

Safe Use of Radiographs in Dentistry

Radiography is an essential tool in dental practice, but recent reports of possible overutilization and overdose of radiation in some areas of health care have raised concerns among patients and practitioners about the use of radiographs in dentistry. While the radiation dose from dental X-rays is low, there are a number of precautions that should be adopted to keep the dose at a minimum while still providing the diagnostic information needed.

The guiding principle in radiation is:

ALARA – As Low As Reasonably Achievable

In dentistry, the ALARA principle can be applied during many phases of the radiographic process:

- determining the need for and type of radiographs to take;
- using “best practices” during the actual making of images, including the application of office quality control procedures;
- interpreting the images completely and accurately to obtain all the diagnostic information they contain.

When to take radiographs

Dentists must apply clinical judgment in deciding when and what type of radiologic examination to prescribe, realizing that the same examination may not be appropriate for all patients. There is no recommended frequency for panoramic radiograph or full-mouth surveys (FMX). The decision to repeat a panoramic radiograph or FMX should be based solely on the individual patient's needs—not on the frequency allowed in the dental insurance contract. The only imaging examination with a frequency recommendation is the bitewing, its frequency based on an assessment of the patient's caries risk.

The clinical decision should be:

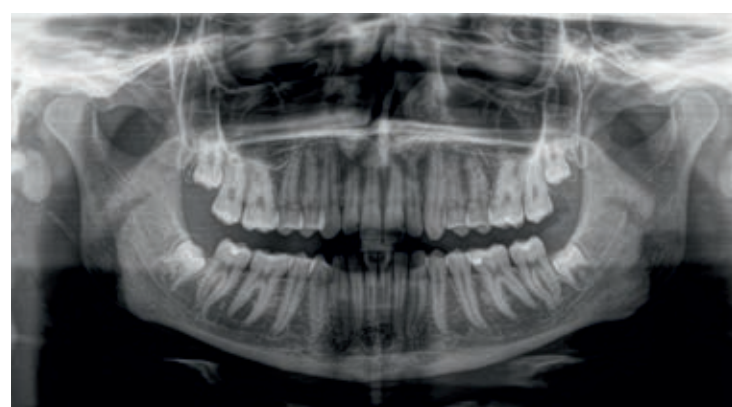
- based on findings from the patient history and clinical examination
- tailored to the needs of the individual patient
- influenced by the patient's risk of dental disease
- supported by the dentist's knowledge of disease progression and utility of various imaging techniques

Some factors to consider in deciding to prescribe radiographs:

- health status of a new or established patient
- date and availability of most recent prior radiographs
- patient age and stage of dental development
- risk of dental caries
- clinical evidence of periodontitis
- number of teeth and desire for prosthodontic care
- pain, swelling or other signs or symptoms of dental disease



Periapical Radiograph



Panoramic Radiograph

ADA/FDA recommendations for prescribing dental radiographs.*

The recommendations in this table are subject to clinical judgment and may not apply to every patient. They are to be used by dentists only after reviewing the patient's health history and completing a clinical examination. Because every precaution should be taken to minimize radiation exposure, protective thyroid collars and aprons should be used whenever possible. This practice is strongly recommended for children, women of childbearing age and pregnant women.

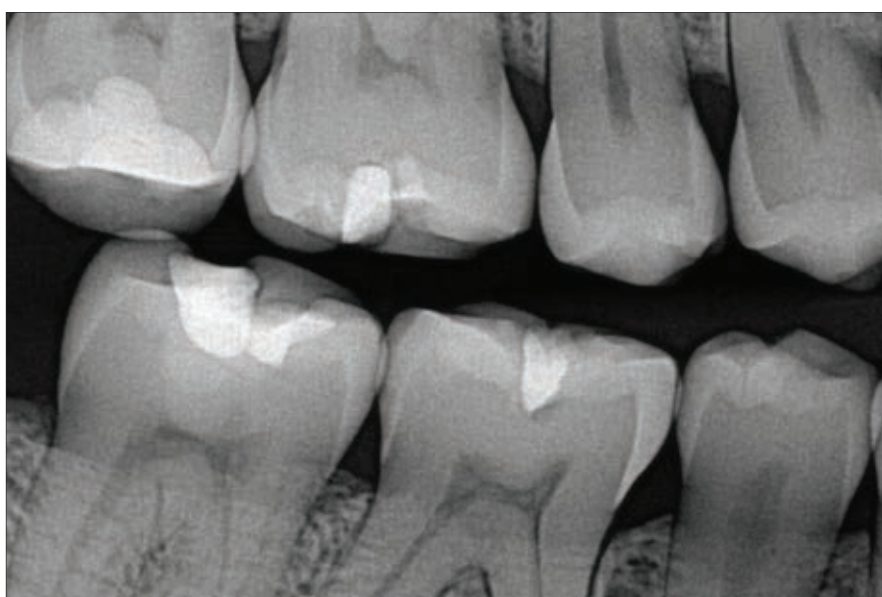
TYPE OF ENCOUNTER	PATIENT AGE AND DENTAL DEVELOPMENTAL STAGE				
	Child With Primary Dentition (Prior to Eruption of First Permanent Tooth)	Child With Transitional Dentition (After Eruption of First Permanent Tooth)	Adolescent With Permanent Dentition (Prior to Eruption of Third Molars)	Adult, Dentate or Partially Edentulous	Adult, Edentulous
New Patient† being evaluated for oral diseases	Individualized radiographic examination consisting of 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 examination at this time	Individualized radiographic examination consisting of posterior bitewings with panoramic examination or posterior bitewings and selected periapical images	Individualized radiographic examination consisting of posterior bitewings with panoramic examination or posterior bitewings and selected periapical images; a full-mouth intraoral radiographic examination is preferred when the patient has clinical evidence of generalized oral disease or a history of extensive dental treatment	Individualized radiographic examination at six- to 18-month intervals	Individualized radiographic examination, based on clinical signs and symptoms
Recall Patient† With Clinical Caries or at Increased Risk of Developing Caries†	Posterior bitewing examination at six- to 12-month intervals if proximal surfaces cannot be examined visually or with a probe	Posterior bitewing examination at 12- to 24-month intervals if proximal surfaces cannot be examined visually or with a probe	Posterior bitewing examination at 18- to 36-month intervals	Posterior bitewing examination at six- to 18-month intervals	Not applicable
Recall Patient† With No Clinical Caries and Not at Increased Risk of Developing Caries†	Posterior bitewing examination at 12- to 24-month intervals if proximal surfaces cannot be examined visually or with a probe	Posterior bitewing examination at 18- to 36-month intervals	Posterior bitewing examination at 24- to 36-month intervals	Posterior bitewing examination at six- to 18-month intervals	Not applicable
Recall Patient† With Periodontal Disease	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 in which periodontal disease (other than nonspecific gingivitis) can be demonstrated clinically				Not applicable
Patient (New and Recall) for monitoring of dentofacial growth and development, and/or assessment of dental/skeletal relationships	Clinical judgment as to need for and type of radiographic images for evaluation and/or monitoring of dentofacial growth and development		Clinical judgment as to need for and type of radiographic images for evaluation and/or monitoring of dentofacial growth and development; panoramic or periapical examination to assess developing third molars	Usually not indicated for monitoring of growth and development. Clinical judgment as to the need for and type of radiographic image for evaluation of dental and skeletal relationships	
Patient With Other Circumstances Including, but not Limited to, Proposed or Existing Implants, Pathology, Restorative/Endodontic Needs, Treated Periodontal Disease and Caries Remineralization	Clinical judgment as to need for and type of radiographic images for evaluation and/or monitoring of these conditions				

* Reprinted from American Dental Association Council on Scientific Affairs and U.S. Food and Drug Administration (2012). "Dental Radiographic Examinations: Recommendations for Patient Selection and Limiting Radiation Exposure." pp. 5-7

† Clinical situations for which radiographs may be indicated include, but are not limited to, the following: **Positive historical findings:** Previous periodontal or endodontic treatment, history of pain or trauma, familial history of dental anomalies, postoperative evaluation of healing, remineralization monitoring, presence of implants or evaluation for implant placement. **Positive clinical signs/symptoms:** clinical evidence of periodontal disease, large or deep restorations, deep carious lesions, malposed or clinically impacted teeth, swelling, evidence of dental/facial trauma, mobility of teeth, sinus tract ("fistula"), clinically suspected sinus pathology, growth abnormalities, oral involvement in known or suspected systemic disease, positive neurologic findings in the head and neck, evidence of foreign objects, pain and/or dysfunction of the temporomandibular joint, facial asymmetry, abutment teeth for fixed or removable partial prosthesis, unexplained bleeding, unexplained sensitivity of teeth, unusual eruption, spacing or migration of teeth, unusual tooth morphology, calcification or color, missing teeth with unknown reason, clinical erosion.

‡ Factors increasing risk for caries may include, but are not limited to, the following: high level of caries experience or demineralization, history of recurrent caries, high titers of cariogenic bacteria, existing restoration of poor quality, poor oral hygiene, inadequate fluoride exposure, prolonged nursing (bottle or breast), diet with high sucrose frequency, poor family dental health, developmental or acquired enamel defects, developmental or acquired disability, xerostomia, genetic abnormality of teeth, many multisurface restorations, chemotherapy/radiation therapy, eating disorders, drug/alcohol abuse, irregular dental care.

Bitewing radiographs and caries detection

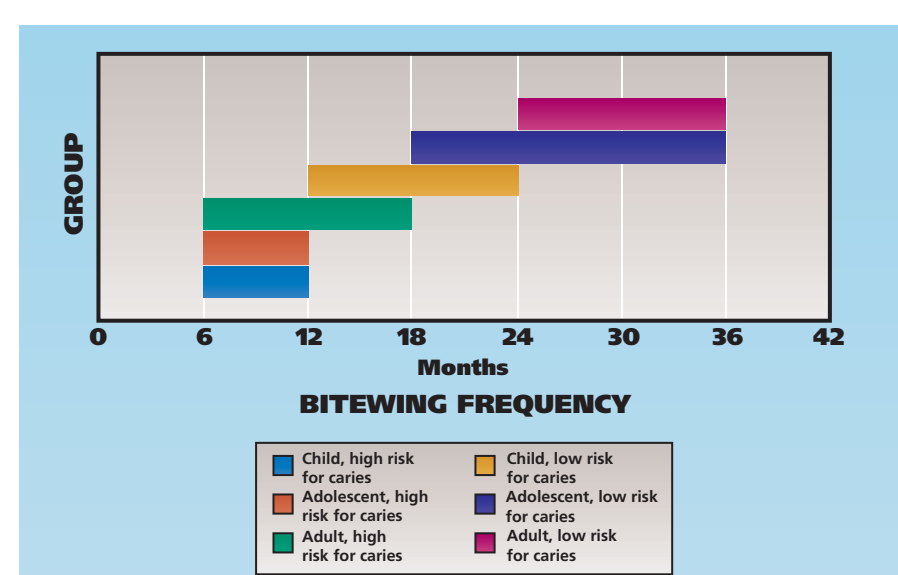


Bitewing of healthy mouth

The use of bitewing radiographs is based on an assessment of the patient's caries risk.

Factors that increase caries risk include, but are not limited to:

- high level of caries experience
- history of recurrent caries
- high level of cariogenic bacteria
- poor oral hygiene
- diet with high sucrose frequency
- inadequate fluoride exposure
- xerostomia from medications, radiation therapy or other causes
- drug/alcohol abuse



Best Practices in Dental Radiography



X-RAY MACHINE FEATURES

- Tube potential: 60 to 80 kVp. Constant potential machines recommended due to lower dose required
- Adequate beam filtration, consistent with state and national laws
- Accurate electronic exposure timer
- Stable x-ray head and arm, without drifting
- Digital imaging reduces dose by 40-60%
- Hand-held devices must be FDA-approved

FILM EXPOSURE AND PROCESSING

- Tube current (mA), tube potential (kVp), and exposure time should be set to produce optimal images
- A darkroom is preferred over a daylight loader for ease of infection control
- Films should be processed following manufacturer's directions for time, temperature, and frequency of processing solution change
- Processing film by sight is a violation of ionizing radiation rules in many states
- Darkrooms should be well ventilated and dental staff should take precautions to avoid contact with processing solutions
- Disposal of used processing solutions and lead foil should be done following state or local laws

IMAGING RECEPTOR

- Intraoral radiography
 - Digital sensor or F-speed film
- Extraoral radiography
 - Digital sensor or cassette with rare earth screens
- Source-to-image receptor distance 20-40cm

COLLIMATION OF X-RAY BEAM

- Beam should conform to size and shape of sensor or film
 - Rectangular collimator reduces radiation dose up to 5-fold compared with round collimator
- Some panoramic x-ray machines permit limiting the beam size for children to reduce dose
- Cone beam computed tomography (CBCT) scans should be limited to area of interest
 - Radiation dose is reduced
 - Image quality is increased



SENSOR/FILM HOLDERS

- Devices that align the beam with the sensor/film are strongly recommended for all intraoral radiographs to minimize errors due to cone cutting or improper vertical or horizontal beam angle
- Sensor/film holders should be heat-sterilizable or disposable for optimal infection control



PATIENT PROTECTION EQUIPMENT

- Leaded aprons (or non-leaded equivalents) are recommended unless all other dose reduction techniques, including rectangular collimation, are implemented
- Leaded thyroid collars/shields are strongly recommended for all children and pregnant women and for other adults when they will not interfere with the exposure
- To avoid damage, lead aprons and shields should be protected from bending and should be inspected periodically

OPERATOR PROTECTION

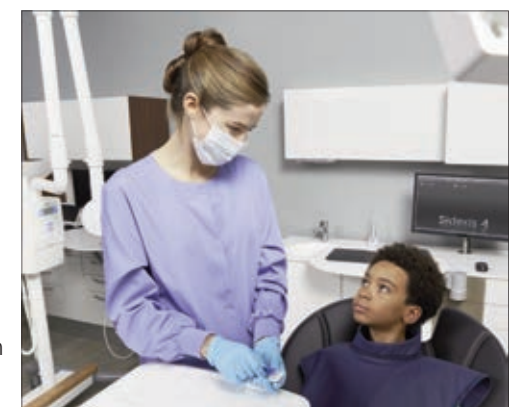
- Implementation of a radiation protection program that includes operator education
- Provision of safe location for operator during exposure
 - Behind a protective barrier or a minimum 2 m (6 ft) from beam
- Monitoring operator radiation exposure and adherence to state and national laws and recommendations on dose limits
 - Maximum permissible annual dose for health care workers is 50 mSv
 - Maximum lifetime dose is 10 mSv multiplied by person's age in years
 - Personal dosimeters ("radiation badge") may be required in certain circumstances (e.g., for pregnant operators) but are recommended generally

QUALITY ASSURANCE

- Protocols should be developed and implemented for all parts of the dental radiography system (x-ray machine, film processing, minimizing errors and the need to retake radiographs, operator education, etc)
- X-ray machines should be inspected regularly, according to state regulations
- Film processing solutions should be evaluated daily and changed as needed

INFECTION CONTROL

- Standard precautions for infection control should be used routinely
- Wear gloves when exposing radiographs and handling contaminated film packets or digital sensors
- Disinfect or use protective covers on all equipment or supplies that could be contaminated with saliva, changing these covers after each patient
- Cover digital sensors with a new plastic barrier sheath for each patient; after use, spray or wipe the sensor with an EPA-registered hospital disinfectant
- Open film packets without contaminating film inside
- Use heat-sterilizable or disposable sensor/film holders
- Darkrooms are preferred over daylight loaders for infection control purposes



RADIOGRAPH VIEWING AND INTERPRETATION

- All radiographs, digital or film, should be viewed under optimal conditions, generally in a quiet location with reduced ambient lighting, on a calibrated computer monitor or well-maintained viewbox
- All images should be interpreted in their entirety for all pathologic changes and variations of normal
- Dentists are responsible for interpreting the entire scan volume when using CBCT, consulting with an expert when necessary

