mak ing exposures. Additional exposure may occur while attempting to stabilize the tube head during exposure. Slight amounts of radiation leakage occur through all x-ray tube heads and, therefore, contact with the tube housing during expo sures must be avoided. Any instability of the tube head should be corrected by proper adjustment of the suspension arm.

Summary

With proper use of modern film and equipment, required diagnostic information from dental x-rays can be obtained while minimizing patient exposure. Conversion from D-speed to F-speed (INSIGHT) film alone, with no other changes, reduces exposure by 60%. When F-speed film is combined with the use of rectangular collimation, dosage is less than one-fifth that from D-speed film and round collimators. Other practices, such as the use of open-ended parallel projection collimation, maintaining source-to-skin distances of at least 20 cm (and preferably 40 cm), and using 60-80 kVp tube voltage settings, also minimize the level of patient dose.

Radiation doses to the patient from dental radiography, assuming optimum technique and state-of-the-art technology, are relatively small when compared to doses from other medical procedures and environmental sources. Thus, clinical need rather than patient dose should determine which radiographic examination, if any, is to be prescribed for a patient.

From the selection of patients for radiographic examination, through the exam itself, to the interpretation of the results, the dentist has a professional obligation to control radiation exposure in the dental office. The dentist must eliminate any unnecessary exposure and keep all necessary exposure As Low As Reasonably Achievable.

References

Technical Report of the Commission on Dental Products: Recommendations for radiographic procedures. International Dental Journal, June 1989.

White, S.C. 1992 Assessment of radiation risk from dental radiography. Dentomaxillofacial Radiology, 1992, V.21, Aug. 118-26.

The Benefits of Dental X-Ray Examinations, American Dental Association W138, 2000.

To obtain a free copy of any of the publications referred to in this pamphlet, please visit carestream.com.

To obtain assistance in converting to the F-speed, INSIGHT films mentioned in this pamphlet, or to obtain further information on other Carestream dental film products or recommendations:

- In the U.S. or Canada, please call 800-933-8031

Other Publications in the Dental Radiography Series

- Exposure and Processing in Dental Film Radiography
- Guidelines for Prescribing Dental Radiographs
- Successful Intraoral Radiography
- Successful Panoramic Radiography
- Quality Assurance in Dental Film Radiography

Would you like to know more?

For more information call **800.933.8031** or visit **carestream.com.**

© Carestream Health, Inc., 2024.
Carestream, INSIGHT, Ultra-speed, LANEX and T-MAT are trademarks of Carestream Health. 8179 DE BR 0224 CHSP-8510; Rev: 6