Essential Tips for Dental Radiographers

The Academy of Dental Learning and OSHA Training, LLC, designates this activity for 2 continuing education credits (2 CEs).

Martin S. Spiller, DMD

Health Science Editor: Megan Wright, RDH, MS

Publication Date: May 2010

Updated Date: December 2021

Expiration Date: December 2024

Conflict of Interest Disclosure: ADL does not accept promotional or commercial funding in association with its courses. In order to promote quality and scientific integrity, ADL's evidence-based course content is developed independent of commercial interests. Refund Policy: If you are dissatisfied with the course for any reason, prior to taking the test and receiving your certificate, return the printed materials within 15 days of purchase and we will refund your full tuition. Shipping charges are nonrefundable.

California Registered Provider Number: RP5631

Answer Sheet: **Essential Tips for Dental Radiographers**

1. ________	3. ________	5. ________	7. ________	9. ________
2. ________	4. ________	6. ________	8. ________	10. ________

Name: ____ **Profession:** _________________________

License State: ____________ **License Number:** ________________ **Expiration Date** _____________

Address ____

City: ____________________________________ **State:** __________ **Zip Code:** _________________

Telephone:________________________________ **Fax:** ____________________________________

E-mail: ____

If you have downloaded the course and printed the answer sheet from the Internet please enter payment information below.

Card type: ___________________ **Card Number:**____

Exp. Date: _______________ **Name as it appears on card:** __________________________________

***To enter your answers online you MUST return to our website www.dentallearning.org.**

Return answer sheet:

- Via fax: 800.886.3009
- Via email: CESupport@dentallearning.org
- Postal Mail: ADL, PO Box 14585, Albany, NY 12212

***PLEASE PRINT CLEARLY; ILLEGIBLE ANSWER SHEETS WILL NOT BE PROCESSED.

Notes:

Course Evaluation

Please place an X in the box to rate these statements:	Poor	Fair	Good	Very Good	Excellent
The content fulfills the overall purpose of the course.					
The content fulfills each of the course objectives.					
The course subject matter is accurate.					
The material presented is understandable.					
The teaching/learning method is effective.					
The answers to the test questions are appropriately covered in the course.					
How would you rate this course overall?					
Time to complete the entire course and the test?	**Hours:** __________			**Minutes:** ________	
	Google				
	Other Search Engine				
	Friend/CoWorker				
	Other				
Do you have any suggestions about how we can improve this course? If so please note them on a separate sheet of paper and send it in with your answer sheet.					
If you studied the course online, did all the links work? If not please note the page and link on a separate sheet of paper and send it in with your answer sheet so we can fix it.					

Instructions

1. Review the Objectives: Objectives provide an overview of the entire course.
2. Read the course material.
3. Complete the test:
    a. Return to our website: www.dentallearning.org, click on Take the Exam, enter your answers, register, if you are new customer (existing customers login), pay for the course, click Grade Test. Your test will be graded immediately. If required, complete the course evaluation. Your certificate will display for you to print.
    b. If you would rather, you may return your completed answer sheet and course evaluation to us via the options listed below.

To successfully complete the course you must score 80% or above on the test. If you do not score 80% you may retake the test one more time free of charge. If you fail a second time you must purchase a new course and test.

If you've downloaded this coursebook off the Internet you can:

- Return to our website (www.dentallearning.org) to take the test online (only if you have not purchased the coursebook separately). You will need to provide credit card information at the time you submit your test online for scoring.
- Write your answers on the one-page answer sheet included in this book, complete the credit card payment information, and return the form to the address below, fax, or email address below. Or, you may send a check or money order to the address below with your answer sheet.

Academy of Dental Learning and OSHA Training, LLC (ADL)
P.O. Box 14585
Albany, NY 12212
Fax: 800.886.3009
Email: CESupport@dentallearning.org

Answer sheets received without payment will not be processed.

We grade all tests in a timely manner; if you do not receive your certificate within five days, please email CESupport@dentallearning.org.

There is no time limit for return of your answer sheet. Completion dates are taken from the envelope postmark or the finish date recorded in the computer when you do an online exam. Tests MUST be completed in the licensing cycle you wish to use the credits.

If you are dissatisfied with the course for any reason, prior to taking the test and receiving your certificate, return the printed materials within 15 days of purchase and we will refund your full tuition. Shipping charges are nonrefundable.

If someone else would like to use this material after you are done, he or she may register with us and take advantage of a “sharing discount”. Courses downloaded from the Internet can be shared at the same tuition rate as currently available on our website. Please call us if you need an extra answer sheet or download one from our website. There is no “sharing discount” for online exams.

The author and ADL have made every effort to include information in this course that is factual and conforms to accepted standards of care. This course is not to be used as a sole reference for treatment decisions. It is your responsibility to understand your legal obligations and license requirements when treating patients. ADL is not responsible for the misuse of information presented in this course. The material in this course cannot be reproduced or transmitted in any way without the written consent of ADL.

Table of Contents

Course Description

This course begins its discussion with shadow casting techniques, the Clark Shift, and then continues to examine intraoral film placement, descriptions of radiographic surveys, and patient management techniques including how to control gagging. The course discusses film processing principles, mounting, infection control, and common operator errors. It provides information regarding qualities of excellent radiographs and useful techniques that, if mastered, ensure quality x-rays.

Objectives

At the completion of this course, the learner will be able to:

- Name the main series of dental x-rays.
- List all the qualities of excellent x-rays and know the steps to achieve them.
- Understand the benefits and drawbacks of implementing digital radiology in a dental office.
- Describe proper processing techniques for exposed film.
- List common X-Ray operator errors and ways to avoid them.

About the Authors

Martin S. Spiller, DMD

Martin Spiller graduated in 1978 from Tufts School of Dental Medicine. He is licensed in the state of Massachusetts and has been practicing general dentistry in Townsend, MA since 1984. Upon graduation from dental school, Dr. Spiller spent four years as a U.S. Army officer. During this time he attended a dental general practice residency in which he received training in numerous dental specialties including: oral surgery, endodontics, pedodontics, and orofacial surgical techniques and facial trauma.

In 2000, he began work on a general dentistry website (www.doctorspiller.com). The intention at first was to educate the general public about dental procedures and the concepts behind them. Eventually, the website became popular with dental professional Students. Dr. Spiller was asked to write this course based on academic study, hard won experience in the practice of dentistry, and his proven ability to write clear and concise content.

Megan Wright, RDH, MS

Ms. Wright is a continuing education editor and writer as well as a Temp PRN with agencies in the Washington State area. Ms. Wright earned her MS at the UNM and Pierce College of Washington State in 1997 and certification in Utilization of the 970 Diode Laser and Safety in Dentistry in February of 2015. Ms. Wright works to implement Dental Education seminars as a Hospital-Dental Liaison building collaborative, mutual efforts to promote patient wellness between medical practitioners and dentists while prioritizing care for untreated, medially compromised patients.

The History of X-Rays

Wilhelm Conrad Roentgen, a Bavarian physicist, discovered x-rays. He was working with sealed glass vacuum tubes, each containing a cathode and anode. During his experiments, he applied voltage to these tubes and noticed a screen near the tubes was glowing. He blocked the path of the rays to see if this would prevent the screen from glowing. When he placed his own hand between the tube and screen, he could see the outline of his bones on the screen. This historic discovery, on November 8, 1895, dramatically changed diagnostic procedures in medicine and dentistry. Roentgen received the first Nobel Prize in physics in 1901 for his discovery of x-rays.

Roentgen's Hand

Shadow Casting

One of the most important concepts in dental radiography is shadow casting. Once the operator realizes the correlation between the position and angulation of the various elements in radiography and the way ordinary shadows are cast (for example, the way your own shadow is cast on the ground on a sunny day) , the entire process of film/sensor and source placement becomes easier to understand. Only the basics of shadow casting are reviewed in this course. For a detailed presentation of shadow casting, and more regarding film use, refer to our Advanced Radiology course.

Parallel Technique vs. Bisecting the Angle

Parallel Technique

The receptor and long axis of the tooth should be parallel. As in the paralleling technique, the distortion of the recorded image is decreased. A projector casting our shadow on a perpendicular wall shows a reasonable representation of our shape in the shadow. However, if we stand as the sun sets, our shadow on the ground gets longer and longer. The shadow elongation is greater at the feet than at the head. When the sun is directly overhead, our shadow is extremely foreshortened. This sort of distortion is important to understand when taking periapical films, since often, there is not enough room in the mouth to place film parallel to the teeth.

The image below, left shows an extracted tooth lying flat on x-ray with the beam aimed at 90 degrees to both. This image shows the truest representation of the tooth size and shape.

In the x-ray on the right, the beam i s at 90° to the sensor. However, the tooth crown is tilted up and lies at 30° to the sensor and beam. The tooth in this image is foreshortened. This image shows what happens when there is not enough room in the mouth to keep the sensor and beam properly aligned. The way to compensate for this problem is to use a technique which splits or bisects the angle between the sensor and the tooth.

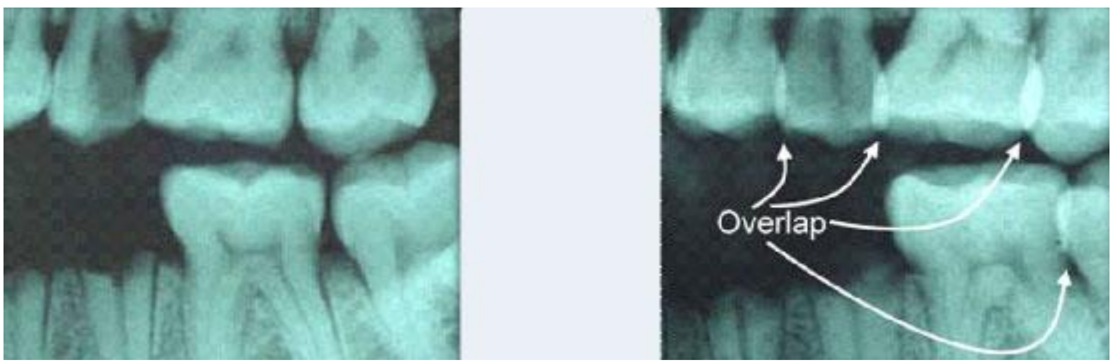
In the image below the tooth was at the same angle as the image to the right. The difference in the exposure was that the beam was repositioned so that it split the difference in angle between the sensor and tooth. Notice the filling is slightly foreshortened, and the pulp chamber is visible. The roots are elongated compared to the roots in the image at right. These consequences are due to adjusting the angle of the beam.

The x-ray beam should be perpendicular to the receptor. If this technique is not used, the image will shift and cause overlapping of adjacent structures on to the image. If the beam is at a lateral angle to the sensor while trying to take bitewing x -rays, the crowns of the teeth may appear to be overlapping and this will obscure the contacts.

The Rinn sensor holder keeps the beam perpendicular to the sensor, but unfortunately , the actual sensor is not always parallel to the teeth. These principles are especially important when taking bitewing x-rays in which contacts between teeth must be clearly visible.

Misangulation of the x-ray beam causes adjacent teeth shadows to overlap, obscuring incipient caries and other anatomical structures. This principle applies to a single tooth when multiple structures such as the nerve space and fillings may overlap in various ways depending on the relative angulations of the source and the tooth. The radiograph below, left side, was taken with all three elements--the sensor, teeth, and the beam--in optimum alignment.

The sensor is parallel to the teeth, and the beam is perpendicular to both. Notice the contact areas between the teeth are clear, and there is no overlap. The radiograph below right was taken with the sensor and teeth parallel, but the beam is angled about 20 degrees from the mesial. Notice the contacts between the teeth overlap. This overlap can easily obscure any caries that may be present. Also notice how the root caries on #14 are apparent in the left radiograph but not on #14 in the right one, which was shot from a mesial angle.



This concept is most easily understood using a simple example. Picture a sharp shadow of your hand with the fingers spread apart. As long as the palm of your hand is perpendicular to the sun, your hand’s shadow is an accurate representation of your hand, fingers spread. Now imagine slowly twisting your hand so your palm becomes parallel to the sunlight. Even though you are keeping your fingers spread, the shadow shows the spaces between the fingers progressively getting smaller until the fingers overlap entirely.

Shadow Casting Tricks

Having read information regarding shadow casting helps you understand why many radiographs may not come out the way you would like. The distortions you see in x-rays result from incorrect alignment of the beam, object, and sensor. Almost no intraoral radiograph is free from some degree of distortion. There are two things you can do to produce the best radiograph possible.

1. Align the three factors--the source, teeth and sensor to reduce distortion as much as possible.

2. Use, and even exaggerate, distortion to your advantage.

Trick 1: Bisecting the Angle
(Helpful when sensor cannot be placed parallel to the long axis of the teeth.)

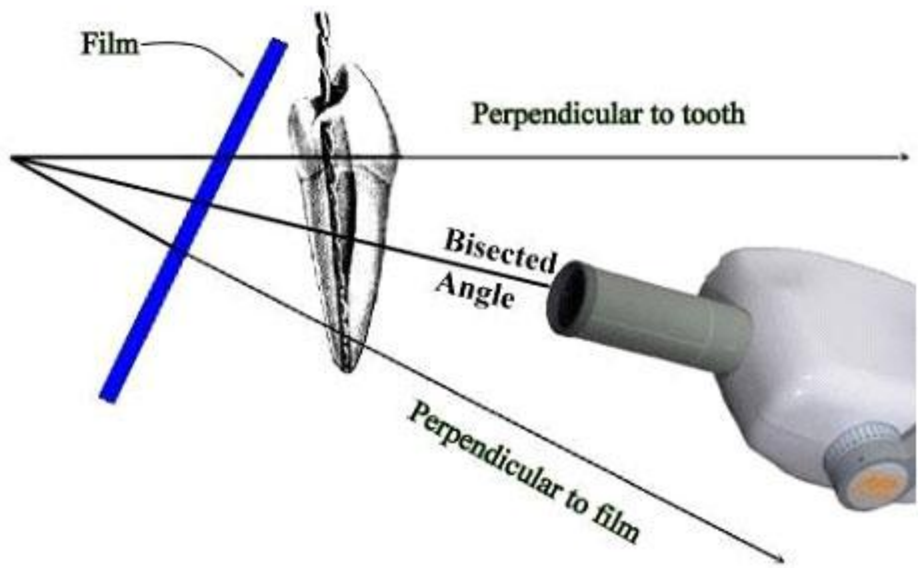
There is an easily learned technique in which the operator can overcome most distortion (foreshortening or elongation). This technique is called bisecting the angle, and once mastered can be used to produce the least distorted images of all periapical radiographs in a full mouth series.

Bisecting the angle works especially well in cases in which a low palate or a mouth floor necessitates tilting a periapical sensor medially. While the apical part of the tooth is slightly foreshortened, coronal portions are equally elongated producing an overall image that is quite satisfactory.

Once mastered, this technique shortens the time needed to complete a full mouth series. The technique works especially well when taking periapical x-rays for endodontic purposes, because the overall radiographic length of the tooth approximates very closely with the actual occlusal-apical length.

The Rinn apparatus may be used in this procedure; however the x-ray tube is not placed parallel with the ring. The ring and alignment arm may be helpful in visualizing the film alignment. However, the dental practitioner is able to use sensor holder without the ring apparatus.

1. Place film in the mouth using a bite block or the sensor holder from a Rinn apparatus without the ring or the metal rod.
2. Position the film as close to parallel to the long axis of the tooth as is possible.
3. Position the x-ray tube perpendicularly to the sensor, and note the tube angle. Call this position one.
4. Reposition the tube perpendicular to the tooth. Call this position two.
5. Reposition the tube so it is at an angle exactly between positions one and two. This is the angle that will produce the least distorted shadow of the tooth.



Once mastered, this technique is faster and more accurate than using the Rinn, since you do not need to change the apparatus between shots. It always produces the least distorted shadow possible when the angle of the sensor and teeth can be compensated for by the beam angle.

This technique is essential with occlusal x-rays on a child. Place sensor in the child's mouth perpendicularly to the long axes of both the upper and lower incisors. Aim the beam perpendicularly to the film surface and angle midway between perpendicular to the sensor and perpendicular to the teeth.

Rinn's XCP system sensor holders help keep film perpendicular to the x-ray beam which eliminates one source of distortion, but they cannot eliminate the distortion produced when the sensor is not parallel to the teeth. With practice, developing a technique that utilizes angle bisecting does produce less distorted intraoral images and saves quite a lot of time.

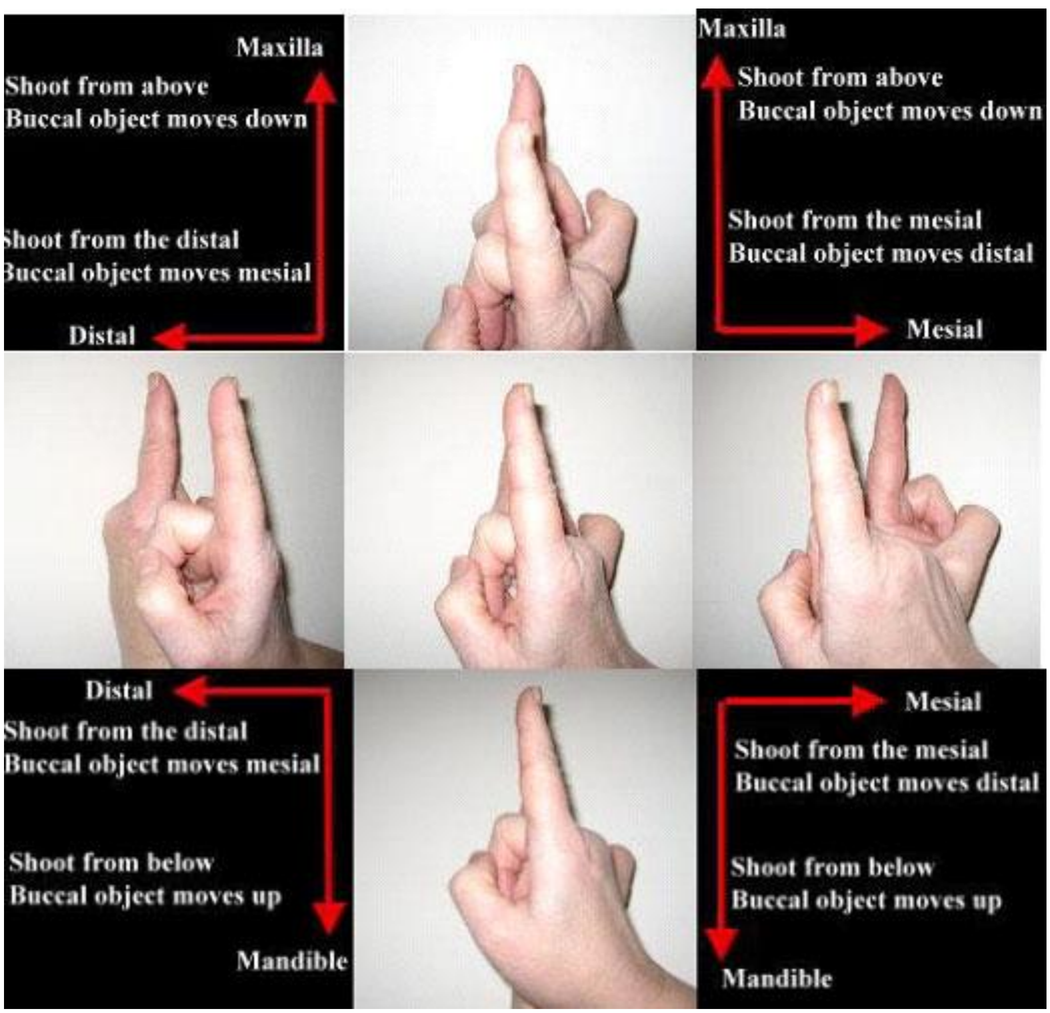
Trick 2: Moving the Cone

Due to a patient's gag reflex, it is often impossible to position the sensor far enough posteriorly to get a clear shot of a maxillary second or third molar. It is also often difficult or nearly impossible to get a periapical of the entire first premolar due to the mandibular curve or the shape of the palate.

Moving an object up, down, right, or left on a radiograph is fairly easy. This technique takes advantage of the fact that the sensor is generally at least three or four millimeters palatal or lingual to the teeth you want to move. In fact, the further to the lingual you can move or tilt the sensor, the further you can move the image of the teeth.

To understand this technique, look at the photographs on the following page. Point your index fingers of both hands up, close your left eye, and hold the index fingers parallel as in the photograph in the middle. Look through your right eye, and shift your hands as a unit to the right. Notice that the finger farthest from you seems to shift left. When you move your hands as a unit to the left and you are looking through your left eye, the finger farthest from you seems to shift right. The same thing happens when you shift your hands up or down.

This is the parallax effect, and we use it to our advantage to get that difficult-to-shoot third molar, or to move the image on the x-ray so that the root-tip or crown is not cut off. You never have to move the sensor if you use digital equipment. Just shift the tube head so the image shifts in the opposite direction. If you want a third molar to move mesially, shoot from the distal. If you need to drop the root tip of a maxillary molar back onto the image, shoot from a higher angle. Remember, you must reangle the tube head toward the sensor so that the beam is aimed toward it.



Trick 3: The Clark Shift

(Using parallax to determine the buccal-lingual position of an object in bone.)

The Clark Shift is an old trick used by radiologists to determine whether an impacted tooth, tumor, or other object is located to the buccal or to the lingual of adjacent teeth roots, (or to any other object visible on a radiograph but not otherwise visible in the mouth).

A radiograph is just a shadow, and a shadow is a two-dimensional projection of a three- dimensional object onto a screen. When you look at a single x-ray, you see two objects superimposed over each other. It is impossible to tell from that single x-ray image which of the objects lies to the buccal and which lies lingually or palatally.

On the other hand, if you take two shots of the same field from two different angles, parallax causes the buccal object to move distally and the lingual object to move mesially. This is how computerized tomography makes three-dimensional reconstructions of large anatomic structures. CT scanners take multiple shots from different angles, and use the rules of parallax to mathematically calculate an object's three dimensional structure.

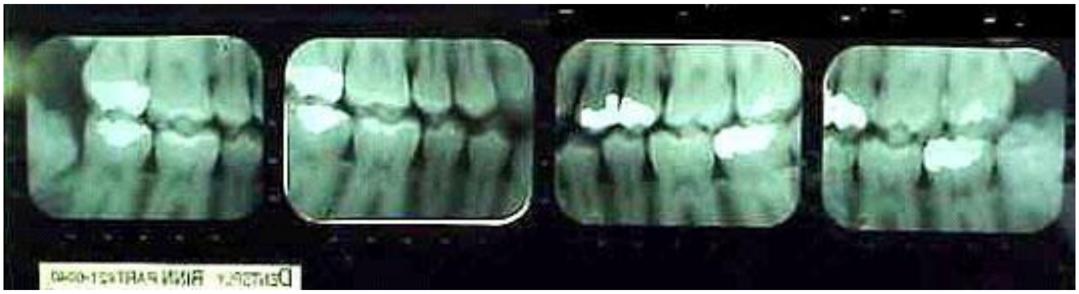
Trick 4: The MBD Rule

If you shoot from the **M**esial, a **B**uccal object moves **D**istally. If you shoot two images of an impacted canine, and the canine tooth shifts distally with respect to the roots of the lateral and the first premolar on the shot taken from a mesial angle, then the canine is located to the buccal of those roots.

Radiographic Surveys

Three common series of radiographs taken in dental practice are bitewing surveys, full mouth surveys, and panoramic film. Bitewings consist of a premolar and molar view of each side of the mouth taken in occlusion (two or four x-rays). Full mouth surveys consist of an x-ray series that represents every tooth in the patient's mouth (with three to four millimeters of surrounding bone) and all other tooth bearing areas of the mouth even if edentulous (no teeth present). Bitewing x-rays are taken to examine premolar and molar contact areas, and periapicals for teeth and edentulous areas.

The Bitewing Series (BWX)



A bitewing series consists of either two or four images taken of the back teeth (although some offices take images of front teeth as well). The patient bites down, so images contain both the top and bottom teeth. A bitewing series is the minimum set of x-rays most offices take to document the teeth and gums' internal structures.

With children under 12 or without erupted adult second molars, two x-rays, one on either side, are sufficient. With anyone over age of 12 or anyone who has erupted adult second molars, it is advisable to take two x-rays on each side of the mouth to account for the second and developing third molars and also to adjust for differences in the mesial/distal angulation between the molars and premolars.

A bitewing series can be taken by placing the sensor in the patient's mouth either horizontally or vertically. Horizontal placement (preferred for decay detection) means placing the sensor with the longer side down into the floor of the mouth. Vertical placement means placing the sensor with the shorter side down into the floor of the mouth. Vertical sensor placement displays more root length and bone apices, but fewer teeth. This technique is preferred in patients with periodontal loss to detect bone levels.

Full Mouth Series (FMX)

Full Mouth Series (FMX)

Notice that each tooth is seen in multiple x-ray images. This redundancy is important, because it offers the dentist much information that cannot be learned from clinical examination alone. Each x-ray is shot from a slightly different angle, and the difference in angulation can reveal many aspects of the tooth/teeth in question.

As you know, shadows may be longer or shorter than the object which casts them depending on the angle of the light source and the screen upon which they are projected. Different angulations cause some structures to overlap, obscuring important information, while adjacent views shot from slightly different angles convey other information.

It is important to remember to start the full mouth s eries with anterior views, because easy sensor placement establishes credibility with the patient. The recommended order for taking a full mouth series films is:

Maxillary arch	Mandibular arch
1. Central and lateral incisors	1. Central and lateral incisors
2. Right cuspid	2. Right cuspid
3. Right bicuspid	3. Right bicuspid
4. Right molars	4. Right molars
5. Left cuspid	5. Left cuspid
6. Left bicuspid	6. Left bicuspid
7. Left molars	7. Left molars
8. Bitewings	8. Bitewings

Intraoral Film Placement Technique

Intraoral x-rays are taken with the sensor inside the mouth. They include periapical, bitewing, and occlusal films. Periapical radiographs help diagnose teeth, bone, lamina dura, and periodontal ligaments. The image must include at least three to four millimeters beyond the tooth apex.

Bitewing radiographs are used to diagnose problems with crowns and interproximal areas. Decay, calculus, overhanging margins, and interproximal bone loss are best detected in bitewing x-rays, because teeth are not overlapped as in periapical images. Occlusal x-rays are used to diagnose disorders of the jaw or palate.

Panoramic x-rays, particularly when combined with intraoral bitewing x-rays, create an excellent patient baseline. A panoramic x-ray can serve as primary in situations where resolution is not an overriding factor or if taking intraoral x-rays are not possible.

Maxillary Central and Lateral Incisors

Begin the full mouth series with the maxillary central incisor region. Patients usually tolerate this x-ray well. The sensor is inserted vertically into holders. The beam should pass perpendicularly to the sensor plane, and the sensor should be at a 90º angle to the interproximal maxillary central incisor area. The sensor is placed well into the palatal region in the area of the second bicuspid. If the sensor is too close to the teeth, the palate curve may prevent parallel placement.

Maxillary Cuspids

For maxillary cuspids, the sensor is placed into the holder vertically. The cuspid is centered on the sensor which is placed well into the palate. The central x-ray beam is perpendicular to the sensor and at a right angle to the long axis of the tooth. The mesial contact should be open, but often the distal contact is unavoidably overlapped. The next x-ray will display the distal contact area.

Maxillary Bicuspids

With maxillary bicuspids, the sensor is placed horizontally in the holder. The contacts between first and second premolars are centered on the sensor with the central x-ray beam perpendicular to the sensor. The contacts for the distal of the canine through the distal of the second premolar should be open. Sometimes a cotton roll must be placed between the bite block. This will stabilize the bite and keep the block from rotating because of the canine occlusion.

Maxillary Molars

For maxillary molars, the sensor is placed horizontally in the holder. The second molar is centered on the sensor with the central x-ray beam perpendicular to the sensor. The contacts of the first, second, and third molars should be open. The third molar region should be included in this x-ray even if the tooth is not present. In practice, it may not always be possible to place the sensor parallel to the teeth. In the event a non-parallel technique is necessary, refer to the section on shadow casting to learn how to bisect the angle between the tooth and the sensor.

Mandibular Anteriors

With mandibular anteriors, the sensor is placed vertically in the holder. The mandibular central incisors are centered on the sensor with the central x-ray beam perpendicular to the sensor. The contacts between the central incisors should be open. The sensor should be placed as far into the patient's mouth as possible without causing discomfort--usually as far back as the second premolar. The tongue is moved back and must not be between the sensor and the teeth, or it will affect the image. The lateral incisors should be visible in this x-ray image, as well. Two smaller images, instead of 1 adult-size sensor image, may be taken with a child-size sensor if the patient's mandible is unusually narrow.

Mandibular Cuspids

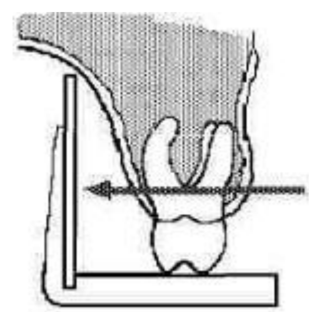
With mandibular cuspids, the sensor is placed vertically in the holder. The mandibular canine is centered on the sensor with the central x-ray beam perpendicular to the sensor.

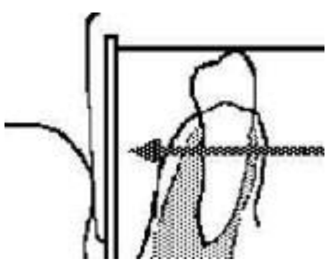
The mesial, lateral, and distal first premolar contacts should be present in this x-ray, with the canine mesial and distal contacts open. The tongue should be mildly displaced so sensor can be inserted into the floor of the mouth and far enough away from the teeth so that it doesn't bend.

The canine shot is very rarely accomplished keeping the sensor parallel to the tooth because of the shape of the space available. For this reason, it is practical to place the sensor at a steep incisal/apical angle and use the angle splitting technique to aim the beam.

Mandibular Premolars and Molars

For mandibular premolars, the sensor is placed horizontally in the holder. The contacts between the first and second premolars and the first molar are centered on the sensor. The central beam should be perpendicular with the long axis of the tooth. The sensor should contain the distal of the canine through the mesial of the second molar, with the contacts open.





The sensor should be placed as far into the patient's mouth as his or her anatomy will allow. Mandibular premolar x-rays include a complete view of the mandibular first molar. The trick to taking the premolar shot is to position the sensor as far anteriorly as the mandible curve will allow. Be careful about the placement of this x-ray, because the rigid edge can be uncomfortable. If the patient is instructed to gently close rather than bite the film holder, it will be more secure and more comfortable. Edge-ease cushions are available at some offices, and are a great comfort to patients with tori present.

The Tongue

There are two keys to placing the sensor in mandibular molar and premolar areas. The first is to explain to the patient that there is enough room if they relax their tongue. Nervous patients raise their tongue causing the mylohyoid muscle to contract and the floor of the mouth to rise.

When the patient relaxes their tongue, there is much more room in which to place the sensor and therefore, less pain. The second key to placing the sensor is to angle the sensor to the lingual, medially toward the tongue. This positions the sensor's edge well away from where the mylohyoid muscle attaches on the lingual aspect of the mandible.

Once sensor is placed, it is easy to push the tongue dorsum out of the way in order to bring the sensor parallel to the teeth. The mylohyoid muscle slopes inferiorly as it approaches midline and when the inferior sensor border is placed into position, it is less likely to encounter strong resistance. Not every patient can be persuaded to relax their tongue, and it is not always possible to extend the inferior border of the sensor so that it falls below the apices of the teeth.

In this case, place the sensor at a steep angle leaving the inferior border angled far lingually to the top of the sensor. Aim the beam from a low angle. This will shift the shadow up, so the apex will appear on the image. Note: this will also foreshorten the tooth image on the image.

The Panoramic Film (Panorex)

The panoramic x-ray is a large, single image that displays the entire bony structure of the teeth and face. It takes in a much wider area than any intraoral image showing structures outside their range including sinuses and temporomandibular joints. Panoramic x-rays expose many pathological structures such as bony tumors and cysts, as well as the wisdom teeth. They are quick, easy to take and cost little more, if at all, than a full series of intraoral x-rays. In addition to medical and dental uses, panoramic x-rays are especially good for forensic purposes in the event of catastrophic or natural disasters.

The main disadvantage of panoramic oral surveys is low resolution. Properly exposed intraoral x-rays are always crisp and sharp while panoramic x-rays show slightly fuzzy outlines. They are not good for diagnosing caries, and visits that include a panoramic film should also include a set of bitewings. In the event a patient is prone to gagging, a panoramic x-ray may prove adequate by itself.

Panoramic x-rays differ from others in that they are entirely extra-oral, which means the sensor remains outside the mouth while the machine shoots the beam through other structures from the outside. Panoramic x-rays have a number of advantages over intraoral x-rays. Since they are entirely extra-oral, they work quite well for patients who gag and cannot tolerate sensor placed inside their mouths.

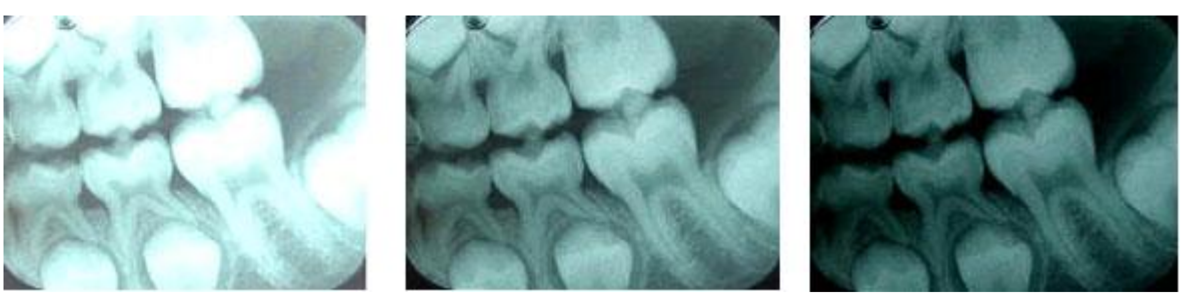
The patient stands in front of the machine, and the x-ray tube swivels around behind his head. Another advantage of panoramic x-rays is that they expose patients to very little radiation. The radiation needed to expose a panoramic x-ray is about the same needed to expose two intraoral x-rays (periapical or bitewing).

Density, Contrast and Related Imaging Terms

To properly evaluate dental x-ray quality and optimize your practice's imaging activities, it is helpful to understand some key imaging terms. Two measures of dental x-ray quality are density and contrast.

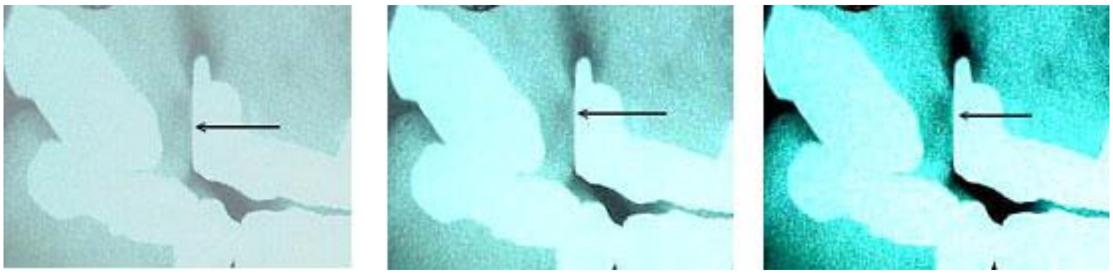
Density

The optical density is the degree of picture blackening after exposure. The darker the area in question, the higher the density. Density is measured by the ability of the silver in the x-ray to prevent light from passing through. X-rays that have too little density appear too light. X-rays that have too much density appear too dark. In either case, detail can be lost. If an x-ray is too light, detail is washed out in the lighter areas of the picture. If a film is too dark, detail is lost in the dark areas.



Contrast

In the three images below, notice the difference in appearance of the caries on the mesial of the second image as the contrast increases from left to right.



Contrast is the difference in optical density (darkening) between areas of interest in a radiograph. For this reason, contrast is critical for distinguishing objects in a radiograph.

Radiation

High doses of radiation to the entire body can cause acute effects. Long term or chronic effects come from repeated exposure to radiation. The body attempts to repair the damage but cannot keep up if exposures are regular or strong enough. X- ray o perators should monitor the amount or radiation they are exposed to by using a radiation-measuring badge.

These badges are worn while at work and sent in to a company regularly to be evaluated for radiation exposure. Operators should step behind a lead barrier when exposing x-rays. If no barrier is available, they should stand at least six feet away and between 90° and 135° to the primary beam.

Operators should never hold x-rays for a patient during exposure. When taking intraoral x-rays, patients must wear lead aprons and a thyroid collar. To significantly increase his or her risk of skin cancer, a patient would have to undergo 25 complete mouth series, done with film not digitally, in a short time. The benefit of detecting disease far outweighs the risk of radiation exposure caused by dental radiography.

Radiation exposure varies according to technique, amount of collimation, high speed receptors (film or sensors,) and k ilovoltage. The paralleling technique using a long cone provides the least amount of radiation and the best quality radiograph. Rectangular collimation reduces the tissue area exposed to x-ray beams by 60 to 70%.

Digital Radiography

For many dental offices, the latest trend in technology is paperless technology. There are many benefits to having a paperless office. Files can be accessed and saved even after unforeseen events occur such as fires. The digital trend is making clinicians aware of the drawbacks of traditional films. One such drawback is the time it takes to handle or retrieve a patient's film, and the time it takes to duplicate it for insurance companies or for patients.

Darkrooms cost more, and they require maintenance. Film requires an interconnected system in which there is room for processing errors to occur. This can mean increased radiation exposure for the patient due to retakes. Moreover, traditional film is not eco- friendly.

In the mid 1980s, Francis Mouyen at the University of Toulouse developed digital x-rays. At first images could not be stored. Software companies remedied the problem. Digital x-rays became recognized and first used in the United States after FDA (Food and Drug Administration) approval in 1990. Digital radiography is widely used and quickly becoming the preferred method for many dental professionals.

In an article on Medscape.com, Dr. Jeff Burgess explains, "Digital radiography (DR) is ubiquitous in medicine, with more than 75% of medical clinics in the United States having converted to digital use since 2000. In fact, within medicine, the conversion to digital has been mandated by the US government.

In contrast, based on several recent dental surveys, a minority of dental practices in the United States and elsewhere have converted to digital radiology or other digital systems. These surveys suggest that the use of this technology in dentistry appears to depend on specialty (more often used by general dentists), location (large population centers vs small cities), and cost.

In one 2007 dental survey conducted by the American Dental Association, only

36.5% of dentists in the United States used digital imaging, and this was primarily for bitewing and periapical radiography. Approximately 20% used this technology for panoramic studies. Nonetheless, awareness of the potential benefits of digital imaging generally and digital radiography specifically is increasing with each new technical innovation being introduced. It has been estimated that, by 2016, the proportion of digital dental imaging systems will double from the number estimated in 2009."

Digital images can be transmitted via modem within seconds. Images can be inserted into a word processing document (such as treatment plans) and printed. Patient radiographs can easily be transmitted from one dentist to another without losing quality. Additionally, images can be manipulated to optimize brightness and contrast enabling dentists to enhance and view areas of concern.

Some say digital images are more graphic and detailed and therefore ideal to use for patient education. Digital radiographs can be magnified and displayed for patients. Patients can be shown caries, and periodontal bone loss can be measured. This is especially useful in endodontic procedures. Intensity, contrast, and brightness can be enhanced to make diagnosis more accurate. A great deal of time can be saved not waiting for records to be received through the mail.

It is more cost effective to use digital radiography. Clinical errors are eliminated, because mislabeling patient computer records does not occur. However, the most beneficial aspect of using digital radiography over traditional x-rays is less radiation exposure to patients! Offices using digital radiography should still follow FDA/ADA guidelines.

Critics of digital radiography present some concerns. The size of the digital sensor and holder is bulkier and more rigid than conventional x-ray film, and they are less comfortable for patients. Additionally, when using a digital system, a cord hangs out of the patient's mouth causing further discomfort. However, there are many digital sensor aids that help with patient comfort and act as barriers to infection.

Infection control is an important concern. Specifically, infection control involves using barriers between patients and machines, because hardware is sensitive to common disinfectant chemical sprays. All dental practitioners should learn and practice manufacturers' guidelines when disinfecting equipment.

Though digital radiography has many advantages there are concerns about the exclusive use of digital imagery. There are differences in size between digital and regular films For example, digital detectors housed in the sensor are smaller than #2 films, and structures being filmed may not always be captured on one image. Sometimes more than one image must be taken to get the same structures that could have been seen on one #2 x-ray film.

Although digital imaging saves money and time, initial equipment costs are substantial. Solid state sensors are expensive, ranging between $8,000 and $10,000. There are yearly insurance fees. PSP plates used in the Phosphor Plate System method cost $30.00 each. They are fragile and tend to accumulate scratches with misuse.

There has been concern surrounding security of patient records stored on computer systems and the ability to tamper with stored records. However, it takes complex processes, knowledge, and equipment to breach security. When an image is saved and stored, it contains a creation date. Each digital image is connected to the patient's file. There is no way to alter patient names. It is vital that the correct patient file is open on the computer before digital images are taken. This will guarantee images directly attached to a patient's file are not misfiled.

Computers also track when images are accessed and altered. However, no matter what alterations are made, the image time stamp cannot be altered. Only limited changes can be made to images. Digital software companies use watermarks on altered images, so that both insurance companies and practitioners will know if an image has been changed. Images cannot be accidentally confused with another patient's records; x-rays coming out of a processor cannot be submitted to the wrong patient chart or insurance carrier.

The most beneficial aspect of digital radiography is less radiation exposure to the patient! This is referred to as the ALARA principle, that the patient receives more benefit than harm. It is an acronym for "As L ow As Reasonably Achievable." Offices using digital radiography should still follow FDA/ADA guidelines, including but not limited to placing lead aprons on patients during exposure time.

Some say digital images are more graphic, detailed, and ideal to use during patient education. Patients can more vividly be shown caries and periodontal bone loss. In addition, digital radiography saves time waiting for records to be received through the mail. Digital radiography ensures images are correctly labeled and charted, which limits clinician errors. Once a patient's file is opened on a computer, there is no way to mislabel digital films.

A typical imaging system is composed of a video camera, a frame grabber with A/D and D/A converter, a host computer with optical disk storage, image processing software or hardware and a video monitor. Once the image is in the computer, it can be manipulated, enhanced, enlarged, filtered, and compared to other images. The technique used to capture the image must be reproducible. Two images of the same area taken at different times can be accurately compared.

Critics of digital radiology cite that bulkier and more rigid sensors and holders cause patient discomfort. Digital systems require a cord hang out the patient's mouth which may cause further discomfort. However, there are many digital sensor aids to help with patient comfort and act as infection control barriers. These aids protect against sensor damage and can prevent the sensor from slipping.

Digital Radiology Systems

Indirect systems can utilize preexisting equipment. This means substantially lower costs than with other systems. Indirect digital radiology uses a traditionally exposed film and flatbed or slide scanner to copy images into a JPG or TIFF file that is stored in the computer. Clinicians can take pictures of traditional films with a digital camera and transfer images into digital format. Software from Televere Systems called TigerView copies images using a scanner and automatically arranges them in proper orientation and order. These images can be manipulated, rotated, and enhanced. Zoom, contrast, brightness, and orientation are also variables that can be manipulated. TigerView software is reasonable in cost but not as popular as Direct System software.

The semi direct system of digital radiology uses methods from both the direct and indirect systems. The semi direct system is similar to the indirect system in that stored images are scanned into the computer. The semi direct method uses a photo stimulable phosphor (PSP) also known as a storage phosphor plate. Phosphor plates temporarily store images until they are transferred into a computer. Special packets are used to hold phosphor plates. These look similar to traditional films.

Semi direct systems are more comfortable for patients than digital sensors used in the direct technique, because they are thinner. The phosphor is placed in the patient's mouth in the same way as standard x-ray films. Plates are covered with phosphor crystals which temporarily store x-ray proton energy. Crystals form latent images, similar to the ones formed on x-ray films. The plates are placed in a scanner that reads the image using a laser beam.

The scanner transfers images into patients' computerized charts. Phosphor plates must be transferred to the scanner in darkness or the plates will be erased by ambient room light. To reuse plates, they are laid out in bright light which erases stored images. The direct system is much faster than the semi-direct or indirect system, and the images are marginally better.

The direct system works with a solid state sensor. The word direct refers to the digital image that is produced directly, without extra steps involved in having to manually develop a phosphor plate, or scan x-ray films into a digital file. There exist two types of sensors used in a solid state or direct system. The most widely used is the charge coupled device (CCD). CCDs are used in digital cameras as well as digital radiography.

A second system recently developed is called the CMOS sensor system, which works differently than CCDs but delivers similar results. A CCD is a semiconductor chip with a rectangular grid of millions of light sensitive elements used to convert light images into electrical signals. When images are taken, radiation energy stimulates sensors and creates images. There is a scintillation layer atop the electronic chip that turns x-ray photons into light photons.

Each of the millions of light sensitive elements in the CCD underlying the scintillation layer converts light photons into analog electrical impulses. Impulses are converted into numbers between 0 and 65536 (with the newest generation of sensors). The numbers transmitted correspond to the intensity of light transmitted to each tiny element in the rectangular array by the scintillating layer. In this way, images are converted to millions of pixels which are reassembled by the computer into a coherent image. CCDs used in dental imaging are the same as the CCDs used in digital cameras.

Digital radiographs are composed of many shades of gray spanning from black to white known as continuous tone images. This means shades of gray blend together with no noticeable interruptions. To convert data from the sensor into digital form, each image element is converted into a bit of information by an analog to digital converter. This information describes the light intensity (brightness) and its location in relation to the picture as a whole. Each small piece of information is called a pixel (short for picture element).

The computer reassembles the pixels in the correct order and brightness to build a digital image. Image processor manufacturers use standard 12 bit or 4,096 levels of gray for images. The latest image processors use a 16 bit or 65,536 levels of gray. Increasing number of bits expands the gray scale so digital images more closely resemble original images. The higher number of pixels used to define the image and the more closely they are packed, the closer the digital image resembles the original image.

This means that a digital image is identical to images presented on x-ray films. The more pixels and bits of information involved in the picture, the more memory the computer requires for processing and storing the image. A typical imaging system is composed of an image receptor like a camera or a CCD, a frame grabber with A/D and D/A converters, a host computer with hard disk storage, image processing software or hardware, and a video monitor. Once the image is stored in the computer, it can be manipulated, enhanced, enlarged, filtered, and compared to other images. The technique used to capture images must be able to reproduce images of the same area taken at different times so they can be compared.

Another sensor is the metal oxide semiconductor (or CMOS) based chip. The primary difference with the CMOS sensor is that the electronic components are integrated inside the electronic chip instead of having a scintillation layer like the CCD sensor. Though it saves time and money to produce CMOS sensors with internal mechanisms, the charge coupled device is used more often probably, because the CCD was on the market first. On the other hand, CMOS sensors have most of their required circuitry and components integrated into the sensor, resulting in a smaller, and a less power consuming system overall, which is more technologically advanced.

Citing the Journal of Medicine, Radiology, Pathology & Surgery (2019), 1, 11–16, the Department of Oral Medicine and Radiology:

Schick Technologies (Long Island City, NY) was the first vendor to replace the CCD by a CMOS for the purpose of solid state intraoral radiographic imaging. The CMOS was an active array technology invented in Scotland in 1988. For CMOS detectors, pixels are read individually, so blooming is not the problem it can be with CCDs. When the pixel array receives the signal from the digital controller, the pixel sensors capture the intensity levels of the wavelength-filtered light and output the result as an analog voltage signal. The analog signal is converted into digital by the ADC so that the final signal leaving the CMOS sensor can be used and further processes by other digital components on the printed circuit board of the device. On comparison with CCD’s CMOS do not require charge transfer, hence providing an increased sensor reliability and lifespan.

Techniques used for digital radiography still use sensor holding devices similar to those used with x-rays. When a digital system is installed in an office, the sensor generally comes with Rinn sensor positioning devices. Software and computer maintenance guidelines are provided and should be followed. Computer screens should be ergonomically placed and appropriate for clinicians and patients. Aprons are still needed, and each office should follow FDA/ADA guidelines.

Bluetooth and Remote Controls

In an article titled, Recent Advancements in Dental Digital Radiography, Authors N. R. Diwakar, S. Swetha Kamakshi explain how Bluetooth technology is beginning to be used as the latest advancement in digital radiology in dentistry:

“Use of Bluetooth and Remote Controls for Image Transfer Bluetooth Recent intraoral sensors in direct and semidirect digital technology use Bluetooth wireless transmission from the control module to the CPU. While the sensor is corded, Bluetooth eliminates the time, expense, and complexities of hardwiring the operatory. Sensor and control module can be easily moved among operatories, lowering equipment cost and bulky USB control boxes and other types of receivers, considerably reducing the investment to share the system among multiple treatment rooms. Bluetooth transmits image data with greater stability and consistency than any other wireless choice. Remote controls The sensors in CCD’s use remote control that contains all the electronics of the sensor. The button on the remote control activates, at a distance, the acquisition interface in the imaging software. The remote control is connected to the computer with its USB 2.0 connector.”

Infection Control

Infection control requires using barriers between the patient and equipment. Ha rdware is sensitive to common chemical sprays used for disinfection. Preventing cross-contamination is critical with direct digital radiography systems (DDR equipment). Current manufacturers’ recommendations for standard precautions are limited to the use of plastic barrier sheaths which are known to tear or leak.

One study found plastic barriers failed 40% of the time. The authors of another study found that using a latex finger cot significantly reduced leakage to no more than 6%. To minimize the potential for patient cross-contamination, the CDC recommends cleaning and disinfecting sensors with an EPA-registered intermediate-level (tuberculocidal) disinfectant after removing barriers and before use on another patient. Because sensors and associated computer components vary by manufacturer, manufacturers should be consulted regarding specific disinfection products and procedures.

It is important to review the patient’s medical history before taking radiographs. The dental practitioner must wear clean gloves and mask with each patient. Disinfect the exposure button and tube head or cover t h e m with fresh protective barriers each patient. Anything touched during procedures should be disinfected. It is important to remember that as soon as plastic covered sensor is placed in a patient’s mouth, plastic and sensor are contaminated and should be handled accordingly.

When the series is complete, disassemble Rinn and remove plast barrier off of sensor with gloves on. Then assemble all contaminated instruments (including RINN) in a container and transport them to the sterilization area. After changing gloves, wipe down sensor and cord, according to Manufacturer's instructions, while holding sensor, always, in palm of hand to protect it. Return Sensor, carefully, to office's protected place for it, ensuring cord and sensor are free from being pinched in cabinet door, drawer, or dropped.

Source: http://www.practicon.com/item/digital-x-ray-sensor-hanger-7001228/7001228

Patient Management

Patients often view x-ray procedures with disdain. They may have had bad experiences, and sometimes, children are overwhelmed. Operators displaying confidence and compassion can do wonders for patient compliance.

Gag Reflex

The key to control gagging is breathing through the nose, or holding the breath. When the posterior tongue blocks the throat, gagging does not occur. To position the tongue, ask the patient to open his mouth as wide as possible and then hum through the nose. If noise comes through the mouth, ask the patient to block the throat with the back of his tongue and try humming again.

Once the patient is humming through his nose with his mouth wide open, tell him to inhale through his nose with his tongue in this position. With breathing controlled this way, patients are less likely to gag. It sometimes helps to lighten the mood by asking the patient to hum a tune for a few moments while you listen and congratulate him on his fine singing voice! As long as patients remember to breathe through the nose and open wide while you insert the sensor, the gag reflex is easy to control.

Although gagging is a physical reaction, it has a psychological component as well. With patients who gag, it is best to start the series with anterior or premolar films. These are placed further forward in the mouth and are less likely to stimulate the gag reflex. This helps the patient realize they can successfully have x-rays taken.

Don’t leave the sensor in the patient’s mouth any longer than necessary. Set up the machine and complete all necessary tasks before placing sensor in a patient’s mouth. Instruct the patient to breathe through his nose while placing sensor, and set the sensor in place, with confidence. If the patient gags, reassure him that this is common, and that you know what to do to control it.

There are mouth washes and throat lozenges available that anesthetize the mouth. Some practitioners swear by salt on the tongue, while other practitioners ask patients to concentrate on objects or pictures in the room. Tell patients to breathe through the nose. Since the gag reflex is triggered by psychological factors, ask patients to concentrate on something else.

Concerned Patients

Patients will sometimes refuse x-rays. Many do not want to be exposed to radiation. Explain that radiation risks in the dental practice are small in comparison to diagnostic benefits. Also explain that every effort is made to expose patients to the least amount of radiation possible. If a patient has recently had x-rays for medical purposes, they may not want to be exposed again. Each case will be different. If a patient still refuses x-rays, have the dentist speak to the patient. To establish your professional credibility, every effort should be made on your part to explain the situation to the patient.

Safety issues are best resolved by explaining to patients that the amount of radiation received from dental x-rays is so small, it would take 20 full series surveys (360 films in all) to equal the same amount of radiation received from normal environmental background sources over the course of one year. It may be helpful to have a printed handout available that contains this information.

A comparison chart showing radiation exposure:

Item Dose of Radiation in Millisieverts (mSv)	
Banana	0.00001 mSv
Dental X-ray	0.005 mSv
Living within 50 miles of a nuclear power plant	0.01 (per year) mSv
A flight from New York to Los Angeles	0.04 mSv
Smoking 1 ½ packs of cigarettes	0.08 mSv
Living at sea level	0.25 (per year) mSv
Mammogram	0.3 mSv
Abdominal CT scan	14 mSv
Dental	
Digital pan + 4 BWS	27 Sv
Digital FMX	60 Sv
Film FMX	75 - 180 Sv
Digital FMX + Digital pan	74 Sv
Film pan + Film FMX	94 - 199 Sv

If a patient is pregnant, or thinks she might be pregnant, it is probably best to consult with the patient's physician before any x-rays are taken, especially if the patient is in her first trimester. If a patient thinks she might be pregnant, it is wise to postpone routine x- rays.

To Lead Apron or NOT to Lead Apron

While digital radiography is known to use lower amounts of radiation than film-based models, radiation is still being generated. We also know that radiation is accumulative over time and with exposures. The radiation dose you received 10 years ago when you had that CT scan remains with you the rest of your life. Every subsequent exposure to radiation adds to that accumulated amount. Every precaution should be taken to ensure that radiation exposure is "as low as reasonably achievable," known as the ALARA principle. Most dental professionals feel that a leaded apron minimizes exposure to the abdomen and should be used when any dental radiograph is taken. Also, a leaded thyroid collar can protect the thyroid from radiation, and should also be used whenever possible. The use of a leaded thyroid collar is recommended for women of childbearing age, pregnant women, and children.

According to Dianne Glasscoe Watterson, RDH, BS, MBA, in her article titled, Lead Shield Dilemma, in the Oct 16th, 2014 RDH Magazine, many clinicians vary greatly in their lead apron beliefs and practices with the new digital technology.

The National Council on Radiation Protection & Measurements (NCRP) published a guideline for radiation protection in dentistry in 2003 titled "NCRP Report No. 145: New Dental X-ray Guidelines: Their Potential Impact on Your Dental Practice." This report stirred considerable controversy with this statement: "The use of leaded aprons on patients shall not be required if all other recommendations in this report are rigorously followed."

This statement came from the ADA: "The amount of scattered radiation striking the patient's abdomen during a properly conducted radiographic examination is negligible. The thyroid gland is more susceptible to radiation exposure during dental radiographic exams given its anatomic position, particularly in children. Protective thyroid collars and collimation substantially reduce radiation exposure to the thyroid during dental radiographic procedures. Because every precaution should be taken to minimize radiation exposure, protective thyroid collars should be used whenever possible. If all the [NCRP] recommendations for limiting radiation exposure are put into practice, the gonadal radiation dose will not be significantly affected by use of abdominal shielding. Therefore, use of abdominal shielding may not be necessary"

What are the NCRP recommendations?

- Thyroid collars should not be used on extraoral radiography (panoramic and cephalometric)
- All intraoral X-ray head collimators shall be rectangular, not circular, to minimize stray radiation.
- For film X-rays, the film speed shall be "E" or faster. D film shall no longer be used. Since Kodak no longer makes E speed film, this will mean going to F-speed or using another manufacturer's film.
- High-speed (400 or greater) rare-earth intensifying screens shall be used in extraoral films and digital systems shall employ a similar equivalent.
- For all new construction, shielding design will need to be provided by a qualified expert. Lead need not be used if proper thickness of gypsum board is used for the walls.
- Dentists must examine their patients before ordering or prescribing X-rays.
- Rigid dark room requirements, documentation and daily developer chemistry evaluation, and a quality assurance protocol manual will be required.

All dental professionals need to be aware of their particular state guidelines. For the California reader who addressed the question above, California mandates the use of the lead shield, although many experts today do not feel the use of the lead shield is necessary. However, we have to take into consideration the opinions and beliefs of our patients. Some patients would feel unsafe without the lead shield.

Informed Consent/Informed Refusal

The patient should give documented informed consent as well as be given a full explanation of benefits and risks of radiation exposure. Patients must specifically express their permission to have x-rays taken. A written, signed consent form is the easiest way to document the patient's approval. It is also wise to have the patient sign a d o c u m e n t if they refuse recommended x-rays, as the dentist may be limited in diagnosing problems without x-rays. A signed refusal demonstrates to the patient that he is aware and responsible for limitations created by not getting x-rays.

Taking Quality X-Rays

Exceptional diagnostic radiograph will contain the following characteristics:

Periapical Radiographs

- The correct anatomic area should be represented.
- At least 3-4 mm (1/4 inch) of alveolar bone should be visible beyond the apex.
- The image should not be elongated or foreshortened.
- The radiograph should have acceptable density.
- The radiograph should be free of film handling or processing errors.
- The interproximal contacts should not overlap.
- There should be no cone cuts.
- The embossed (raised) dot should appear at incisal or occlusal edges.
- In a complete mouth radiograph series, the apex of each tooth should be visible at least once, preferably twice.

Bitewing Radiographs

- The interproximal contacts should not be overlapped from the distal surface of the canine to the mesial surface of the third molar.
- The crowns of the maxillary and mandibular teeth should be centered in the image from top to bottom.
- The crest of the alveolar bone should be visible with no superimposition of the crowns of the adjacent teeth.
- The occlusal plane should be as horizontal as possible.

Common Operator Errors

Operator errors in sensor placement and tube head angulation often result in undiagnostic x-rays which are useless to the dentist and must be retaken. Every effort should be taken to minimize the following errors as each retake exposes the patient to more radiation.

Sensor Placement

- In all premolar views, the distal of the cuspid is visible.
- All molar views should contain the third molar region even if the tooth is not present in the mouth.
- When focusing on a specific tooth, it should be centered on the sensor.
- Sensor must be placed high enough in the palate or low enough in the floor of the mouth to clearly show the apex of the tooth in question and three to four mm of bone.
- It may be beneficial to use a cushion, such as Edge-Ease™, around the sensor’s edge, especially if a patient has tori, either along the mandible or in the mid-palatal region.

Tube Head Angulation

Errors in tube head angulation are common. When using an instrument, make sure the tube head is aligned correctly, parallel with the indicator rod, and is aligned with the ring (if using a Rinn apparatus). If not using a Rinn, the beam should be parallel to the bitewing tab, or at an angle that splits the difference between the angulation of the sensor and the angulation of the tooth. Sensor positioning devices are helpful and when used correctly, they generally produce satisfactory results.

When a patient's anatomy gets in the way, it is best to bisect the angle. For example, if the patient has a shallow palate, and the instrument will not allow sensor to be placed parallel to the long axis of the tooth, bisect the angle to avoid foreshortening. Overlapping is another common angulation error. If the cone is not perpendicular to the sensor, the contacts will be overlapped. Due to the curve of the arch, some areas will likely overlap. It is better to take two adult-sized sensor images: Take one in a premolar view and take one in a molar view separately so all contacts will be open.

Cone cutting is another common error. This happens because the operator positions the cone too distally (mesial cone cuts are the most frequent kind). The image will be cone cut when the tube head is not covering the whole area of the sensor. The best way to avoid this is to look at the sensor in the patient's mouth and aim the cone head directly toward the sensor instead of guessing from extra-oral landmarks.

Ask the patient to grin wide so you can see down the buccal corridor (the area between the buccal surfaces of the teeth and the buccal mucosa). This will make it much easier to aim the cone. If the patient moves, the sensor’s alignment within the cone diameter will be affected. Watch the patient as you expose x-rays.

Conclusion

This course is intended for dental staff members interested in reviewing radiology. Understanding general shadow casting principles, principles of parallax, and the Clark Shift helps practitioners take expert, diagnostic x-rays and will save patients from unnecessary radiation exposure. Once you learn these techniques, such as bisecting the angle, you will consistently take quality radiographs. Since many dental offices are becoming paperless, understanding digital radiographic systems is not only advantageous and useful knowledge for practitioners but it is becoming required.

References

American Dental Association (ADA) Protocals for Taking Patient Radiographs, accessed online December, 2019.

Burgess, Jeff DDS, MSD; Arlen D Meyers, MD, MBA. “Digital Dental Radiography” http://emedicine.medscape.com/ Updated Feb 10th, 2016. Accessed December, 2019.

Diwakar NR, Kamakshi SS. Recent advancements in dental digital radiography. J Med Radiol Pathol Surg 2015;1:11-16.

Journal of Medicine, Radiology, Pathology & Surgery (2015), 1, 11–16.

National Council on Radiation Protection & Measurements (NCRP), Guideline for Radiation Protection in Dentistry: "NCRP Report No. 145: *New Dental X-ray Guidelines: Their Potential Impact on Your Dental Practice*." 2019.

Washington State Department of Health (WA DOH), Whole Body Radiation, accessed online December, 2019.

Watterson, Dianne G. “Lead Shield Dilemma.” RDH Magazine, Volume 34. Issue 10 (2014): Web. Article accessed December, 2019.

Essential Tips for Dental Radiographers Test

1. Misangulation of the ________ causes overlap, obscuring incipient caries:
    a. Teeth
    b. Patient’s head
    c. X-ray beam
    d. None of the above
2. The three elements to keep in optimum alignment in order to achieve a good diagnostic x-ray:
    a. Floor of the mouth, sensor, teeth
    b. Palate, teeth, x-ray beam
    c. Source, teeth, sensor
3. The principle behind bisecting the angle is to:
    a. Split the difference between the angle of the tooth and the angle of the sensor lining up the beam at that imaginary point
    b. Line up the x-ray beam at an imaginary point between the floor of the mouth and teeth
    c. Achieve a diagnostic x-ray as sensor and teeth are unable to be parallel to one another for whatever reason
    d. A and C
4. What are some concerns of implementing digital x-rays?
    a. Initial cost is significant
    b. Patients are exposed to more radiation
    c. Concerns with fraud and manipulation of image
    d. All of the above.

e. A and C

5. The following statement/s are true regarding patient’s consent and x-rays:

   a. The patient should give documented informed consent as well as be given a full explanation of benefits and risks of radiation exposure

   b. A written, signed, consent form is the easiest way to document the patient's approval

   c. A signed refusal demonstrates to the patient that he is aware and responsible for limitations created by not getting x-ray

   d. All of the above

6. The following are FALSE regarding digital radiography:

   a. Even in pregnant patients and children, thyroid collars are no longer recommended per The National Council on Radiation Protection & Measurements (NCRP)

   b. Digital sensors are more rigid but less sharp on the edges vs film

   c. There is LESS radiation exposure using digital sensor vs film

   d. Blue-tooth capabilities are now being used in digital radiography

7. The CDC recommends disinfecting digital sensors with an EPA-registered disinfectant after removing the disposable barrier.

   a. True

   b. False

8. Exceptional diagnostic x-rays have the following qualities:

   a. The occlusal plane should be as vertical as possible in the x-rays

b. The interproximal contacts should not overlap

c. At least 3-4 mm of alveolar bone should be visible beyond the apex

d. A and C

e. B and C

9. When taking x-rays, a general rule of thumb is:

   a. Place the sensor parallel to the teeth and the cone perpendicular to the sensor

   b. Place the sensor perpendicular to the teeth and the cone parallel to the sensor

   c. Place the sensor parallel to the teeth and the cone parallel to the sensor

10. Gagging is best controlled by:

   a. Persuading the patient to breathe through the nose

   b. Being firm with the patient

   c. Having the patient pant through the mouth

   d. telling the patient t he problem is all in their head and force x-rays quickly