

Radiographic Selection Criteria



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Disclaimer: Participants must always be aware of the hazards of using limited knowledge in integrating new techniques or procedures into their practice. Only sound evidence-based dentistry should be used in patient therapy.

Conflict of Interest Disclosure Statement

- The author reports no conflicts of interest associated with this course.

Introduction – Radiographic Guidelines

The guidelines for prescribing radiographic examinations will be presented and discussed to assist dentists in the appropriate selection of patients for radiographic examinations.

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Overview

This continuing education course will present and discuss the latest recommendations for prescribing radiographic examinations to assist dentists in the optimal application of radiation safety measures and the appropriate selection of patients for diagnostic imaging.^{1,2} These recommendations recapitulate and update the 2012 document and provide decision-making guidance on applicable imaging modalities as well as the safety measures and practices that undergird and support imaging procedures and systems.^{1,3} The updated guidance takes the form of consensus recommendations due to limitations in the available evidence acquired from a comprehensive review of dental radiation safety research, guidance from national and international agencies, and regulatory standards.^{1,2} Clinicians should base imaging decisions on the patient's medical and dental histories, clinical examination findings, disease risk assessments, and the presence of specific clinical conditions.¹ Prior to any radiographic examination, previous radiographs should be obtained and reviewed, and any imaging procedure, particularly cone beam computed tomography (CBCT), should be prescribed judiciously to minimize patient radiation exposure.¹ When properly utilized, radiographic imaging examinations contribute to dental treatment decisions that optimize patient care.¹

In addition, radiographic imaging should be individualized for each patient and should never be based on administrative or arbitrary requirements such as insurance coverage, a fixed time schedule, nor convenience.¹ The goal

of applying radiographic recommendations is to eliminate unnecessary patient exposures in adherence to the ALARA (As Low As Reasonably Achievable) and with CBCT, ALADA (As Low As Diagnostically Acceptable) Principles while maximizing diagnostic yield.⁴

Learning Objectives

Upon completion of this course, the dental professional should be able to:

- Discuss priority practice-level radiation measures.
- Discuss the basic parameters of regulatory compliance regarding the safe use of radiographic imaging equipment, radiation safety program measures, and operator training requirements.
- Identify ways to limit occupational exposure to dental radiographic personnel and dental patients.
- Discuss the elements of an effective quality assurance and quality control program.
- Outline measures that can be taken to minimize radiation dose and optimize imaging when using traditional imaging modalities.
- Describe measures that can be taken to minimize radiation dose and optimize imaging in CBCT imaging.
- Provide examples of clinical indicators and imaging recommendations for patients with dental caries, periodontal disease, and the presence of third molar, supernumerary, and supplemental teeth.
- Discuss patient imaging recommendations for orthodontics, head and neck lesions, TMD and orofacial pain, dental implants, and endodontics.
- Discuss imaging considerations and precautions for pediatric patients.
- List the imaging recommendations for the new patient with respect to age (child, adolescent, adult) and dentition status.
- Outline the imaging recommendations for recall patient with high and low caries risk

Introduction

Radiographic selection criteria guidelines were developed to assist the dentist in making informed decisions about diagnostic imaging for patients under their care. Since the 1980's, several iterations of selection criteria guidelines have been issued. The guidelines

were originally developed in 1987 by a panel of dental experts and the U.S. Food and Drug Administration (FDA) with subsequent updates by the American Dental Association (ADA) and the FDA in 2004 and 2012.^{3,5,6} The most recent documents, Optimizing Radiation Safety in Dentistry: Clinical Recommendations and Regulatory Considerations, and American Dental Association and American Academy of Oral and Maxillofacial Radiology Patient Selection for Dental Radiography and Cone-beam Computed Tomography will be the focus of the forgoing discussion.^{1,2}

These publications are meant to be utilized in tandem to update the 2012 guidelines relative to radiation safety, imaging practices, exposure reduction measures, and regulatory requirements as well as to provide evidence-based decision-making guidance including clinical indicators for patient selection, the timing and frequency of diagnostic imaging, and the use of relevant imaging modalities for general and pediatric dental care practitioners.^{1,2} Limitations in the available evidence resulted in consensus recommendations rather than formal guidelines and are subject to new evidence that becomes available through further research or evidence-based review.¹

The discussion of the updates to the 2012 guidelines will begin with the regulatory requirements, radiation safety measures, radiation dose reduction measures, and imaging practices that inform and support diagnostic imaging. Subsequent to that foundation, the current evidence-based decision-making recommendations will be presented including clinical indicators for patient selection, the timing and frequency of diagnostic imaging, and the use of relevant imaging modalities including 2D and 3D imaging methods.¹ The general framework for 2D imaging recommendations includes the following categories: type of encounter (new or recall), patient age designation (child, adolescent, adult), stage of dental development (primary, transitional, permanent dentitions and partially/completely edentulous), and vulnerability to risk factors (caries, periodontal disease). Recommendations for 3D imaging are addressed by using Specific Clinical Indicators that provide imaging guidance in particular clinical circumstances. The general

framework of the guidelines includes these major categories:

- type of encounter - new or recall
- patient age designation – child, adolescent, adult
- stage of dental development – primary, transitional, permanent dentitions and partially/completely edentulous
- vulnerability to risk factors – caries, periodontal disease

Radiation Exposure in Dentistry

Radiographic imaging procedures in dental practice are among the most frequently performed examinations in the United States on healthy individuals, and globally, one of the most common.⁷⁻⁹ It is well-established that x-radiation is detrimental and, when delivered with enough intensity, a known carcinogen.^{10,11} The effects of radiation are cumulative and any amount of ionizing radiation exposure has the potential to increase the risk of adverse health outcomes, especially in children who are more susceptible from longer cumulative lifespan exposures and higher organ radiosensitivity.¹¹⁻²⁰ In dental practice, the effective radiation dose associated with typical imaging modalities ranges from low-dose intraoral and panoramic imaging to higher dose CBCT.² The radiation dose delivered to the patient in CBCT varies among manufactures, scanner type, exposure parameters, imaging protocols, and the field of view (FOV) for the particular scan selected.^{2,21-24} It is prudent, therefore, to keep patient exposure to ionizing radiation low and mitigate patient exposure through adherence to recommended safety practices and procedures.

Priority Practice-level Dose Reduction Recommendations

There are many ways to minimize radiation exposure to dental patients. First and foremost are fundamental priority concepts that, when incorporated into dental imaging practices, will serve to minimize exposure to dental patients and reduce risk. The priority radiation dose reduction measures are outlined in Table 1.

Table 1. Priority Practice-level Dose Reduction Recommendation.²

1. Familiarity and compliance with applicable local, state, and federal laws.
2. Prescription of radiographs based on diagnostic and treatment planning needs, and a good-faith effort by the dentist to acquire prior dental imaging examinations.
3. Utilization of digital receptors in lieu of film for intraoral, panoramic, and cephalometric imaging.
4. Use of rectangular collimation for intraoral imaging whenever possible.
5. Utilization of CBCT only when lower-dose options will not yield the necessary diagnostic information.

General Recommendations for All Imaging Modalities Regulatory Oversight

Compliance with all applicable local, state, and federal regulatory requirements for the safe and effective use of radiographic imaging modalities subsumes adherence with proper equipment installation, utilization, and maintenance, as well as optimization (balancing image quality with patient dose), patient and operator protection, infection control measures, and operator training for radiographic procedures and equipment.² In new facilities or in facilities installing or relocating radiographic and/or CBCT equipment, local and state regulations must be followed with regard to radiation safety and structural requirements during office construction or renovation.² Manufacturer’s instructions for safe and proper machine operation, maintenance, and infection control measures for radiographic, CBCT, and related radiographic imaging equipment must be followed.²

Radiation Safety Program and Staff Training

The dental practice must develop and implement a radiation safety program for all staff members that provides instructions and guidance to maintain safe and effective radiographic imaging systems.² The program must align with nationally accepted radiation safety recommendations for the protection of both patients and staff personnel and be facilitated under the guidance of a qualified

expert.² Reviewed on a regular basis, the program must be updated periodically to ensure it is current and in compliance with established regulations and contemporary guidance.² Staff members who perform radiography-based dental and maxillofacial imaging must possess the requisite education, training, qualifications, and licensure as required by local, state, and federal regulations.²

Quality Assurance and Quality Control Program

Personnel utilizing radiographic equipment also must establish a quality assurance and quality control program.^{2,24} The program must be implemented and monitored by a qualified expert and reflect current guidance.² Quality assurance (QA) in dental and maxillofacial radiography requires that specific steps are taken to provide diagnostic images while minimizing patient radiation exposure.^{2,24} This is accomplished through compliance with manufacturer and regulatory measures regarding device usage.^{2,24} In addition, machine operators must be qualified and credentialed according to state regulations.^{2,24} Quality Control (QC), an integral part of QA

concentrates on testing and measurement of radiographic devices, image receptors, and other technical components of the imaging chain.^{2,25} The purpose of QC is to ensure that the entire imaging system maintains a consistent level of acceptable performance as determined by QA activities.^{2,24,26,27} NCRP Report 177 provides detailed guidance on the parameters of QA/QC and procedures for documentation of QC measures, designation of qualified personnel responsible for each activity, monitoring of results, and mechanisms to enact corrective actions to remedy identified issues or substandard performance.^{2,24} Specifically intraoral, panoramic, and cephalometric x-ray machines should be inspected at least every four years or as required by state law, whichever is more stringent.^{2,24} Regular testing, planned monitoring, and scheduled maintenance of x-ray equipment, digital image receptors, scanning and display equipment are all important aspects of a comprehensive QA/QC program.²⁴ CBCT imaging units should be inspected every two years, but preferably on an annual basis.^{2,24} Specific guidance for CBCT quality control is available through both national and international organizations and agencies.²⁸⁻³⁰

Table 2. Quality Assurance and Quality Control Program Recommendation Summary.^{2,24}

Personnel

- Quality assurance and quality control program established, overseen, and monitored by a qualified expert.
- QA/QC program aligned with and periodically updated per contemporary quality assurance and quality control guidance.

Equipment

- Machine operator manuals for all radiographic systems and components are available to user(s).
- All imaging equipment is operated according to manufacturer's instructions.

Intraoral Machines

- Units are surveyed by a qualified expert at time of installation, and at least every 4 years thereafter or per local and state law, or after necessary adjustments are made.
- Image receptors are acceptance tested annually for digital, monthly for film.
- Technique charts are developed and posted for each unit including exposure settings for examination type, receptor, patient size and type-adult/child.
- Plate scanners and/or film processors are evaluated at installation and regularly thereafter. Film processing systems require daily monitoring prior to film processing as well as solution replenishment, machine cleaning and solution change when indicated.

CBCT Units

- CBCT imaging and dosimetry performance must be evaluated by a qualified expert at least every 2 years, preferably annually.

Occupational and Operator Use of Ionizing Radiation

Operator Training Requirements and Radiation Safety Practice

Radiographic imaging examinations are typically delegated to qualified (as mandated by state law) auxiliary personnel, dental assistants and dental hygienists. During imaging procedures, dental personnel should stand behind a protective barrier that permits observation of the patient during exposure. If a barrier is not present, the clinician should stand at a 6 feet/2 meters distance from the x-ray source and at a position greater than a right angle (90-135° angle) to the primary beam. If a handheld x-ray unit is used for intraoral imaging, the device must be used according to the manufacturer's guidelines.

Dental staff members who may be exposed to an annual effective dose greater than 1 mSv or as otherwise determined by local or state guidance, should consider wearing dosimeters (Figure 1) to track their quarterly and annual occupational exposure.^{2,24}



Figure 1. Personal Dosimeter

Pregnant dental personnel operating x-ray equipment must comply with recommendations outlined in the established radiation safety program, including limiting occupational exposure, use of protective radiation barriers, and personal dosimetry regardless of anticipated occupational exposure.^{2,24}

Table 3. Occupational Whole-Body Dose Limits.²⁴

Type	International Units	Traditional Units
Annual	50 mSv	5 rem
Embryo-fetus (term)	5 mSv	0.5 rem

Patient Radiation Safety and Protection

Recommendations for Safety and Protection

Prior to any radiographic examination, the dentist should obtain the patient's medical/dental history, conduct a clinical examination, and acquire and review previous radiographic images, particularly CBCT scans.¹ CBCT examinations should not be routine nor be used for screening purposes.³ Clinicians should base any imaging decision on the patient's history, clinical findings, disease risk assessments, and the presence of specific clinical conditions and other clinical signs and symptoms that may impact the patient's oral health.¹ Radiographic imaging should serve as an adjunct to the clinical examination in the diagnosis, effective treatment planning, and management of the patient with confirmed or suspected dental disease, pathosis, injury or other pertinent indicators.¹

The dentist should prescribe dental radiographic imaging and CBCT scans only when there is an expectation that the diagnostic yield will enhance patient safety, benefit patient care, or substantially improve the clinical outcomes.² The clinical prescription of radiographic imaging as well as CBCT should be justified by professional judgement based on established contemporary selection and recall criteria to ensure the benefit of the radiographic examination outweighs the radiation risk.³¹ In addition, the radiographic equipment used to image the patient must be configured to optimize imaging and dosimetric performance with regard to the age and size of the individual.^{9,24,32,33} The intended goal is to optimize patient treatment while limiting radiation exposure.

Pediatric patients should be given special consideration when radiographic imaging is used, regardless of modality. As previously discussed, children and young adults are more susceptible to the effects of ionizing radiation exposure. The dentist must justify any prescribed radiographic examination with consideration given to the age and size of the patient, developmental status in terms of tooth eruption and clinical tooth spacing, careful patient positioning, and application of dose-reduction measures to keep the dose as low as possible.^{3,9,15,19,24,32-37} Exposure of the thyroid to the x-ray beam is of particular concern and requires application of dose reduction measures including rectangular collimation, and careful patient positioning.^{25,35}

Although patient shielding has been recommended in the past, thyroid collars and abdominal/ gonadal shielding are no longer recommended during diagnostic intraoral, panoramic, cephalometric, and CBCT imaging and should be discontinued³⁸ These devices do not protect against internal scatter radiation and can produce artifacts by blocking the primary beam, leading to retakes.^{23,25,38} Patient radiation dose can be effectively minimized through the use of rectangular collimation, proper patient positioning, and application of dose reduction measures.^{24,38}

Radiation Dose Minimization and Image Optimization for Traditional Imaging Modalities

Intraoral Image Receptors

Digital receptors for intraoral and extraoral radiographic imaging, including the charge-coupled device (CCD), complementary metal oxide semiconductor (CMOS) or photostimulable phosphor plate detectors, should be used in place of film to reduce radiation dose to patients. If film is used for intraoral radiographic imaging, F speed film should be used to achieve greater dose reduction and D speed should no longer be used.^{24,28} When using intraoral radiographic imaging, receptor holders with x-ray beam guides should be used whenever possible (Figure 2). Film-based panoramic or cephalometric extraoral radiographic imaging should utilize rare-earth intensifying screens with matching high-speed film of 400 or greater.²⁴

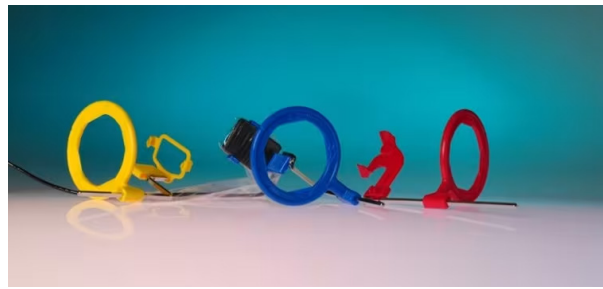


Figure 2: Digital Receptor Holders

X-ray Beam Collimation

The x-ray beam should be collimated to the receptor size and shape whenever possible to limit the amount of primary and scatter radiation delivered to the patient during intraoral imaging. Rectangular collimation is preferred over round collimation because it reduces radiation dose to the patient significantly, approximately fivefold.^{24,39} Rectangular collimation has the added benefits of improving image geometry and reducing scatter radiation which degrades the resultant image.⁴⁰ This impacts intraoral digital receptors because they are more sensitive to scatter radiation than film.⁴⁰ Receptor holding devices have beam guide insets to facilitate rectangular collimation alignment. Several commercial devices are available to convert round to rectangular collimation.

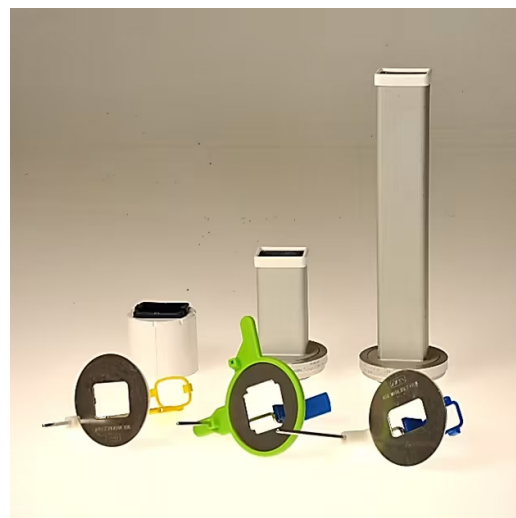


Figure 3. Rectangular Collimators.

Source-to-Skin Distance

The distance from the x-ray focal spot or radiation source and the skin surface should be as long as possible but not exceed 20 cm (Figure 4). The use of long position indicating devices serves to maximize the distance between the source and skin surface which limits divergence of the x-ray beam and the area of exposure.



Figure 4. Source-to-Skin Distance

Kilovoltage Range

The optimal operating kilovoltage (kV) range for intraoral x-ray machines is 60-80 kV but not to exceed 80 kV.²⁴ (Figure 5) Consult the manufacturer's operating manual to determine the appropriate exposure time for each area of the mouth per the type of receptor being used to image the patient. Technique charts should be used to indicate proper exposure settings for intraoral and extraoral radiographic imaging systems with adjustable settings.¹ The clinician should make appropriate exposure adjustments when imaging children versus adult patients. X-ray machines should be evaluated regularly at intervals mandated by state regulation.



Figure 5. Intraoral X-ray Machine Control Panel

Handheld Intraoral X-ray Devices

Intraoral x-ray imaging systems include devices held by the operator during imaging procedures. Handheld devices are advantageous in certain situations and environments in which access to a traditionally wall-mounted unit is difficult or inaccessible.²⁴ Handheld devices must be FDA cleared (meet federal safety and design standards), used according to manufacturer's instructions, restricted for use only by authorized personnel with proper training, and stored securely out of public reach when not in use.^{2,24} These devices can present radiation safety and technique challenges for the operator and patient.²⁴ As such, specific training in proper device holding, imaging technique, and x-ray beam alignment is necessary to produce diagnostic images without patient re-exposures and to maximize operator protection from the backscatter shield.^{2,24}



Figure 6. Handheld Intraoral X-ray Device

Radiation Dose Minimization and Image Optimization for CBCT

CBCT, to reiterate, should never be used routinely by the dentist for imaging patients when any other lower dose modality would provide the necessary diagnostic information.^{9,15,20-24,41-54} This imaging method delivers a considerably higher dose when compared to traditional imaging methods and should be reserved for situations in which 3D images of the teeth and adjacent structures are necessary for proper diagnosis and treatment planning.^{9,15,20,21,24,34,40-42,47,49,51,54-63} Most

new systems provide scanning protocols with lower-dose setting options.^{60,61,64,65} In addition, operators can reduce patient exposure by using the smallest FOV necessary for the clinical purpose as well as manually adjust the combination of the x-ray tube output and the scan time when feasible.^{50,52,54,59,60,62,66-68}

Patient Selection for Dental Radiography and Cone Beam Computed Tomography

The current update of the 2012 selection criteria guidelines provides consensus-driven recommendations and decision-making guidance for the use of various imaging modalities in general and pediatric dental practices.^{1,3} With advances in radiographic imaging, the use of CBCT has increased necessitating further guidance on the use of this 3D imaging modality.¹ The updated recommendations address the appropriate indicators for patient selection, timing, and the frequency of diagnostic imaging, including both 2D and 3D imaging.¹ The guidelines, however, are not a substitute for the clinical judgement of the dentist nor do they guarantee specific patient outcomes.¹ It is expected that the radiation safety measures previously described are incorporated alongside the recommendations for prescribing dental radiographic examinations.¹ With regard to CBCT, the dentist who orders or uses this technology for patient imaging is responsible for the interpretation of all findings within the scanned volume including regions beyond the area of interest.¹ This is both a legal and professional requirement and the standard of care for interpretation regardless if the dentist is a radiology specialist or not.¹ As such, when expertise is lacking or the case is complex, referral to an oral and maxillofacial radiologist is recommended to provide optimal patient care and to mitigate risk.¹

General Radiographic Recommendations

- Adherence to professional guidelines laws, and public health guidelines relative to all parameters of radiation safety practices is

expected.^{1,24,50}

- No radiographic screening is performed prior to a clinical examination.

The decision to provide any radiographic examination, including CBCT, must be justified and the benefit must outweigh the radiation risk.^{2,50}

- All radiographs are examined for caries, calculus, bone loss, developmental or acquired anomalies, and pathoses per professional guidance.^{2,50,52}

- Intraoral imaging is useful in dentoalveolar trauma but if the region of interest extends beyond the oral cavity, extraoral imaging may be necessary.^{2,50,69,70}

- Radiographers must be trained in patient positioning, appropriate imaging techniques, patient preparation, and removal of metallic objects that could impact diagnostic image quality.^{2,24,50}

- Clinicians, dental staff, and radiographers must be knowledgeable about radiation risks for imaging modalities and be able to communicate risks to patients.^{2,24,50}

- CBCT is NOT indicated for caries detection.⁷¹

Recommendations for Specific Clinical Indicators

The specific indicators for the detection of caries; periodontal disease; orthodontics and developmental disorders; third molars, supernumerary and supplemental teeth; head and neck lesions; temporomandibular disorders and orofacial pain; dental implants; and endodontics will be presented, respectively.

Imaging Recommendations for Caries Indications

- Periapical radiographs are indicated for anterior proximal caries that are not visible clinically.^{1,3}

- Bitewing radiographs are indicated for posterior proximal caries that are not visible clinically.^{3,72}

- Periapical or bitewing radiographs may be indicated for occlusal caries.^{1,3,72}

- Periapical or bitewing radiographs may be indicated for root caries.^{1,3,72,73}

- Visual examination is preferred over radiographic imaging for the diagnosis and

depth of smooth surface caries without clinical signs or symptoms associated with pulpitis or apical periodontitis.^{1,3}

Imaging Recommendations for Periodontal Disease

- For patients with periodontal disease, the frequency of radiographic imaging depends on clinical findings and treatment response.^{1,3,74}
- Prior to periodontal treatment, radiographic documentation of disease sites is important for diagnosis, baseline documentation, and treatment planning.^{1,3,74}
- Radiographic evidence of the presence and severity of bone loss is not indicative of active periodontal disease.^{1,3,74}
- A full mouth intraoral survey with vertical bitewing radiographs as necessary is recommended following a comprehensive clinical examination of the patient.^{1,3,74}
- Generally, management of periodontal disease does not warrant CBCT imaging, but it may be indicated to treatment plan complex cases.^{1,3,74}
- Vertical bitewing radiographs (Figure 7) are recommended to assess bone levels in the permanent dentition of patients with a history of or active periodontal disease.^{1,3,74}

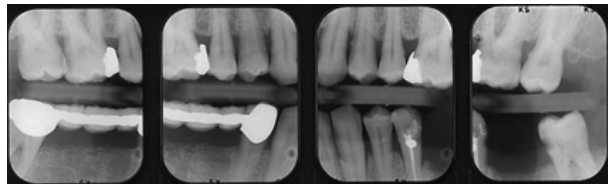


Figure 7: Vertical Bitewing Survey

Imaging Recommendations for Orthodontic Indications

- Panoramic imaging should be used as the initial imaging modality for monitoring tooth eruption prior to initiating orthodontic treatment and associated root alignment.^{1,48,75,76}
- Lateral cephalometric imaging may be used to assess the severity of CII or CIII malocclusion without a vertical component.^{1,48,75-77}
- Periapical radiographs (Figure 8) are the most appropriate imaging method to assess root morphology, root blunting or resorption, and periapical lesions.^{1,48,75-79}

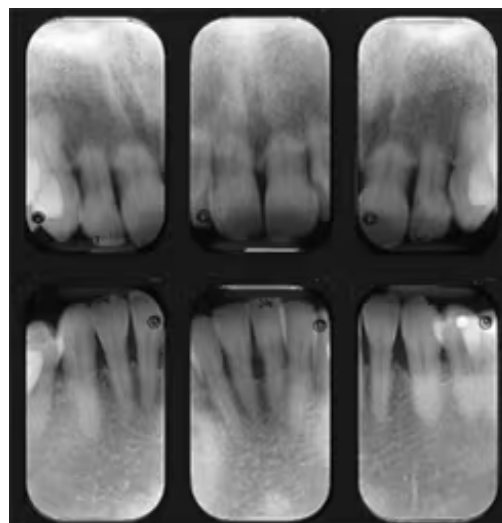


Figure 8: Anterior Periapical Images Depicting Root Resorption

- Low dose CBCT is recommended to assess facial asymmetry but if not available, posterior-anterior (PA) cephalometric imaging may be used.^{1,48,76,77,80}
- CBCT can aid site selection for interradicular mini implants and have been found to improve success rate compared to 2D imaging alone.¹ CBCT imaging benefits should be weighed against the increased radiation dose case by case.^{1,48,81}
- Panoramic imaging is recommended for assessment and treatment planning when clinical indicators like suspected pathosis, delayed eruption, or orthodontic concerns, but should be avoided unless justified by substantial changes in clinical status or developmental age.^{1,49,82-87}

Imaging Recommendations for Third Molars, Supernumerary and Supplemental Teeth

- Routine screening for third molars, supernumerary and supplemental teeth is not recommended without clinical indications.^{1,3,31}
- Panoramic imaging (Figure 9) is recommended for assessment and treatment planning if clinical indication for evaluation of third molars, supernumerary and supplemental teeth.^{1,51,81-87}



Figure 9: Panoramic Image Showing Horizontal Impaction of the Mandibular 3rd Molars

- Panoramic imaging frequency for third molars, supernumerary and supplemental teeth should be determined by the stage of dental development and clinical need.^{1,3,81-84,87}
- CBCT imaging should be considered if a panoramic image indicates an increased risk of inferior alveolar nerve injury.^{1,51,85,87}
- CBCT imaging should only be used if radiographic findings affect risk assessment or treatment decisions.^{1,51,84-87}

Imaging Recommendations for Head and Neck Lesions

- The prescription of the type and frequency of radiographic imaging for head and neck lesions should be determined by medical/dental history, clinical findings, potential diagnosis and existing imaging.¹⁻³
- Given the broad spectrum of disease entities, an individualized approach should be used to select the most appropriate imaging modality for jaw lesions.^{1-3,88}
- Various imaging modalities are utilized by oral and maxillofacial pathology, oral medicine, and orofacial pain disciplines depending on clinical indications like manifestation, history, symptomology, examination findings, laboratory and test results, and therapeutics as relevant to each case.¹ The broad range of imaging modalities such as CBCT, magnetic resonance imaging (MRI), ultrasonography, are possible all of which must be determined through a benefit-risk decision-making process.¹
- If pathosis is suspected or identified radiographically, appropriate referral to a specialist may be warranted before additional imaging is completed.

Imaging Recommendations for Temporomandibular Disorders (TMD) and Orofacial Pain

- Panoramic imaging may be considered for initial imaging of patient with TMD disorders to rule out gross osseous abnormalities, but it may not be sufficient for definitive temporomandibular joint (TMJ) diagnosis.^{1,89}
- CBCT is the preferred imaging modality to assess the bony components of the TMJ, such as degenerative joint disease, idiopathic condylar resorption, arthritides or developmental abnormalities.^{1,89,90}
- Multidetector computed tomography (MDCT) or CBCT is preferred for suspected condylar fracture or trauma to characterize fracture location, displacement, associated hard tissue injury (Figure 10).⁸⁹ MRI is preferred for suspected soft tissue trauma like the presence of adhesions or detection of hemarthrosis.⁹¹⁻⁹³

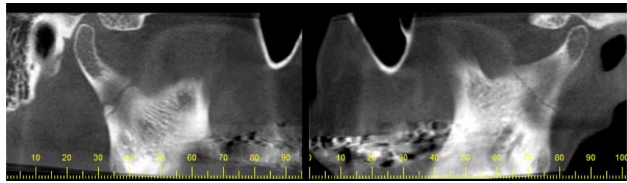


Figure 10: CBCT Imaging Depicting Bilateral Condylar Fractures

- MRI should be used for definitive assessment of soft tissue pathology, including disc displacement, joint effusion and inflammatory changes. T1 (proton density-weighted) MRI is recommended for disc morphology and position. T2-weighted MRI is recommended for joint effusion.^{89,92}
- TMJ internal derangements are common and do not require imaging unless functionally limiting.¹ Open- and closed-mouth MRI imaging is recommended for evaluation of TMJ disc displacements.^{89,93}
- Imaging should only be used when clinical findings suggest a need for further investigation or treatment planning and not as a routine part of TMD diagnosis.^{93,94}
- Referral to a medical or dental specialist is recommended when orofacial pain is suspected to be of non-TMD origin and non-odontogenic origin such as neurovascular, neurogenic, neoplastic, systemic infectious or other secondary causes.¹ Advanced imaging modalities like MRI, MR angiography, MDCT, positron emission tomography (PET) may be indicated on the basis of the suspected etiology to support accurate diagnosis and management.⁹³⁻⁹⁵

Imaging Recommendations for Dental Implants

- Panoramic imaging is appropriate for initial assessment while CBCT is recommended for presurgical planning and implant placement.^{52,60,96}
- CBCT applications in implant therapy: 3D imaging is recommended when the clinical examination indicates bone grafting or reconstruction is needed.⁵²
- CBCT imaging should be used to assess the relationship of relevant structures to the implant site.^{52,60,96}
- 3D imaging is recommended to assess the volume of bone in edentulous ridge implant sites (Figure 11).⁵²
- CBCT imaging should be used to assess the maxillary sinus and alveolar ridge prior to augmentation procedures.^{52,60,96}
- CBCT imaging is necessary for fabrication of surgical guides that are static or used during dynamic navigation of implant placement.^{52,60,96}
- CBCT should be used to assess implant sites previously augmented.^{52,60,96}
- CBCT should be used to assess complications with previously placed implants.^{52,60,96,97}

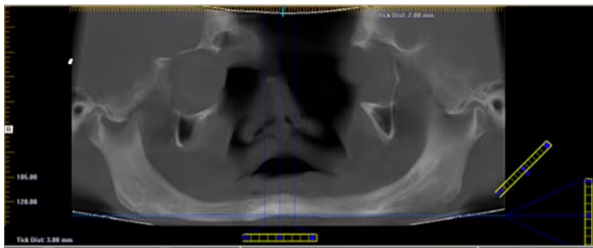


Figure 11: CBCT Panoramic Reformat to Assess Edentulous Mandibular Ridge

- Implant restoration delivery imaging should be conducted using 2D intraoral radiography.¹ A bitewing or periapical should be placed perpendicular to the implant to provide baseline peri-implant bone level information and for long-term reassessment.^{3,60}
- Implant maintenance imaging includes:
 - Periodic 2D intraoral radiographic imaging evaluation of the implant as an adjunct to recall visit or maintenance examination undertaken on the basis of the clinical judgement of the dentist or dental care professional.⁹⁸
 - 2D intraoral radiographic imaging is the

modality of choice to evaluate the peri-implant bone level.^{52,60,97,98}

- CBCT is the modality of choice to evaluate implant complications associated with improper anatomic implant location.⁹⁹
- CBCT in autotransplantation:
 - CBCT is recommended to assess the integrity of the donor tooth and recipient site.⁹⁹⁻¹⁰¹
 - CBCT is recommended for fabrication of the replica donor tooth try-in.⁹⁹⁻¹⁰¹
 - 2D imaging is recommended to assess the survival of the autotransplanted tooth.³

Imaging Recommendations for Endodontics

- For initial assessment and tooth evaluation, 2D imaging is the primary modality of choice.^{52,102,103}
- CBCT may be indicated after initial clinical evaluation and 2D imaging assessment with consideration given to:
 - Contradictory or non-specific signs and symptoms
 - Unusual root or apical anatomy
 - Suspected or unclear apical pathosis
 - Large radiolucency involving multiple teeth or involving one or both cortical plates
 - Calcified canals
 - Root resorption
 - External cervical resorption
 - Previous endodontic treatment
 - Persistent pain
 - Suspected perforation or separated instrument
 - Suspected maxillary sinusitis of endodontic origin
- When CBCT is indicated, the smallest field of view (FOV) should be used to record the needed information using voxel sizes $\leq 0.1\text{mm}$ to provides improved diagnostic accuracy.¹
- For diagnosis and treatment planning of dentoalveolar trauma, CBCT is the modality of choice in patients with confirmed or suspected dentoalveolar trauma not adequately assessed with 2D imaging.^{52,102,103}
- MRI, ultrasonography, sialography, or other advanced imaging may be indicated for salivary or other soft tissue injuries in the absence of other maxillofacial or soft tissue injury.¹
- For the management of endodontically treated teeth with secondary, persistent, or recurrent disease, CBCT is indicated to assess

the causes of new, persistent, or recurrent apical periodontitis and to determine the indications and strategies for surgical or nonsurgical retreatment like lesion size, cortical involvement, surgical planning, and grafting need.^{2,52,99,101,102-110}

- CBCT may be helpful in the discussion of endodontic and non-endodontic options for general dentists who often perform the initial screening and discuss further treatment options with the patient and consultation with an endodontist.¹
- For intentional reimplantation and autotransplantation, CBCT is indicated for confirmation of root anatomy compatibility with atraumatic extraction, and fabrication of a 3D tooth replica of the donor tooth. CBCT imaging may be helpful in difficult treatment.^{52,102}
- Intra-operative imaging is indicated for the identification and localization of calcified canals, canal branching, canal obstruction, and perforation.
- CBCT aids in identification of the spatial relationship of obliterated canals and assists in guided endodontics.
- For post-treatment evaluation, periapical imaging is indicated unless there is evidence of persistent disease (Figure 12). A small FOV CBCT should be considered to identify the etiology and treatment planning options for persistent disease.^{52,102,111}



Figure 12: Post-treatment Periapical image

- For the diagnosis of vertical root and crown-to-root fractures, periapical imaging or CBCT

may be indicated. CBCT is the modality of choice when the clinical examination and intraoral imaging are inconclusive.^{52,102,111}

- Periapical imaging is better in endodontically treated teeth but CBCT imaging in non-endodontically treated teeth is useful to detect patterns of peri-radicular bony changes indicative of root fractures or when the clinical examination and 2D imaging are inconclusive.^{102,111}
- To evaluate endodontic treatment complications, CBCT is indicated for assessment of perforations,^{52,102} root resorption that may be amenable to surgical or nonsurgical retreatment, or other complications.^{52,102}
- For nonsurgical retreatment, CBCT is indicated to localize root apices and locate adjacent structures, canal obstruction, thickness of remaining dentin, major voids, or irregularities in obturation.^{52,102}
- For surgical retreatment, CBCT was found to have higher accuracy than 2D imaging for definitive assessment of surgical endodontic treatment outcomes.¹¹²

General Recommendations for Pediatric Patients

- Consideration must be given to the susceptibility of children and young adults to the effects of radiation. As such, radiographic imaging must be prescribed judiciously and effective dose-reduction measures applied including selection criteria, collimation, optimization of exposure settings.^{2,3,52,113} Lead shielding of pediatric patients during imaging is not indicated.³⁸
- The frequency of radiographic examinations for the patient in the primary, mixed, or early adolescent dentition depends upon the medical/dental history, clinical examination, caries and periodontal risk assessment, tooth eruption, and trauma experience assessment.^{3,27} Follow-up radiographic imaging after the initial radiographic examination should be determined similarly.^{3,71,82}
- Radiographic examination after dental trauma is indicated in addition to a thorough clinical examination in accordance with the International Association of Dental Traumatology guidelines.^{1,7,69}
- Intraoral radiographic imaging

recommendations for pediatric patients with primary, mixed, early adolescent dentitions presenting with severe gingival inflammation from systemic conditions follow.

- Initial assessment should include maxillary and mandibular occlusal, periapical, and bitewing radiographs.¹

- Tooth mobility should be evaluated rather than periodontal probing of hemorrhagic gingiva.^{3,82}

- Extraoral imaging recommendations for pediatric patients include:

- An initial panoramic radiograph should only be obtained after complete eruption of permanent first molars and all mandibular incisors unless needed earlier to assess oral pathosis (Figure 13).¹

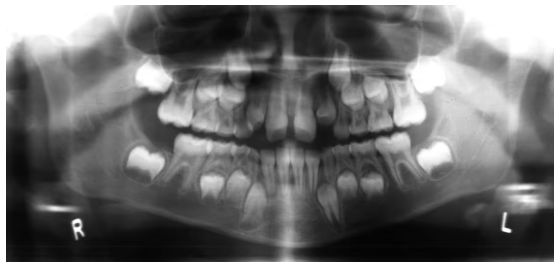


Figure 13: Panoramic Image After Eruption of Permanent First Molars

- Extraoral bite-wing radiographs (Figure 14) may be used for children with special health care needs or who are unable to tolerate intraoral radiography. They should only be considered after clinical examination and assessment for caries and periodontal disease risk, trauma experience, eruption deviations, and third molars.^{2,3,72} Extraoral bitewings provide a radiation dose three times higher than intraoral bitewings and may have lower diagnostic quality.^{2,3,72} Therefore, they should be used judiciously.

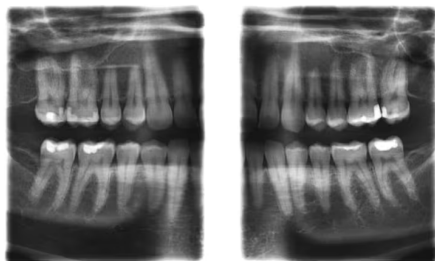


Figure 14: Extraoral Bitewings

- CBCT specific recommendations include the following:

- Initial assessment should include maxillary and mandibular occlusal, periapical, and bitewing radiographs.¹

- The evidence does not support the use of CBCT for caries detection.^{71,72,114-116}

- CBCT may be considered when 2-dimensional imaging does not provide adequate information, such as during suspected pathosis, trauma, or localization of impacted teeth.⁷¹

- The child's ability to follow instructions and remain still should be considered when prescribing radiographic imaging, especially when the modality requires longer exposure time, like panoramic or CBCT imaging procedures.⁷¹

Historical and Clinical Indicators

The dentist can consider indicators such as caries risk as well as historical findings and positive clinical signs and symptoms to determine the need for dental imaging (Table 4).

Table 4. Historical and Clinical Situations Indicative of the Possible Need for Radiographs.¹

CLINICAL INDICATORS	
Positive Historical Findings	Positive Clinical Signs and Symptoms
1. Previous periodontal or endodontic treatment	1. Clinical evidence of periodontal disease
2. History of pain or trauma	2. Large or deep restorations
3. Familial history of dental anomalies	3. Deep carious lesions
4. Postoperative evaluation of healing	4. Malposed or clinically impacted teeth
5. Remineralization monitoring	5. Swelling

Positive Historical Findings	Positive Clinical Signs and Symptoms
6. Presence of implants, previous implant related pathosis or evaluation for implant placement	6. Evidence of dental and/or facial trauma
	7. Teeth mobility
	8. Sinus tract/fistula
	9. Clinically suspected sinus pathosis
	10. Growth abnormalities
	11. Oral involvement in known or suspected systemic disease
	12. Positive neurologic findings in the head and neck
	13. Evidence of foreign objects
	14. Pain and/or dysfunction of the temporomandibular joint(s)
	15. Facial asymmetry
	16. Abutment teeth for fixed or removable partial prosthesis
	17. Unexplained bleeding
	18. Unexplained teeth sensitivity
	19. Unusual eruption, spacing or migration of teeth
	20. Unusual tooth morphology, calcification or color

Positive Historical Findings	Positive Clinical Signs and Symptoms
	21. Unexplained absence of teeth
	22. Clinical tooth erosion
	23. Peri-implantitis

Initial Imaging Recommendations Based on the Type of Encounter

New Patient Evaluation

For new patients being evaluated for oral diseases, the recommendations for radiographic imaging are organized by age and the type of dentition. The radiographic examination, if indicated, should be individualized for each patient taking into consideration the previously discussed parameters and the patient's clinical presentation. Table 5 outlines the recommendations at a glance. Subsequent discussion of each category follows the table.

New Patient Recommendations				
<u>Child with Primary Dentition</u>	<u>Child with Mixed Dentition</u>	<u>Adolescent with Permanent Dentition</u>	<u>Adult Dentate Partially Dentate</u>	<u>Adult Edentulous</u>
Individualized exam: selected periapicals or occlusals if indicated	Individualized exam: bitewings & panoramic	Individualized exam: bitewings & panoramic	Individualized exam: bitewings & panoramic	Individualized exam based on clinical signs & symptoms
Bitewings if contacts are closed	Or bitewings & selected periapicals	Or bitewings & selected periapicals	Or bitewings & selected periapicals	
		Full mouth survey if indicated	Full mouth survey if indicated	

Child with Primary Dentition

The necessity of radiographic imaging for the new child patient with a primary dentition is dependent on the patient's clinical presentation and the clinician's ability to visually inspect the proximal surfaces of the teeth. If the new child patient presents with no evidence of disease

and open proximal contacts, a radiographic examination may not be necessary at the present time.

However, once the proximal contacts are closed, radiographic bitewing imaging for caries assessment is warranted. A selected periapical or anterior occlusal radiographic examination may be indicated to evaluate tooth development, dentoalveolar trauma, or suspected pathoses. Periapical and bitewing radiographic imaging may be necessary to assess pulpal pathosis in primary molars.

Child with Transitional Dentition

For new patients with a mixed or transitional dentition, it is important to consider risk factors for dental caries. Caries incidence varies among children and higher caries patterns are associated with some racial and ethnic groups and lower-income families.^{1,17,118} As such, posterior bitewings are indicated (Figure 15).



Figure 15. Child Bitewing Survey.

Although atypical, if clinical evidence of periodontal disease is observed in this age group, selected periapicals and bitewing

radiographs are indicated to determine the extent of periodontitis and alveolar bone involvement.

Periapical or panoramic imaging is useful for the purposes of evaluating tooth development. Panoramic imaging also is useful to assess craniofacial trauma. Intraoral imaging is preferred over panoramic imaging in the evaluation of dentoalveolar trauma, root shape, root resorption and pulpal pathosis.

Occlusal imaging may be used independently or in combination with panoramic imaging in the following situations:

- an unsatisfactory panoramic image is due to an abnormal incisor relationship.
- for localization of tooth position.
- the clinical examination provides a reasonable expectation of pathosis.

Adolescent with Permanent Dentition prior to the Eruption of Third Molars

There are a variety of factors that can influence the incidence of caries in the adolescent new patient that may result in increased risk. Among these are variations in dietary habits and inattention to daily oral hygiene practices. These same factors may impact periodontal health. Posterior bitewings and selected periapical images may be useful in these instances. If the patient presents with clinical evidence of generalized oral disease or with a history of extensive prior dental treatment, a full mouth survey is preferred.

Panoramic imaging can be utilized to assess tooth development, particularly the third molar teeth, to determine their presence, position and degree of development (Figure 16). Occlusal and/or periapical images can be used to determine the position of an unerupted or supernumerary tooth.



Figure 16. Panoramic Image Third Molar Evaluation.

Depending on the patient’s clinical presentation or situation, an individualized radiographic examination comprised of posterior bitewings and selected periapical images or posterior bitewings and a panoramic image is indicated. As previously mentioned, when generalized oral disease or extensive prior dental treatment is observed, a full mouth survey is recommended.

Adult Dentate Patient

Like other new patients in this category, adult dentate or partially edentulous patients need to be evaluated for proximal and recurrent carious lesions as caries risk and their associated risk factors may change over time. Posterior bitewings can be used for this purpose (Figure 17).

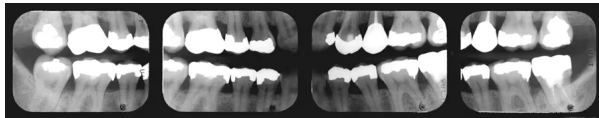
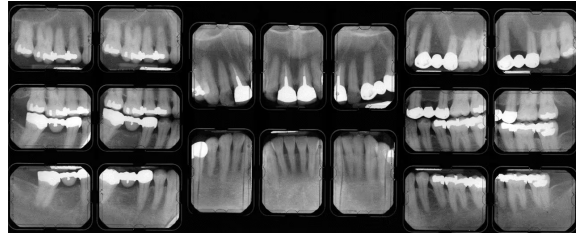


Figure 17. Posterior Bitewing Radiographs

Periodontal disease and root caries increase with age.^{118,119} Previous experience with periodontal disease and its treatment are important to explore if the new adult patient does not present with signs or symptoms of active disease.¹ Selected intraoral imaging may be necessary to assess the patient’s current periodontal status. Panoramic imaging may be useful in conjunction with posterior bitewings if periapical pathosis or unerupted teeth are suspected, partially erupted teeth are observed, carious lesions are present or clinical facial swelling is evident.²⁰ In summary, an individualized radiographic examination comprised of posterior bitewings and selected periapical images or posterior

bitewings and a panoramic image are recommended when indicated. If the patient presents with clinical evidence of generalized oral disease or a history of extensive dental treatment, a full mouth survey is preferred (Figure 18).^{1,3}

Figure 18. Full Mouth Series of Radiographs



Adult Edentulous Patient

For the edentulous new patient, an individualized radiographic examination based on patient clinical signs, symptoms and the proposed treatment plan is recommended.¹ Several studies which focused on treatment outcomes indicated that there is little evidence to warrant screening radiographic imaging for the new edentulous patient.^{120,122}

For those edentulous new patients who present for the initial assessment of oral prosthetic treatment, a radiographic prescription was deemed appropriate.³ The radiographic examination recommended in this instance may consist of the following possible surveys: full mouth periapical images or a combination of panoramic, occlusal or other extraoral imaging. This is especially important when implant therapy is planned for the edentulous new patient as radiographic imaging is important in the diagnosis, prognosis and treatment of the patient.^{3,60}



Figure 19. Panoramic Image of Edentulous Patient

Radiographic Examination of the Recall Patient

Bitewing radiography, primarily for the purpose of detecting interproximal caries, is the only time-based type of radiographic examination included in the guidelines. The recommended intervals are based on research regarding the rate of caries progression through tooth structure and factors that indicate the patient may be at increased risk for caries. Risk factors associated with caries development include poor oral hygiene, high frequency sucrose exposure, and low fluoride intake. The ADA provides further information on caries risk assessment.¹²³

Table 6 summarizes the radiographic recommendations for recall patients with no clinical caries or those who have a low caries risk. In addition, recall patients who presents with clinical caries or who have a high caries risk are addressed as well.

Table 6. Radiographic Examination of the Recall Patient Based on Caries Risk. ^{1,3}					
Recall Patient Recommendations Based on Caries Risk					
Recall Patient	Child with Primary Dentition	Child with Mixed Dentition	Adolescent with Permanent Dentition	Adult Dentate Partially Dentate	Adult Edentulous
With No Clinical Caries or Low Caries Risk	Bitewings at 12 to 24 month intervals if contacts are closed	Bitewings at 12 to 24 month intervals if contacts are closed	Bitewings at 18 to 36 month intervals if contacts are closed	Bitewings at 24 to 36 month intervals	Not Applicable
With Clinical Caries or High Caries Risk	Bitewings at 6 to 12 month intervals if contacts are closed	Bitewings at 6 to 12 month intervals if contacts are closed	Bitewings at 6 to 12 month intervals	Bitewings at 6 to 18 month intervals	Not Applicable

Clinical Caries and Evidence of High-risk Factors for Caries

Children with Primary and Transitional Dentition

The recall child patient with either a primary or transitional dentition who presents with evidence of clinical caries, may have proximal caries. Identification of additional risk factors suggest proximal caries may be present as well. If the proximal contacts are closed, bitewing radiographic imaging is the only means of detecting the carious lesions. In such circumstances, a posterior bitewing examination is recommended at 6-to-12-month intervals. Usually two posterior bitewings are adequate to examine the proximal surfaces of the teeth, one on each side.

Adolescents

Similarly, the recall adolescent patient with a permanent dentition who presents with evidence of clinical caries and/or risks factors for caries, may have proximal caries present. A posterior bitewing examination is recommended at 6-to-12-month intervals when proximal contacts are closed. Usually two to four posterior bitewings are adequate to examine the proximal surfaces of the teeth, one or two on each side.

Adult Dentate, Partially Edentulous, Edentulous Patient

Adult recall patients either dentate or partially edentulous who present with clinical caries or increased risk factors for such, should be examined radiographically for new or recurrent carious lesions. The time interval should be determined based on caries risk assessment. A posterior bitewing radiographic examination is recommended at 6-to-18-month intervals. The patient's caries risk may change so the recall interval may need to be adjusted over time. For the adult edentulous recall patient, no radiographic examination is indicated without evidence of disease.

No Clinical Caries and No Evidence of High-risk Factors for Caries

Child with Primary and Transitional Dentition

The recall child patient with either a primary or transitional dentition who presents with no evidence of clinical caries or no increased risk factors for caries, may have proximal caries. As previously mentioned, increased caries risk has been demonstrated in specific subgroups of children^{18,19} and this data should be taken into consideration when determining the frequency of the radiographic examination. A posterior bitewing examination is recommended at 12-to-24-month intervals if the proximal surfaces of the teeth cannot be examined clinically. The interval recommendation is based on the rate of caries progression in primary and transitional dentitions. Children receiving routine dental care are more likely to be at a lower risk for caries.¹

Adolescents

The recall adolescent patient with a permanent dentition who presents with no evidence of clinical caries or no increased risk factors for caries, may have proximal caries. As such, proximal carious lesions can only be identified through radiographic means. The radiographic recommendation consists of posterior bitewings at 18-to-36-month intervals. The time frame is based on the rate of caries progression in this age group while taking into consideration the caries susceptibility of young permanent teeth.

Adult Dentate, Partially Edentulous, Edentulous Patient

The recall adult dentate or partially edentulous patient who receives regular care and presents with no signs and symptoms of oral disease have a low caries risk. Caries risk factors may change over time, and this must be taken into consideration when evaluating the adult recall patient. The recommended radiographic examination is posterior bitewings at 24-to-36-month intervals. Radiographic examination of the recall adult edentulous patient is not indicated.

Radiographic Examination of the Patient with Active Periodontal Disease or a History of Periodontal Treatment

The determination regarding radiographic examination of the recall child, adolescent, or adult patient with clinical evidence of periodontal disease or a history thereof, is based on the expectation that the information obtained will be critical to proper diagnosis and treatment. A clinical examination of the periodontium should be performed as well as documentation of the clinical signs and symptoms of periodontal disease in order to effectively determine the type and frequency of the radiographic examination. Professional judgment and case-by-case evaluation is necessary to determine the appropriate survey. The recommended survey may consist of, but is not limited to, selected periapical and bitewing images (Figure 20) where periodontal disease other than nonspecific gingivitis is clinically evident.^{1,3} See Table 7 for a summary of the

radiographic recommendations.

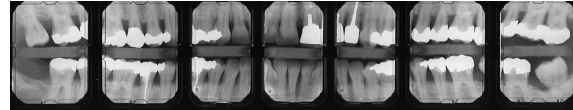


Figure 20. Anterior and Posterior Vertical Bitewing Survey

Table 7. Radiographic Examination of the Recall Patient Based on Periodontal Disease.^{1,3}

Recall Patient Recommendations Based on Periodontal Disease					
Recall Patient	Child with Primary Dentition	Child with Mixed Dentition	Adolescent with Permanent Dentition	Adult Dentate Partially Dentate	Adult Edentulous
With Periodontal Disease	Clinical judgment for need & type of images	Clinical judgment for need & type of images	Clinical judgment for need & type of images	Clinical judgment for need & type of images	Not Applicable
	May include selected periapicals and/or bitewings as indicated	May include selected periapicals and/or bitewings as indicated	May include selected periapicals and/or bitewings as indicated	May include selected periapicals and/or bitewings as indicated	

Summary

The latest recommendations for prescribing radiographic examinations recapitulate and update the 2012 document.¹⁻³ Decision-making guidance on the applicable imaging modalities as well as the safety measures and practices that undergird and support imaging procedures and systems are provided.¹⁻³ Clinical indicators for patient selection, the timing and frequency of diagnostic imaging, and the use of relevant imaging modalities for general and pediatric dentistry are provided to facilitate decision-making.¹⁻²

The clinical recommendations are meant to serve as a framework to support the professional judgment of general and pediatric dentists.¹ Imaging decisions should be made on the basis of comprehensive clinical examination along with a thorough review of the patient's medical, dental, and clinical histories.¹ Radiographic exposure should be justified when the potential diagnostic or treatment benefit outweighs the associated risks.¹ The goal of applying radiographic imaging recommendations and safety practice is to eliminate unnecessary patient exposures while maximizing diagnostic yield.⁴

Course Test Preview

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- 1. Priority recommendations include each of the following practices EXCEPT one. Which is the EXCEPTION?**
 - A. Adherence to local, state and federal laws
 - B. Replacement of film with digital receptors
 - C. Screening patients with panoramic imaging
 - D. Utilization of rectangular collimation
- 2. Prior to prescription of a radiographic examination, the dentist should complete each of the following tasks EXCEPT one. Which is the EXCEPTION?**
 - A. Check if patient insurance will cover the survey cost.
 - B. Conduct a clinical examination of the patient's oral cavity.
 - C. Determine patient risk factors for oral disease susceptibility.
 - D. Review of the patient's dental and medical health histories.
- 3. What is the primary focus of quality control within the overall quality assurance program?**
 - A. Elimination of film imaging
 - B. Regulatory compliance
 - C. Technique chart development
 - D. Measurement and testing
- 4. During patient radiographic imaging procedures, dental staff radiographers should?**
 - A. Position oneself 2 feet away
 - B. Restrain the dental patient
 - C. Stand behind a wall barrier
 - D. Wear a lead abdominal shield
- 5. What is the recommended radiation safety practice for the pregnant dental radiographic personnel?**
 - A. Monitor exposure with a dosimeter
 - B. Refrain from patient radiographic imaging
 - C. Track occupational exposure over 1 mSv/year
 - D. Utilize digital radiographic imaging exclusively
- 6. The dentist should base imaging decisions on each of the following factors EXCEPT one. Which is the EXCEPTION?**
 - A. Clinical examination findings
 - B. Disease risk assessments
 - C. Panoramic screening results
 - D. Patient signs and symptoms
- 7. Which radiation safety practice is the most effective means to limit exposure to the thyroid gland in pediatric imaging?**
 - A. Digital-based imaging
 - B. Kilovoltage selection
 - C. Rectangular collimation
 - D. Thyroid collar shielding

- 8. What is the patient benefit when optimal source-to-skin distance is used for intraoral radiographic imaging?**
- A. Enhances image quality
 - B. Limits area of exposure
 - C. Reduces imaging errors
 - D. Screens out ineffective x-rays
- 9. Each of the following parameters is required for handheld intraoral imaging devices EXCEPT one. Which the EXCEPTION?**
- A. FDA clearance
 - B. Secure storage
 - C. Technical training
 - D. Unrestricted usage
- 10. When the dentist prescribes and utilizes CBCT technology for patient imaging, their interpretation responsibilities**
- A. encompass the entire volume.
 - B. focus on the area of interest.
 - C. focus on the area of interest.
 - D. relevant to the treatment plan.
- 11. In which circumstance is cephalometric imaging indicated for orthodontic treatment?**
- A. Assess CII or CII malocclusion severity
 - B. Assess mini implant site selection
 - C. Assess root morphology and resorption
 - D. Assess tooth eruption prior to treatment
- 12. Because head and neck lesions vary significantly, the best approach for image selection is to**
- A. available range of imaging modalities.
 - B. best modality for lesion evaluation.
 - C. laboratory or test outcomes.
 - D. patient reported symptomology.
- 13. Which is the preferred technology for imaging the soft tissue components of the temporomandibular joint?**
- A. Cone beam computed tomography
 - B. Magnetic resonance imaging
 - C. Multidetector computed tomography
 - D. Positron emission tomography
- 14. In dental implantology, when is panoramic imaging indicated?**
- A. Evaluation of alveolar ridge augmentation
 - B. Fabrication of surgical implant guides
 - C. Initial assessment prior to implants
 - D. Peri-implant bone assessment

- 15. Cone beam computed tomography is recommended for endodontic imaging in each of the following instances EXCEPT one. Which is the EXCEPTION?**
- A. Calcified canals
 - B. Dentoalveolar trauma
 - C. Intentional reimplantation
 - D. Postoperative evaluation
- 16. Panoramic radiography is appropriate for imaging pediatric patient to**
- A. assess the dentition after 1st molar eruption.
 - B. diagnose interproximal carious lesions.
 - C. evaluate severe gingival inflammation.
 - D. localize impacted supernumerary teeth.
- 17. Extraoral bitewings are preferred over intraoral bitewings**
- A. because the associated radiation dose is lower.
 - B. because the resultant image is of higher quality.
 - C. for more comprehensive coverage of the teeth.
 - D. for accommodation of children with special needs.
- 18. In which circumstance is radiographic imaging of the primary dentition not indicated?**
- A. Anterior tooth trauma
 - B. Open proximal contacts
 - C. Proximal surfaces inaccessible
 - D. Unerupted primary teeth
- 19. For adult dentate or partially dentate new patients, when is a full mouth intraoral radiographic survey indicated?**
- A. Evaluation of impacted third molars
 - B. History of extensive dental treatment.
 - C. Isolated areas of periodontal disease.
 - D. Presence of incisal edge attrition.
- 20. For adolescent patients at a low risk for caries, what is the recommended interval for bitewing imaging?**
- A. 6 to 12 months
 - B. 12 to 24 months
 - C. 18 to 36 months
 - D. 24 to 48 months

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Additional Resources

National Council on Radiation Protection and Measurements. Radiation protection in dentistry and oral & maxillofacial imaging. NCRP Report No. 177, Bethesda, MD. 2019 Dec 19.

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