The Academy of Dental Learning & OSHA Training
1101 Sibley Memorial Hwy Ste. 211
St. Paul, MN 55118
(800) 522-1207
CESupport@DentalLearning.org

Essential Tips for Dental Radiographers

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2 credit hours (2 CEs)

Martin S. Spiller, DMD

Health Science Editor:
Michelle Jameson, MA

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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.

Learning Objectives

At the completion of this course, the student 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.

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 several dental specialties including oral surgery, endodontics, pedodontics, orofacial surgical techniques, and facial trauma. In 2000, he began work on a general dentistry website (www.doctorspiller.com), 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.

The History of X-Rays

When Wilhelm Conrad Roentgen, a Bavarian physicist, unintentionally discovered x-rays, he was working with sealed glass vacuum tubes containing both a cathode and an anode. In the course of his experiments, he applied voltage to the tubes and noticed that a screen near the tubes glowed. He blocked the path of these newfound rays with various objects to see what prevented the rays from passing to the screen. Ultimately, he found that when he placed his own hand between the rays and

the screen, he could see the outline of his bones on the screen. This historic discovery on November 8, 1895 dramatically changed diagnostic procedures for both medicine and dentistry. Roentgen received the first Nobel Prize in physics in 1901 for his discovery of x-rays.

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 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, please consider taking our Advanced Radiology course.

Parallel Technique vs. Bisecting the Angle

Parallel Technique

The receptor and long axis of the tooth should be parallel. When the receptor and the long axis of the tooth are parallel, as in the paralleling technique, the distortion of the recorded image is decreased. Your shadow gets longer as the sun sets. Elongation in your shadow is greater at the feet than at the head. If the sun is directly overhead, your shadow is foreshortened. This sort of distortion is important to understand when taking periapical films, since often there is not enough room in a patient's mouth to place the film parallel to the teeth.

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

In the x-ray on the right, the beam is at 90° to the film. However, the tooth crown is tilted up and lies at 30° to the film 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 film and beam properly aligned. The way to compensate for this problem is to use a technique which splits or bisects the angle between the film and the tooth.

In the image further down, right side, 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 film 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.

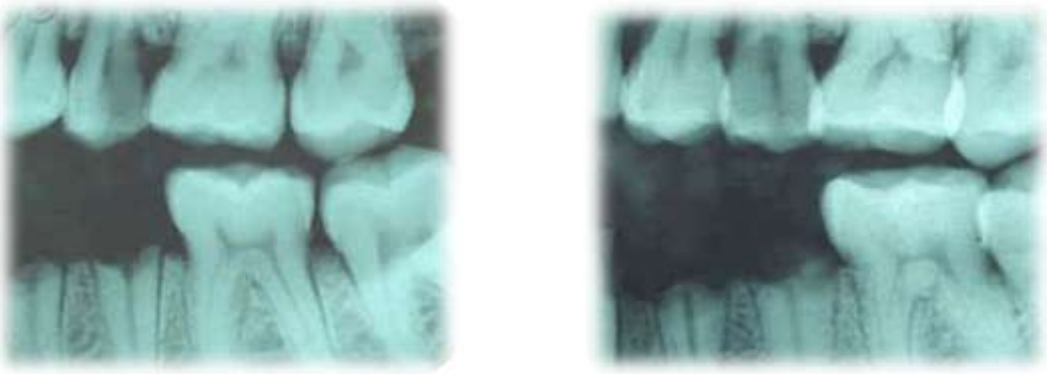
The x-ray beam should be perpendicular to the receptor. If this technique is not used, the image will shift and cause overlapping of adjacent structures onto the film. If the beam is at a lateral angle to the film while trying to take bitewing x-rays, the crowns of the teeth may appear to be overlapping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

The Rinn film holder keeps the beam perpendicular to the film, but unfortunately, the film 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 film, teeth, and the beam--in optimum alignment.

The film 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 film 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 film, 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 film result from incorrect alignment of the beam, object, and film. 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 film to reduce distortion as much as possible.
2. Use, and even exaggerate, distortion to your advantage.

Trick 1: Bisecting the Angle

(Helpful when film cannot be placed parallel to the long axis of the teeth.)

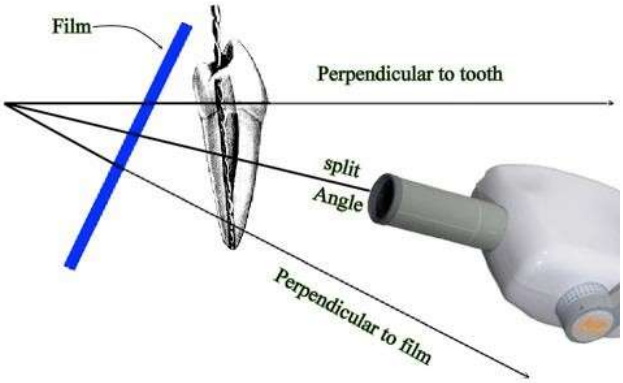
There is an easily learned technique in which the operator can overcome most distortion (foreshortening or elongation). This technique is called bisecting the angle, and once mastered can be used to produce the least distorted images of all periapical radiographs in a full mouth series.

Bisecting the angle works especially well in cases in which a low palate or a mouth floor necessitates tilting a periapical film or 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 films 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 the film or sensor holder without the ring apparatus. Use a disposable Styrofoam Stabe bite block. It is easily compressed and more likely to keep film aligned with the plane of the teeth.

1. Place film in the mouth using a Stabe bite block or the film 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 film, 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 film and teeth can be compensated for by the beam angle.

This technique is essential with occlusal films on a child. In this technique, the child bites the film like cardboard. Place film 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 film and perpendicular to the teeth.

Rinn's XCP system film holders help keep film perpendicular to the x-ray beam which eliminates one source of distortion, but they cannot eliminate the distortion produced when film 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.

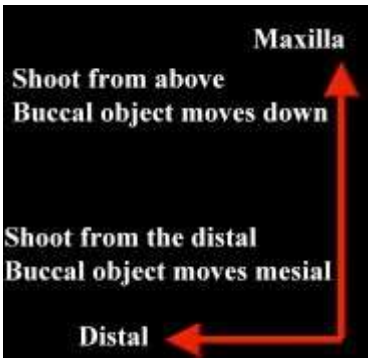
Trick 2: Moving the Cone

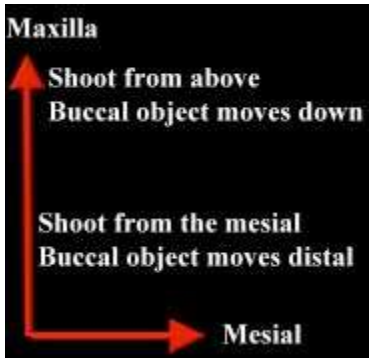
Due to a patient's gag reflex, it is often impossible to position films or sensors far enough posteriorly to get a clear shot of a maxillary second or third molar. It is also often difficult or nearly impossible to get a periapical of the entire first premolar due to the mandibular curve or the shape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

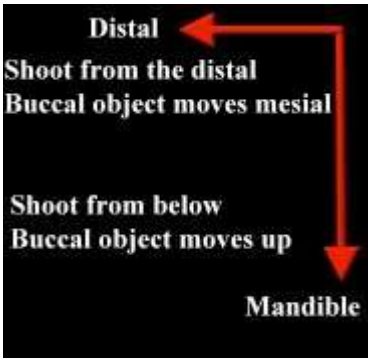
Moving an object up, down, right, or left on a radiograph is fairly easy. This technique takes advantage of the fact that the film or sensor is generally at least three or four millimeters palatal or lingual to the teeth you want to move. In fact, the further to the lingual you can move or tilt the film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

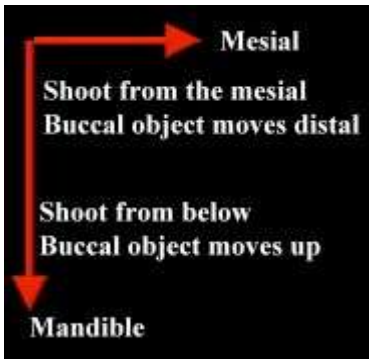
To understand this technique, look at the photographs on the following page. Point your index fingers of both hands up, close your left eye, and hold the index fingers parallel as in the photograph in the middle. Look through your right eye, and shift your hands as a unit to the right. Notice that the 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 film 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 film, shoot from a higher angle. Remember, you must reangle the tube head toward the film 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 film 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 Mesial, a Buccal object moves Distally. If you shoot two films 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

The three most common series of radiographs taken in the dental office are bitewing surveys, full mouth surveys, and panoramic films. Bitewings consist of premolar and molar views of each side of the mouth taken in occlusion (two or four films). The full mouth survey consists of a series of x-rays that properly represent 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 are present). Usually, bitewing x-rays are taken to examine the contact areas of the premolar and molar regions, and periapicals are taken for other teeth and edentulous areas.

The Bitewing Series (BWX)

A bitewing series consists of either two or four films taken of the back teeth (although some offices take films of front teeth as well). The patient bites down, so films contain images of 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 films, 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 films on either 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 films in the patient's mouth either horizontally or vertically. Horizontal placement (preferred for decay detection) means placing films with the longer side down into the floor of the mouth. Vertical placement means placing the film with the shorter side down into the floor of the mouth. Vertical film 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)

This full mouth series consists of four bitewing films taken at an angle to specifically look for decay, and 14 periapical films, which are taken from other angles to image root tips and supporting bone. Not every full mouth series looks exactly like this one, but they all use some combination of bitewing and periapical x-rays to image a complete survey of the teeth and bones. New full series are taken at intervals based on need to assess new or ongoing conditions.

Notice that each tooth is seen in multiple films. 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 series with anterior views, because easy film placement establishes credibility with the patient. The recommended order for taking a full mouth series films is:

Maxillary Arch	Mandibular Arch
Central and lateral incisors	Central and lateral incisors
Right cuspid	Right cuspid
Right bicuspid	Right bicuspid
Right molars	Right molars
Left cuspid	Left cuspid
Left bicuspid	Left bicuspid
Left molars	Left molars
Bitewings	Bitewings

Intraoral Film Placement Technique

Intraoral films are taken with the film inside the mouth. They include periapical, bitewing, and occlusal films. Periapical radiographs help diagnose teeth, bone, lamina dura, and periodontal ligaments. The film 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 films are used to diagnose disorders of the jaw or palate.

Panoramic films, particularly when combined with intraoral bitewing films, create an excellent patient baseline. A panoramic film can serve as a primary film in situations

where resolution is not an overriding factor or if taking intraoral films are not possible.

Maxillary Central and Lateral Incisors

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

Maxillary Cuspids

For maxillary cuspids, film is placed into the holder vertically. The cuspid is centered on the film which is placed well into the palate. The central x-ray beam is perpendicular to the film 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 film will display the distal contact area.

Maxillary Bicuspids

With maxillary bicuspids, film is placed horizontally in the holder. The contacts between first and second premolars are centered on the film with the central x-ray beam perpendicular to the film. 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, film is placed horizontally in the holder. The second molar is centered on the film with the central x-ray beam perpendicular to the film. The contacts of the first, second, and third molars should be open. The third molar region should be included in this film even if the tooth is not present. In practice, it may not always be possible to place the film or 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 film.

Mandibular Anteriors

With mandibular anteriors, the film is placed vertically in the holder. The mandibular central incisors are centered on the film with the central x-ray beam perpendicular to the film. The contacts between the central incisors should be open. Film 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 film and the teeth, or it will show on the radiograph. The lateral incisors

should be visible in this film as well. Two smaller films may be used if the patient's mandible is unusually narrow.

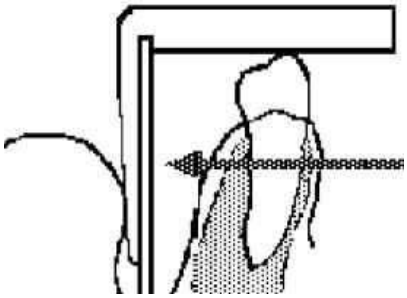
Mandibular Cuspids

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

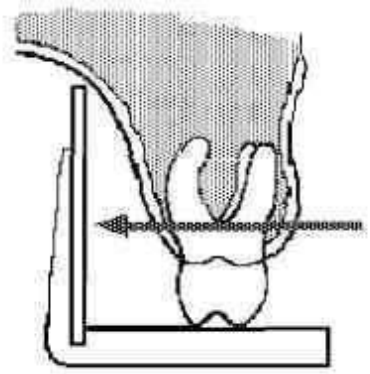
The mesial, lateral, and distal first premolar contacts should be present in this film, with the canine mesial and distal contacts open. The tongue should be mildly displaced so film can be inserted into the floor of the mouth and far enough away from the teeth so that it doesn't bend.

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

Mandibular Premolars and Molars



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



Films should be placed as far into the patient's mouth as his or her anatomy will allow. Mandibular premolar films include a complete view of the mandibular first molar. The trick to taking the premolar shot is to position the film as far anteriorly as the mandible curve will allow. Be careful about the placement of this film, because the sharp 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.

The Tongue

There are two keys to placing film 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 film and therefore, less pain. The second key to placing film is to angle the film to the lingual, medially toward the tongue. This positions the film edge well away from where the

mylohyoid muscle attaches on the lingual aspect of the mandible.

Once film is placed, it is easy to push the tongue dorsum out of the way in order to bring the film parallel to the teeth. The mylohyoid muscle slopes inferiorly as it approaches midline and when the inferior film 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 film so that it falls below the apices of the teeth.

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

The Panoramic Film (Panorex)

The panoramic film is a large, single x-ray film that displays the entire bony structure of the teeth and face. It takes in a much wider area than any intraoral film showing structures outside their range including sinuses and temporomandibular joints. Panoramic films 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 than a full series of intraoral films. In addition to medical and dental uses, panoramic films 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 films are always crisp and sharp while panoramic films show slightly fuzzy outlines. They are not good for diagnosing caries, and visits that include a panoramic film should also include a set of bitewing films. In the event a patient is prone to gagging, a panoramic film may prove adequate by itself.

Panoramic films differ from others in that they are entirely extra oral, which means the film remains outside the mouth while the machine shoots the beam through other structures from the outside. Panoramic films have a number of advantages over intraoral films. Since they are entirely extra oral, they work quite well for patients who gag and cannot tolerate film 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 films is that it exposes patients to very little

radiation. The radiation needed to expose a panoramic x-ray film is about the same needed to expose two intraoral films (periapical or bitewing).

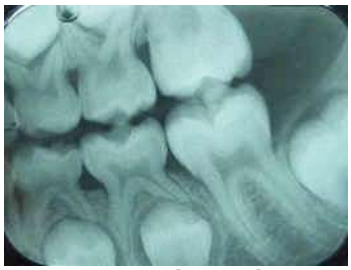
Density, Contrast and Related Imaging Terms

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

Low Density

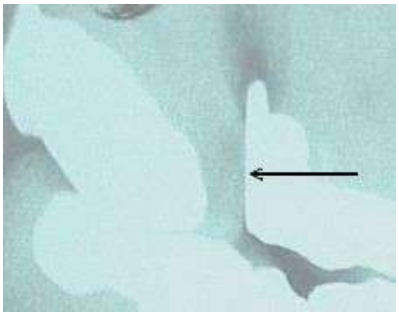


Normal Density

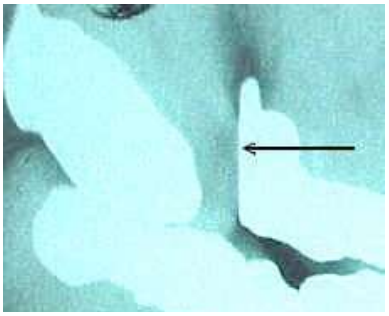
High Density

Contrast

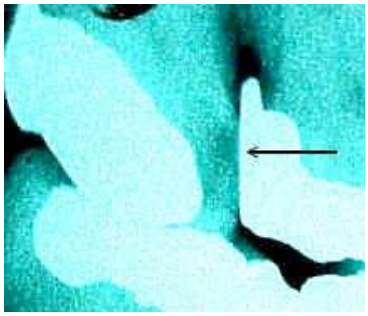
In the three images below, notice the difference in appearance of the caries on the mesial of the second image as the contrast increases from left to right.



Low Contrast



Medium Contrast



High Contrast

Contrast is the difference in optical density (film 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 operators should monitor the amount or radiation they are exposed to by using a film 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 films. 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 films for a patient during exposure. When taking intraoral films, 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 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, film speed, and kilovoltage. 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

The latest trend in dental office technology is digital, resulting in a paperless practice. Digital x-rays became recognized and first used in the United States after FDA (Food and Drug Administration) approval in 1990. Since then, digital radiography is widely used and quickly becoming the preferred method for many dental professionals. There are many benefits to going paperless. Files can be accessed and saved even after unforeseen situations (such as a fire) occur.

The digital trend is also making clinician's aware of obvious drawbacks to traditional x-ray technology. One such drawback is film handling, retrieval, and duplication time. Darkroom maintenance is costly in terms of time and money. Film requires an interconnected processing system that allows for clinician error, and traditional film is not eco-friendly.

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 Low 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.

Infection Control

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 them with fresh protective barriers each patient. Anything touched during procedures should be disinfected. The instruments must be sterile and stored in closed containers. It is important to remember that as soon as film is placed in a patient’s mouth, it is contaminated and should be placed in a cup behind a barrier.

When the series is complete, assemble all contaminated instruments in a container and transport them to the sterilization area. Remove gloves and wash your hands. Transport the film to the darkroom. Use a clean pair of disposable gloves in the darkroom to open the packets. Remove the film from the packets without touching it directly (the powder from the gloves will leave an imprint on the film). Collect contaminated packets on a disposable paper towel. When all films are out of the packets, discard the towels and packets, and remove your gloves. After washing your hands, process films as usual. The darkroom equipment will not be contaminated. Disinfection can be achieved by wiping film packets with bleach or disinfectant spray before taking them into the dark room.

Envelopes

Barrier envelopes are available for intraoral films. Film packets with barrier envelopes

are positioned in the patient's mouth and exposed. After removing the exposed x-rays, tear open the barrier envelope and drop films into a clean cup without touching them with your gloved hand. After films are placed in cups, discard your gloves. This prevents patient fluids from coming into contact with films and keeps glove powder from depositing onto films.

Infection Control with Digital Equipment

Infection control requires using barriers between the patient and equipment. Hardware 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.

Patient Management

Patients often view x-ray procedures with disdain. They may have had bad experiences, and children are sometimes overwhelmed by technology. Confidence and compassion on the part of the operator can do wonders for patient compliance.

Gag Reflex

The key to control gagging is breathing through the nose or holding the breath. No one gags while they are eating, even though food fills the entire oral cavity. The position of the tongue in the mouth is important; as long as the posterior portion of the tongue blocks the throat, gagging does not take place. In order to properly position the tongue, ask the patient to open his mouth as wide as possible and hum through his nose. If any noise comes out his mouth, ask the patient to block the throat with the back of his tongue.

Once the patient is clearly humming through the nose with his mouth wide open, tell him to be sure to inhale with his tongue still blocking his throat. With breathing controlled this way, patients are less likely to gag. It sometimes helps to lighten the mood by having the patient hum a tune for a few moments while you congratulate him on a fine singing voice! As long as patients remember to breathe through the nose and open very wide while you insert films, 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 film 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 film in the patient's mouth any longer than necessary.

Set up the machine and complete all necessary tasks before placing film in a patient's mouth. Instruct the patient to breathe through his nose while placing film, and set the film 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.

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.

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 document 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.

Film Processing

After films have been exposed, they need to be processed. Even with the best placement technique, a cooperative patient, and the highest quality x-ray equipment, a film can be rendered useless for diagnostic purposes during processing.

Darkroom

The darkroom should be kept clean. Chemical fumes affect film emulsion, so store unused film in a separate room. There should be plenty of work space, especially next to processing tanks. Keep the darkroom at 70ºF to 80ºF and at 70% humidity. It should be completely dark with no cracks where light may filter in.

There should be hot and cold running water near the tanks with mixing valves so temperature can be regulated. A white light source and safe light should be available within four feet of the working surface.

Automatic Film Processing

Automatic film processors develop radiographs faster with more consistent results than do manual processers provided chemicals are maintained. A series of rollers inside the unit guide film through chemicals. The processor uses a heating element that keeps solutions at constant temperature--usually between 85ºF to 105ºF. Higher temperatures shorten time needed for processing. The roller action helps disperse chemicals evenly over film. A special roller at tank end squeezes off most chemicals, so they do not mix or dilute.

The most frequent causes of failure in automatic processors are dirty rollers and old chemicals. Chemicals should be replenished at the beginning of the day. After four full mouth surveys or panoramic films, chemicals need four to six ounces of new solution. Rollers should be washed once a week with warm running water and soaked for ten to fifteen minutes. Two large, extra oral films should be run through the machine to clean the rollers.

Depending on rate of use, solutions should be changed every two to six weeks. Follow manufactures' guidelines and use recommended solutions. Empty all chemicals in an orderly manner, so they do not mix. Follow manufactures' recommendations regarding lubrication, maintenance schedules, and general use. When the machine is not in use, the cover should be kept slightly ajar to let fumes disperse and keep moisture from accumulating on the motor. Feed films in at the recommended rate. Feeding too fast can cause films to stick together.

Film Duplication

X-ray films may need to be duplicated when the patient moves, is referred to a specialist, for insurance preauthorization, or any other time an x-ray record needs to be sent outside the dental office. Originals stay in the patient's chart as a permanent record. Operators can use double films (the type with two films in the same packet) for x-rays that will be sent out. This yields two, good quality films without exposing patients to additional radiation.

Film duplicators can also be used, especially when the originals have already been processed. Duplicating film is sensitive to light and becomes lighter when exposed. Regular x-ray film becomes darker when exposed to light. The duplicating procedure takes place in the darkroom with safelights on. Radiographs are mounted in a special

mount designed for duplication with the embossed (raised) dot side down for optimal contact.

Radiographs are placed on the duplicator and the duplicating film is placed on top with the emulsion side against the radiograph originals. Expose according to the manufacturer's recommendations. The film is processed in the same way as regular 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 film 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.

Film Placement

Correct film placement is critical for success.

In all premolar views, the distal of the cuspid must be 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 film.

The film 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 3 to 4 mm of bone.

Films should not be bent. If the patient is uncomfortable with film edges, try gently reshaping the edge and repositioning the film in the mouth.

Before placing an x-ray film in a patient's mouth, check to make sure it is not backward. The lead foil will leave an artifact on the exposed x-ray and it will be confusing to mount.

Make sure that exposed films are not mixed with unexposed ones.

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 film and the angulation of the tooth. Film 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 film 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 film, the contacts will be overlapped. Due to the curve of the arch, some areas will likely overlap. It is better to position two (2) size-two films in a premolar view and take 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 film will be cone cut when the tube head is not covering the whole area of the film. The best way to avoid this is to look at the film in the patient's mouth and aim the cone head directly toward the film 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 film will be affected. Watch the patient as you expose films.

Processor Errors

The following table summarizes common film processing errors, the results, and possible solutions.

Developer temperature too low	Films too light	Check and adjust temperature
Developing time too short	Films too light	Use a timer
Developer solution too old or diluted	Films too light Yellow or brown film	Keep a schedule of chemical maintenance Change solutions when this begins to happen consistently
Developing time too long	Film too dark Foggy film	Use a timer
Light leak in processing	Film too dark Foggy film	Check processor and darkroom
Film exposed to light before processing	Film too dark Foggy film	Don't open film until safety light is turned on and other lights are off Check safety light for leaks
Films exposed to radiation after exposure	Foggy film	Take exposed films out of room when exposing other radiographs
Fixer too old or contaminated	Yellow or brown film	Check with checking film Replenish and maintain on schedule
Incorrect rinsing between developer and fixer	Streaking	Follow proper protocol for rinsing between chemicals
Chemicals exhausted Incorrect or insufficient washing	Streaking Green film	Run checker film every day Wash longer after fixer
Dirty rollers, fingerprints	Artifacts or Streaking	Clean rollers, handle films by edge
Films sticking together	Green Film	Fix again and rinse
Bending films	Lines on film	Don't bend films
Static electricity	Lightning marks on film	Humidify environment, use Static Guard
Water drops on film	White spots	Don't put film in water after removing it from its wrapper
Developer splash on film	Black spot	Make sure countertop is dry after changing chemicals

Mounting Films

Films must be mounted consistently and correctly. The x-ray mount should have patient's full name, exposure date, and x-ray practitioner's name. In the standard

method of mounting, the raised dot is oriented upward for bitewings and toward the incisal or occlusal edges of all periapicals.

This dot should always face the tube head. If the dot is on the right of the film, the film was taken on the patient's right side; if the dot is on the left side of the film, the film was taken on the patient's left side.

When radiographs are dry, take them with the mount to a view box. Turn all films dots facing up. Take all maxillary films and group them together. Put the bitewing x-rays to the side. Face all mandibular films (dot still up) with incisal edges and occlusal surfaces up and all maxillary films with incisal edges and occlusal surfaces down. Mount x-rays from the facial aspect (from the outside in) as if you are standing in front of the patient.

Mount the films representing the patient’s left side on your right. Sort anterior films and mount them. Mount premolars then molar views. Mount bitewing films. Empty frames on the film mount should be blocked with an opaque film blank. Check that the dots are all on the same side and that objects and restorations on the periapicals match the same areas on the bitewings.

Check root curvatures to make sure they are all pointing distally. The curve of occlusal edges should be upturned at the ends, like a smile. The most common orientation is with the dot raised (pimple), but some practitioners prefer to view x-rays with the dot oriented downward (dimple). The correct way to mount x-rays is according to the direction of the dentist who will be using them.

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 advantageous and useful knowledge for practitioners and one day may be required.

Post Examination

Essential Tips for Dental Radiographers

This test contains ten questions. Please choose the best answer to the following:

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, film sensor, teeth
b. Palate, teeth, x-ray beam
c. Source, teeth, film

3. The principle behind bisecting the angle is to:

a. Splitting the difference between the angle of the tooth and the angle of the film 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 film 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. X-ray films that have too little density appear:

a. Overlapped
b. Green
c. Too light

d. Clear

6. One way to make sure exposed traditional radiograph packets do not spread infectious pathogens is:

a. Air dry before processing

b. Have patient use a rinse like Listerine before taking the radiographs

c. Use a barrier envelope on the film, and remove the envelope without touching the film with a gloved hand

d. Run the films through a heat sterilizer cycle before processing

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 film parallel to the teeth and the cone perpendicular to the film

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

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

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 the problem is all in their head and force x-rays quickly

FAX ANSWER SHEET (703) 935-2190
Essential Tips for Dental Radiographers

Please complete and **fax this form only** to (703) 935-2190. Please print your answers clearly.

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1. _____ **6.** _____
2. _____ **7.** _____
3. _____ **8.** _____
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Please help us improve by circling the appropriate answer.

Ordering experience was convenient. Yes No

I received my workbook or file in a timely manner. Yes No

Course text and test is clear and understandable. Yes No

I will use the course information in my daily practice. Yes No

Overall, I would give this course a grade of _____.

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