An Update on Digital Radiography

By Howard S. Glazer, DDS

Current Recommendations for Taking Radiographs
The overall goal of this article is to provide the reader with information on digital radiography. On completion of this article, the participant will be able to:

1. Review the applications for intraoral radiographs
2. Describe the attributes of traditional and digital radiography
3. Contrast and compare options for sensors for digital radiography
4. Review the use of scanners for digital intraoral radiographs.

Intraoral radiography is an essential procedure in dentistry, enabling the identification and diagnosis of dental conditions and diseases, monitoring and the assessment of treatment outcomes. In the 20th century, intraoral radiography began with the introduction of traditional film radiographs, a technique still used today. The subsequent introduction of digital radiography, initiated with use of a charge-coupled device in 1984 by Dr. Francis Mouyen, has offered additional features and removed the need to develop and fix radiographs before viewing them. For both traditional and digital radiographic images, the contrasting shades observed on images are the result of the difference in the attenuation (penetration) of the x-ray beam as it passes through tissues of varying density.

First introduced in the 1980s, digital radiographic images can now be obtained using sensors and photostimulable phosphor (PSP) plates, respectively direct and indirect methods. The ability to digitally enhance images by adjusting the contrast, brightness, and/or magnification is a significant advantage in comparison to viewing traditional film radiographs. Consideration must be given to the risk vs benefits of radiographs for an individual patient before taking these, and if radiographs are required, radiation exposure must be minimized. Digital intraoral radiography has significantly changed the manner in which radiographs are taken and viewed.

### Educational Objectives

1. Review the applications for intraoral radiographs
2. Describe the attributes of traditional and digital radiography
3. Contrast and compare options for sensors for digital radiography
4. Review the use of scanners for digital intraoral radiographs.
Options for intraoral digital radiography include bitewing, periapical, and occlusal radiographs. Bitewing radiographs are primarily used for the detection of dental caries, preferably at an early stage, and to monitor existing lesions to determine progression, arrestment, or reversal. They can also be used to determine the status of a new or existing restoration. Periapical radiographs are used to assess the periodontium and the presence/absence of periapical lesions such as abscesses or cysts. While bitewing radiographs may aid in the identification and diagnosis of early periodontal defects within the boundaries of the radiograph, the exposure required differs, which reduces their accuracy for this purpose. In endodontic therapy, periapical radiographs are used to determine the anatomy of root canals, their instrumentation (e.g., working length), and the adequacy of root canal fillings. In implant dentistry, they serve to help identify abutment/implant interface or abutment/restoration issues, and to determine the presence and extent of peri-implantitis. Periapical radiographs are taken in additional disciplines, including as supplemental radiographs in orthodontics. Periapical radiographs are less useful than bitewings for the identification and diagnosis of dental caries. Both digital and film bitewing radiographs have been found to be more accurate in another study compared to panoramic radiographs.\(^3\) Bitewing radiographs can be derived using a specific program in panoramic units. These were found to offer poor diagnostic accuracy in comparison to traditional and digital intraoral radiographs in one study.\(^4\) Occlusal images show the floor of the mouth and palate. These are taken less frequently than bitewing and periapical radiographs. (Table 1)

### Traditional and Digital Radiography

Traditional radiography involves the use of a film that contains the film base, a protective coating of hardened gelatin, an emulsion containing gelatin and silver halide crystals (typically silver bromide), and an adhesive layer.\(^2\) When exposed to the x-ray beam, silver ions form on the crystals and bromine is released. These silver ions create a latent image, which becomes visible after processing of the film using developer and fixer.\(^5\) Since fewer x-ray photons penetrate a dense structure, fewer silver ions are produced. This results in a lighter gray appearance, or in the case of a radiopaque restorative material a white appearance. Less dense structures will have a darker appearance on the radiograph. Higher-speed films are now available, including E- and F-speed films vs D-speed films. These contain larger crystals than slower speed film, thereby requiring less exposure time to release silver ions.\(^6,8\) High-speed film has been found in studies to be as accurate as slow-speed film.\(^7,8\)

While artifacts can be introduced in digital imaging, as discussed below, more opportunities for artifacts exist with film radiography. These include fogging due to exposure to light during processing, a washed-out appearance due to incorrect processing, brown stains resulting from incomplete rinsing, discoloration and brown stains due to inadequate fixing, and scratches introduced as a result of bending the film or occurring following processing – e.g., due to

<table>
<thead>
<tr>
<th>TABLE 1. Intraoral radiograph applications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bitewings</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Periapicals</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Occlusals</strong></td>
</tr>
</tbody>
</table>
poor handling, incorrect storage, or the radiograph being only partially hardened because of insufficient time in the fixer. Film radiographs also age and fade over time, and dust on wet radiographs can result in artifacts (Table 2). Traditional radiographs are a less expensive option than digital radiography, and the final films cannot be altered at a later date. Note that it is also possible to scan traditional radiographs and subsequently show these on computer screens.

Digital radiography involves direct or indirect acquisition of the images. In general, digital radiography offers several advantages compared to traditional radiography, including ease of use and improvements in the overall workflow. Chemical processing is not required, reducing exposure to chemicals and time requirements, and removing the need for a dark room or disposal of hazardous chemicals as well as the lead backing contained in film packets. In addition, while faster film used for traditional radiography has significantly reduced radiation exposure, digital radiography results in less radiation exposure on a per radiograph basis. Digital images are easily stored and standardized, and can be digitally enhanced by adjusting the brightness, contrast, and/or magnification to aid in diagnosis and viewing of anatomical features. The ability to show images on a computer screen, and to manipulate them, can help with patient education. On the other hand, the ability to digitally manipulate images lends itself to intentional tampering with images after the fact. Therefore, an additional original image may be archived elsewhere as a fallback. Another potential disadvantage of digital radiography has been the use of thick sensors that are wired, as these can be cumbersome when taking radiographs and uncomfortable for patients. Digital radiography has a different workflow to traditional radiography, and the equipment is more expensive. (Table 3)

### Intraoral Digital Radiography

Intraoral digital radiography can be achieved by direct image acquisition using sensors and by indirect image acquisition using photostimulable phosphor plates (PSP) plates, also known as storage phosphor plates. They differ both

<table>
<thead>
<tr>
<th>TABLE 3. Digital vs traditional radiography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easier to use</td>
</tr>
<tr>
<td>Improved workflow</td>
</tr>
<tr>
<td>Reduced overall exposure to chemicals</td>
</tr>
<tr>
<td>No dark room required</td>
</tr>
<tr>
<td>No disposal of radiographic chemicals/lead</td>
</tr>
<tr>
<td>Time savings</td>
</tr>
<tr>
<td>Less radiation exposure per radiograph</td>
</tr>
<tr>
<td>Ease of archiving</td>
</tr>
<tr>
<td>Ability to digitally enhance images</td>
</tr>
<tr>
<td>Ease of showing patients images</td>
</tr>
<tr>
<td>Digital images can be tampered with</td>
</tr>
<tr>
<td>Discomfort with thick sensors and cords</td>
</tr>
<tr>
<td>Difficulty positioning sensor/PSP plate due to cords</td>
</tr>
<tr>
<td>Cost of equipment and sensors</td>
</tr>
</tbody>
</table>
in the method of image acquisition following exposure to the x-ray beam and the subsequent interpretation of the acquired data for viewing.2

**Sensors**

Two basic types of sensors are available – charge-coupled devices (CCD) and complementary metal oxide semiconductors (CMOS) (Figure 1). A CCD sensor contains silicon wafers with crystals arranged in a pixel matrix. These crystals are disrupted by the x-ray beam and produce electrons that are attracted to the most positive area of the pixels where they form a latent image. If the smallest pixel size is smaller than the required image details, then all information can be captured.2 The latent image is transmitted electrically via the analog-to-digital converter to or within the computer where it is formatted for viewing (Figure 2).

Sensors are available in sizes comparable to traditional film radiographs. A smaller area is captured by sensors, which may necessitate additional images.13 CMOS sensors contain a chip and are typically smaller than CCD sensors. When exposed to the x-ray beam, light is filtered and then converted to an electrical signal by the pixel sensors. This analog signal is then converted to a digital signal for further manipulation to produce a digital radiograph image (Figure 3). CMOS sensors offer good reliability and durability.13 Direct sensors are rapid, with availability of images for viewing in seconds,14,15 and wireless sensors acquire images more rapidly than wired sensors. Wireless sensors also avoid the possibility of patients chewing on a cord. The thickness and hardness of sensors can make them difficult to position and lead to discomfort,16 in particular for thicker sensors.17,18 Sensors are now available that are thinner, significantly
more comfortable, and with rounded edges. High resolution images are also obtained with a scintillator and high-resolution CMOS sensor.

**PSP plates**

PSP plates contain a phosphor crystal-coated layer that stores energy when the x-ray photons reach it. Energy absorbed from the x-rays is stored in the phosphor crystals (Figure 4). The amount of energy stored at a given location varies with the density of the material being x-rayed and therefore the quantity of x-ray photons that can pass through it. After being exposed to the x-ray beam, the PSP plate is then scanned in order to view the image.11,19 PSP plates are semi-flexible although the corners must not be bent, and they are equipped with wireless receptors. They are approximately the same size and thickness as conventional film, with a thinner version now available, and the whole area captures an image.13,19,20 Due to their size and a degree of flexibility, they may be easier to position than sensors21 and more comfortable for patients. Wafer-thin PSP plates are now available that are 30 times thinner than wired sensors, flexible and with rounded corners to increase patient comfort, and that capture 100% of the area exposed.

PSP plates are in general more tolerant of varying levels of exposure than sensors, and can adjust to the range of x-ray attenuation encountered with the density of various intraoral structures and restorations.2,20 As a result, PSP plates
offer a sharp image, and they are less likely to be affected by under- and overexposure than sensors. PSP plates are much less expensive than sensors and potentially reusable for hundreds of images. Nonetheless, PSP plates must be handled carefully to prevent surface damage and scratching, which can introduce artifacts. In one school, PSP plates were able to be used on average around 50 times before they acquired surface defects that would be detrimental to the final image. In another study, PSP plate durability was on average 200 uses. Scratch-resistant PSP plates are now available (Figure 5).

Scanning and Viewing

After being exposed to the x-ray beam, the PSP plate is placed in a scanner and scanned using a laser beam. The electrons stored in the PSP plate are then released as visible light that is strengthened using a photomultiplied tube. The light is then converted to electrical signals and this analog signal is then converted to a digital image. PSP plates are sensitive to light. Therefore, care must be taken to minimize ambient light after removing barrier protection and before placing the PSP plate in the scanner. Scanners with slots are preferable to those with drums with respect to loading PSP plates in ambient light. Inaccurate processing is known to be a source of artifacts that can mimic oral pathology.

Since residual energy is present on the PSP plate after scanning it, this energy must be erased by exposing it to a bright light for several minutes before it can be used again for image acquisition after placing it in a barrier protection sheath. The time required to scan and erase PSP plates has been a drawback, and together can take 20 seconds or up to several minutes depending on how many plates are being processed and their size. Scanners have now been introduced that are faster and easier to load, and include an "erase" cycle rather than requiring a separate device and transfer of the plates from the scanner to an eraser. Simultaneous scanning is now possible for up to 4 PSP plates within 4 seconds and then appear automatically on the screen for viewing.
Positioning sensors and PSP plate for accurate imaging

Accurate positioning and stability of the digital receptor (sensor/PSP plate) is essential for quality accurate images, with best results obtained using arm and ring positioning devices. Bitepieces are similar to bitewing tabs, occupy minimal space, and fit over digital receptors with loops, or stick on, to help keep receptors in place, but do not provide for accurate alignment obtained with positioning devices. As such, bitepieces that attach to positioning devices help to provide for accurate alignment. With correct alignment, the x-ray beam is perpendicular to the long axis of the teeth for bitewing radiography. Patient discomfort can also impede accurate placement, particularly with sensors that are inflexible and hard. Newer sensors have rounded edges, and cushioning tabs that fit over the periphery of sensors, making it softer against oral mucosa. Another option to improve comfort is to use a positioning technique whereby the sensor is positioned more centrally within the intraoral cavity, farther away from the teeth. Positioning errors can result in overlapping teeth, elongated areas, and other inaccuracies. Regarding the accuracy of radiographs in general, bitewings are more accurate for proximal lesions than for occlusal lesions, and also more accurate for the detection of lesions within dentin than early lesions. Film and digital bitewing radiography are overall both accurate for proximal caries detection and monitoring.

Infection Control

Infection-control recommendations for digital receptors include the use of double-barrier protection. Ideally, the barrier protection will be customized for the PSP plate or sensor being used, of double thickness and provide a close-fitting, 100% seal to prevent contamination. For noncustomized barrier protection, the digital receptor should be double-wrapped in barrier protection to reduce the risk of contamination. After removal and disposal of the barrier protection immediately after use, it may be recommended that
the digital receptor be wiped with an EPA-registered cleaner/disinfectant. The specific instructions for reprocessing from the manufacturer of the sensor/ PSP plate you are using should be followed. PSP plates cannot be immersed in high-level disinfectant, nor can the vast majority of sensors.

Positioners and holders used for intraoral radiography contact oral mucosa. Autoclavable positioners and holders should be autoclaved after cleaning, and those that cannot be autoclaved should be cleaned and then immersed in a high-level disinfectant/sterilant.30 Always check the manufacturer’s instructions and follow these. Any single-use disposable items must be disposed of after use on a single patient. Items contacting intact skin include the x-ray unit tube head, digital sensor cords, and control panels. These can be barrier-protected or cleaned and disinfected, depending on the instructions. A computer keyboard and mouse can be treated similarly. Wireless PSP plates and sensors remove the need to barrier-protect wires, saving time. Protective aprons and collars should be cleaned and disinfected. Cleaning wipes are also available as soft fabric that is safe for PSP plate surfaces while able to remove dust, lint, and other superficial debris.

**Radiation exposure and the ALARA principle**

A determination of the need for dental radiographs must first be made. Radiographs should only be taken after consideration of the risks vs the benefit for the individual patient to avoid unnecessary exposure to radiation. Current ADA recommendations provide guidance on the age at which the first radiographs should be taken and the need for and frequency of radiographs for children, adolescents, and adults. The recommendations are also based on dental history, status of the dentition (dentate/partially edentulous/edentulous), clinical signs and symptoms, and evidence of generalized oral disease. Clinical judgment must still be used when considering radiographs.31 Where it is determined that radiographs are appropriate, doses received by patients must be well within allowable limits, and the risk of radiation exposure must be minimized in accordance with the ALARA principle (As Low As Reasonably Achievable) and as few radiographs as necessary taken.31 Collimation and filtration are required to reduce radiation exposure, and rectangular collimation offers greater reductions in exposure than circular collimation. Additionally, scatter is reduced which improves the image quality.

An accurate technique must be used to minimize the possibility of retakes being required, including the use of positioning devices. In addition, processing must be performed with care to avoid artifacts that would result in a repeat radiograph being required.

Using digital radiography rather than film radiography can contribute to reductions in radiation exposure, and allows for image manipulation to aid diagnosis that may reduce exposure by reducing subjective errors and taking of supplemental radiographs. Nonetheless, while digital radiography results in reduced radiation exposure on a per radiograph basis, due to the greater ease with which digital radiographs can be taken and viewed/processed, retakes may be taken more readily than for film radiographs. This can result in increased radiation exposure and loss of some of the relative gain vs film.

Digital radiography also tolerates overexposure to
x-ray beams better than film radiography. Although on an individual basis this could avoid a retake, it also means that overexposure may occur over time without correction. Care must be taken to ensure that the exposure setting is at the lowest level that still permits quality imaging. In the event film radiographs are being used, high-speed films should be used. Protection must be provided to patients, and for intraoral radiographs this includes the use of protective aprons (lead or nonlead) and collars that protect the thyroid.

Conclusions

Digital technology has substantially changed the efficiency with which intraoral radiographs can be taken and viewed. In addition, time saving can be achieved and chemical agents are not required to process the images. Options include sensors and PSP plates. While sensors are direct and enable more rapid viewing of images than PSP plates, they are also rigid, traditionally thick, and are much more expensive. PSP plates are semi-flexible and inexpensive; however, they require careful handling and also require processing in a scanner and erasure of residual energy stored in the plate. Infection-control procedures must be followed, and radiation exposure minimized for patients. Technology advancements have resulted in the availability of thinner sensors. Advancements have also resulted in PSP plates that are wafer-thin and scratch-resistant and in single devices that can now both rapidly scan and then erase multiple PSP plates at the same time. Digital radiography offers significant advantages over traditional film radiography, including the possibility of improved communication with patients, reduced radiation exposure, and higher quality images.

References


21. USAF. DECS. Synopsis of direct and indirect digital radiography systems.


Webliography


1. The contrasting shades observed on radiographic images are the result of the difference in the __________________ of the x-ray beam as it passes through tissues of varying density.
   a. reflection
   b. refraction
   c. attenuation
   d. differential wavelength

2. Bitewing radiographs are less accurate than periapical radiographs for the identification and diagnosis of early periodontal defects, due to the differences in the required __________________.
   a. exposure
   b. wavelength
   c. processing
   d. scanning

3. Higher speed film contains smaller crystals than slower speed film, thereby requiring less exposure time to release silver ions.
   a. True
   b. False

4. Scratches can appear on film radiographs due to __________________.
   a. poor handing
   b. insufficient time in the fixer
   c. incorrect storage
   d. all of the above

5. Digital images can be digitally enhanced by adjusting the __________________.
   a. brightness, color, and/or pixellation
   b. magnification, contrast, and/or color
   c. magnification, brightness, and/or contrast
   d. pixellation, contrast, and/or magnification

6. The ability to digitally manipulate them lends itself to intentional tampering of images.
   a. True
   b. False

7. A charge-coupled device sensor contains silicon wafers with crystals that are disrupted by the x-ray beam and produce ________________ that are attracted to the most positive area of the pixels where they form a latent image.
   a. light
   b. neutrons
   c. electrons
   d. actions

8. If the ________________ pixel size in the pixel matrix contained in a charge-coupled device is ________________ than the required image details, then all information can be captured.
   a. smallest; larger
   b. smallest; smaller
   c. largest; smaller
   d. largest; larger

9. The use of complementary metal oxide semiconductors or charge-coupled devices results in ________________ image acquisition.
   a. direct
   b. indirect
   c. compacted
   d. magnified

10. Wireless sensors ________________.
    a. acquire images more rapidly than wired sensors
    b. avoid the possibility of patients chewing on a cord
    c. are thinner than wired sensors
    d. a and b
11. Photostimulable phosphor plates contain _______________ that store(s) energy, after which the plates are scanned in order to view the image.
   a. a phosphor gel
   b. phosphor crystals
   c. phosphates
   d. a phosphor solution

12. Compared to sensors, photostimulable phosphor plates are generally _______________.
   a. more tolerant of poor handling
   b. less tolerant of varying exposure levels
   c. more tolerant of varying exposure levels
   d. less flexible

13. Scratches on photostimulable phosphor plates can _______________.
   a. be avoided by careful handling
   b. be avoided by using scratch-resistant plates
   c. result in artifacts
   d. all of the above

14. _______________ must be scanned to view the resulting radiographic images.
   a. Charge-coupled devices
   b. Photostimulable phosphor plates
   c. Complementary metal oxide semiconductors
   d. Traditional film

15. It has been reported that scanners with _______________ are preferable to those with _______________ with respect to loading in ambient light.
   a. drums; slots
   b. slots; drums
   c. slots; cylinders
   d. cylinders; drums

16. Photostimulable phosphor plates must be erased to reduce phosphorization after the image is converted for viewing.
   a. True
   b. False

17. One option to improve comfort when placing sensors is to use positioning technique whereby the sensor is positioned more _______________ within the oral cavity.
   a. laterally
   b. mesially
   c. lingually
   d. centrally

18. Generally, infection-control recommendations for digital receptors include the use of _______________.
   a. immersion disinfection
   b. barrier protection
   c. chlorine-based cleaners
   d. barrier protection followed by immersion

19. The risk of radiation exposure while taking radiographs must be minimized in accordance with the _______________ principle.
   a. AMANA
   b. ALOVA
   c. ALARA
   d. ARALA

20. _______________ is a method to help minimize radiation exposure while taking intraoral radiographs.
   a. An accurate technique reducing the need for retakes
   b. The use of a protective apron and collar
   c. Collimation and filtration
   d. all of the above
An Update on Digital Radiography

COURSE EVALUATION
Please evaluate this course using a scale of 3 to 1, where 3 is excellent and 1 is poor.

1. Clarity of objectives .................................... 3  2  1
2. Usefulness of content .................................... 3  2  1
3. Benefit to your clinical practice ......................... 3  2  1
4. Usefulness of the references ............................. 3  2  1
5. Quality of written presentation ......................... 3  2  1
6. Quality of illustrations ................................... 3  2  1
7. Clarity of quiz questions ................................. 3  2  1
8. Relevance of quiz questions ............................. 3  2  1
9. Rate your overall satisfaction with this course ........ 3  2  1
10. Did this lesson achieve its educational objectives? Yes  No
11. Are there any other topics you would like to see presented in the future?

EDUCATIONAL OBJECTIVES
1. Review the applications for intra-oral radiographs
2. Describe the attributes of traditional and digital radiography
3. Contrast and compare options for sensors for digital radiography
4. Review the use of scanners for digital intraoral radiographs.

COURSE SUBMISSION:
1. Read the entire course.
2. Complete this entire answer sheet in either pen or pencil.
3. Mark only one answer for each question.
4. Mail answer form or fax to 732-303-0555.

AGD Code: 130

QUIZ ANSWERS
Fill in the circle of the appropriate answer that corresponds to the question on previous pages.

1. A   B   C   D
2. A   B   C   D
3. A   B   C   D
4. A   B   C   D
5. A   B   C   D
6. A   B   C   D
7. A   B   C   D
8. A   B   C   D
9. A   B   C   D
10. A   B   C   D
11. A   B   C   D
12. A   B   C   D
13. A   B   C   D
14. A   B   C   D
15. A   B   C   D
16. A   B   C   D
17. A   B   C   D
18. A   B   C   D
19. A   B   C   D
20. A   B   C   D

Price: $29  CE Credits: 2
Save time and the environment by taking this course online.

If you have any questions, please email Dental Learning at questions@dentallearning.net or call 888-724-5230.
Current Recommendations for Taking Radiographs

The current American Dental Association (ADA) recommendations on taking radiographs, and the frequency with which they are taken, were developed together with the Food & Drug Administration.1,2 The recommendations provide guidance on when radiographs may be of benefit while considering radiation exposure risk. They address indications for radiographs for new and existing patients, by age and stage of dental development, and consideration of oral health status and health history.1,2 The recommendations are to be used only after completing a clinical examination and reviewing the patient’s health history.2 They are intended to provide guidance that should be combined with clinical judgment.1,2 Table 1 shows the recommendations for new patients in general and for recall patients with the presence/absence of clinical caries and an increased risk for caries as well as for patients with periodontal disease.2 In addition, the need for radiographic examination in new and recall patients for monitoring growth and development, assessment of dental/skeletal relationships, and patients with other circumstances are addressed in the ADA and FDA recommendations. These recommendations can also be found on the FDA website.2 In conclusion, ensuring that radiographs are taken when indicated, and not unnecessarily, is an important aspect of patient care and safety.

Table 1. Recommendations for prescribing dental radiographs2,a

<table>
<thead>
<tr>
<th>TYPE OF ENCOUNTER</th>
<th>PATIENT AGE AND DENTAL DEVELOPMENTAL STAGE</th>
<th>New Patient* being evaluated for oral diseases</th>
<th>Recall Patient* with clinical caries or at increased risk for caries**</th>
<th>Recall Patient* with no clinical caries and not at increased risk for caries**</th>
<th>Recall Patient* with periodontal disease</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Child with Primary Dentition (prior to eruption of first permanent tooth)</td>
<td>Individualized radiographic exam 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 exam at this time.</td>
<td>Posterior bitewing exam at 6-12 month intervals if proximal surfaces cannot be examined visually or with a probe</td>
<td>Posterior bitewing exam at 12-24 month intervals if proximal surfaces cannot be examined visually or with a probe</td>
<td>Clinical judgment as to the need for and type of radiographic images for the evaluation of periodontal disease. Imaging may consist of, but is not limited to, selected bitewing and/or periapical images of areas where periodontal disease (other than nonspecific gingivitis) can be demonstrated clinically.</td>
</tr>
<tr>
<td></td>
<td>Child with Transitional Dentition (after eruption of first permanent tooth)</td>
<td>Individualized radiographic exam consisting of posterior bitewings with panoramic exam or posterior bitewings and selected periapical images.</td>
<td>Posterior bitewing exam at 6-18 month intervals</td>
<td>Posterior bitewing exam at 18-36 month intervals</td>
<td>Posterior bitewing exam at 24-36 month intervals</td>
</tr>
<tr>
<td></td>
<td>Adolescent with Permanent Dentition (prior to eruption of third molars)</td>
<td>Individualized radiographic exam consisting of posterior bitewings with panoramic exam or posterior bitewings and selected periapical images. A full mouth intraoral radiographic exam is preferred when the patient has clinical evidence of generalized oral disease or a history of extensive dental treatment.</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td></td>
<td>Adult, Dentate or Partially Edentulous</td>
<td>Individualized radiographic exam, based on clinical signs and symptoms.</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td></td>
<td>Adult, Edentulous</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

Table 1. Recommendations for prescribing dental radiographs2,a

References
