BB2(13)

DENTAL RADIOGRAPHIC PITFALLS AND ERRORS

Approved for 4 Continuing Educational Units.
Dental Radiographic Pitfalls and Errors 0707

By:
Allan G. Farman, BDS, EdS, MBA, PhD

Revised, 1997 by
Sandra Kolsom, CDA, RDA

Revised, 2003 by
Bonnie Marshall, CDA, EFDA, EFODA, FADAA

Revised, 2007 by
Wilhemina Leeuw, CDA, BS

American Dental Assistants Association
Continuing Education Course

Approved for 4 Continuing Education Credits

©2007 American Dental Assistants Association
INTRODUCTION
Operator error is responsible for the majority of retakes of dental radiographs. An undiagnostic radiograph is worse than no radiograph at all due to the increased radiation to the patient. Operator error can occur either while exposing or processing films, and is due to using incorrect or improper techniques. A routine for exposing and processing films using correct technique and maintenance of equipment is critical to maximize the information obtained from dental radiographs while minimizing patient radiation exposure.

COURSE OBJECTIVES
After completing this course, the dental professional should be able to:

- Recognize exposure, processing and handling errors and pitfalls in intraoral radiography.
- Recognize exposure, processing and handling errors and pitfalls in panoramic radiography.
- Identify ways of correcting errors.
- Understand the basics of Digital Radiography.
- Understand the basics of a "Quality Control Program."

COURSE OUTLINE
I. Introduction
II. Objectives
III. Course Outline
IV. Glossary
V. Exposure and Operator Errors
   A. Underexposure
   B. Overexposure
   C. Double Exposure
   D. Clear Film
   E. Black Film
   F. Reverse Film Placement
   G. Quiz
VI. Incorrect Film Placement and PID Errors
   A. Elongation
   B. Foreshortening
   C. Proximal Overlap
   D. Film Placement
   E. PID (Cone) Cutting
   F. Quiz
VII. Motion, Film Bending and Fog
   A. Motion
   B. Radiolucent Bend Artifact
   C. Radiopaque Bend Artifact
   D. Static Electric Discharge
   E. Fog
   F. Quiz
VIII. Processing Room Errors
   A. Light Leak
   B. Unsafe Safelight
   C. Contamination
IX. Processing Room Errors
   A. Incomplete Submersion
   B. Overdevelopment
   C. Underdevelopment
   D. Developer Temperature
   E. Expired/Exhausted Developer
   F. Air Bubbles and Film Contact
   G. Underfixed
   H. Inadequately Washed
   I. Excess Fixation or Washing
   J. Torn Emulsion
   K. Reticulation
   L. Film Contact
   M. Contamination
   N. Foreign Objects
   O. Quiz
X. Summary of Radiographic Film Handling and Processing Errors
XI. Errors in Panoramic Dental Radiography
   A. Head and Film Positioning
   B. Patient Positioning Errors
   C. Vertical Height
   D. Chin/Head Position
   E. Cervical Spine Slump
   F. Motion
   G. Focal Trough
   H. Magnification
   I. Ghost and Secondary Images
   J. Cassette and Rotational Artifacts
   K. Other Errors
XII. Summary of Panoramic Film Handling and Processing Errors
XIII. Digital Imaging
   A. Direct Digital Radiography
   B. Indirect Digital Radiography
   C. Optically Scanned Digital Radiography
   D. Advantages of Digital Radiography
XIV. Quality Assurance Program
XV. Summary
XVI. References
XVII. Post-Test

GLOSSARY
AGITATE: Gentle shaking motion to ensure saturation.
ARTIFACT: An object on a radiograph that does not belong and can cause the film to be undiagnostic.
CASSETTE: A metal, plastic or cardboard light tight container that holds x-ray film.
CHEMICALS: Developing, fixing and water solutions needed in the developing process.

CONTAMINATION: A radiograph that has a mark (an error) due to water, blood, saliva or chemicals.

DARKROOM: A room where limited light is present (safelight), allowing the x-ray developing process to take place.

DAYLIGHT LOADER: A box attached to an automatic processor where limited light is present in order to allow x-ray developing to take place correctly in a small area and without a darkroom.

DIAGNOSTIC: Radiographs that properly delineate and adequately cover all structures present in a given area. Tubehead and film stability, angulation, exposure factors and processing procedures will be correct, thereby providing complete diagnostic information.

DOUBLE EXPOSURE: A radiograph that has superimposed images due to exposing a film twice prior to development.

ELONGATION: A radiograph that presents distortion, resulting in an image that appears long or stretched; usually the apex is no longer visible.

EMULSION: A silver bromide (silver halide) crystal solution that coats the film. The crystals absorb radiation, when followed by the developing process it produces a radiograph.

FOCAL TROUGH: The patient is positioned into a "zone of sharpness" during a panoramic exposure in order for all radiographed images to be diagnostic.

FOG: A gray appearance on a film that hides the image due to the contrast being lost. This can be caused by safelight errors, chemicals too hot or cold, white light, improper film storage, outdated films and light leaks.

FORESHORTENING: A radiograph that presents distortion, resulting in an image that appears short.

FRANKFORT PLANE: Line connecting the superior border of the external auditory meatus with the infraorbital rim.

GBX-2 FILTER: A ruby red filter that must be used when developing extraoral radiographs.

GHOST IMAGE: An artifact on a film resulting from an object being superimposed onto the film prior to developing.

HERRINGBONE PATTERN: A radiograph with a cross pattern either covering the corners and/or the entire film. Placing the film backwards in the patient’s mouth causes this error.

HORIZONTAL ANGULATION: Angulation in a horizontal plane; right to left or mesial to distal.

INTERPROXIMAL: The areas between teeth in the same arch, mesial and distal. This area is very important when directing the PID in order to open contacts.

LATENT IMAGE: A radiograph that has been exposed and not developed.

MARGINAL: Radiographs that may be adequate and diagnostic in part ONLY. Crowding, tori, or other anatomical difficulties may prevent adequate visualization of the area. A radiograph from a different area in connection with the marginal radiograph may show and/or compensate for the problem.

MID SAGITTAL PLANE: The very center, high point in the palate.

OBLIQUE: A slanting or sloping angle.

OVERDEVELOPMENT: A radiograph that has been left in the developing solutions longer than the recommended time/temperature recommendation. The radiograph has a dark appearance.

OVEREXPOSURE: A radiograph that is too dark due to incorrect and/or excessive exposure settings prior to activation.

OVERFIXED: A radiograph with a weak or light image due to being left in the fix solutions too long. If left in the fix solutions overnight, the image may be completely gone and the radiograph will appear clear.

PID: Positioning Indicating Device. This device is located at the end of the tubehead and should be positioned correctly in order to produce a diagnostic radiograph.

QUALITY ASSURANCE PROGRAM: A program that a dental office establishes in order to maintain and improve quality dental care through quality radiographs.

RADIOLUCENT: Dark areas on film; less dense areas easily penetrated by x-rays.

RADIOPAQUE: Light areas on film; more dense areas which are hard for x-rays to penetrate.

RETICULATION: Cracking of the film emulsion.

SAFELIGHT: A 10 to 15 watt bulb covered with a filter, provides an illumination that does not affect the x-ray film during the developing process.

SENSOR: A device that is used in Digital Radiography.

SNAP-A-RAY: A Type of film holder.

STABE: A type of disposal film holder designed for patient comfort.

UNDERDEVELOPMENT: A radiograph that has a light image due to weak developing solutions and/or has not been left in the developing solutions for the correct time (too short).

UNDEREXPOSURE: A radiograph that is too light due to incorrect and/or insufficient exposure settings prior to activation.
UNDIAGNOSTIC: Radiographs in which any error in film, tubehead placement, stability, angulation, exposure, or processing prevents visualization of the area required. This type of radiograph would require the area to be re-exposed.

UNDERFIXED: A radiograph with a greenish-brown appearance due to weak fix solutions and/or a film that was taken out of the fix solution too soon.

VERTICAL ANGULATION: Angulation in a vertical plane; up and down.

XCP: A Film holding device designed to keep film, teeth, and XCP parallel.

EXPOSURE AND OPERATOR ERRORS

Underexposure

Description: An underexposed film will be light and have less detail than a correctly exposed radiograph. Underexposure occurs when the operator selects a mA, kVp or exposure time that is too low or when the source-to-object distance is too long for the selected exposure settings. For example, if the operator switches from an 8 inch position indicating device (PID) to one of 16 inches, the total exposure in milliampere seconds (mAs) must be quadrupled to compensate for the resulting decrease in beam intensity under the Inverse Square Law. (The intensity of the beam varies inversely as the square of the distance from the source. In other words, the farther away one moves the X-ray tube or source from the object to be radiographed, the less intense the beam becomes, and thus the less density will result in the radiograph.)

Differential Diagnosis: If a correctly exposed film is underdeveloped (due to insufficient developer immersion time, weak and/or exhausted solution or too low temperature), the radiograph will look almost identical to an underexposed film. If the film looks underexposed, first check the developer solution to be sure its strength and temperature are correct. If the solutions are correct, it is likely that the machine settings were at fault.

Consequences: The image cannot be retrieved by chemical, duplicative or bright-light means. A retake radiograph will be necessary.

Remedy: It is the operator’s responsibility to be aware of machine settings, chemicals being used and to refer to the replenishment chart, which should be posted outside the darkroom.

Overexposure

Description: An overexposed film will be too dense (dark) and will be difficult to read under normal illumination. Overexposure can occur by using excessive mA exposure time or kVp settings or decreased source-to-object distance.

Differential Diagnosis: As with underexposed films, the developer should be checked to be certain it meets manufacturer’s recommendations regarding strength, freshness and temperature. If the solution is within tolerances, and the darkroom timer is accurate, the machine settings were probably at fault. If a correctly exposed film is overdeveloped (immersed too long in developing solution, or solution is too warm), then the resulting radiograph will look almost identical to an overexposed film i.e. too dark.

Consequences: The most fundamental concern is that the patient was subjected to excessive radiation and, if the film is grossly overexposed, may have to receive even more during a retake. If the film is overexposed but the image is still detectable, a bright light may give sufficient illumination to make it usable, or a reducing solution (Farmer’s Solution) may clear enough excess density to improve the image.

Remedy: It is the operator’s responsibility to be aware of machine settings, chemicals being used and to refer to the replenishment chart, which should be posted outside the darkroom.

Double Exposure

Description: Double exposures occur when the same film is used for more than one exposure (Figure 1). This can occur if the operator confuses an exposed film with an unexposed film and places the packet into the patient’s mouth as if it were unused. Double exposures can also result from activating the exposure button twice.

Differential Diagnosis: The resulting film is dark because it has technically been overexposed, resulting in confusing, overlapped anatomic images.

Figure 1
**Consequences:** Retakes are almost always necessary because of the lost detail caused by anatomic superimpositions. Fortunately, double use of a packet usually occurs with the same patient in the chair; but if a previously exposed film from one patient were placed into the mouth of another, the operator would be running the risk of cross-contamination and transmitting disease between patients.

**Remedy:** After a film packet has been exposed the operator should place the film into a lead receptacle. Unexposed films and exposed films should never be kept in the same area.

---

### Clear Film

**Description:** Clear films are those that have not been exposed to X-rays or that have the entire emulsion cleared during processing.

**Differential Diagnosis:** This can occur if the X-ray unit is not switched on when the film is made, if the PID is not aligned with the XCP during exposure, if an unexposed film is processed, if the film is placed into the fixer before it goes into the developer or if the radiograph was left in the fixer too long.

**Consequences:** Obviously, a retake will be necessary. If the machine was not on when the exposure was presumably made, the patient will not have received radiation; however, if processing technique caused the error, the patient will be subjected to additional radiation dose.

**Remedy:** The operator should pay close attention to details while exposing all radiographs.

---

### Black Film

**Description:** A black film is one without any detectable image; in other words, a totally dense film.

**Differential Diagnosis:** It would take a great amount of excess radiation exposure to render a black film and, thus, overexposure is an unlikely cause. Exposing the film to white light before processing is the most common cause. In addition, excessive development time or very high developer temperature will also produce black films.

**Consequences:** The cause of the error will need to be corrected and the film retaken, subjecting the patient to additional dose of radiation.

**Remedy:** It is the operator’s responsibility to be aware of machine settings and also the chemicals used and to refer to the replenishment chart, which should be posted outside the darkroom.

---

### Reverse Film Placement

**Description:** Reverse film placement results when the beam passes through the lead foil backing before it strikes the film emulsion. The lead shield attenuates the beam by approximately 66 percent, resulting in a light film with a visible pattern of the embossed lead shield superimposed on the image. The pattern usually resembles a series of V-shaped herringbones or dotted "tire tread" shapes, as in the right side of Figure 2.

**Differential Diagnosis:** The pattern of the embossed backing differentiates reversed film from other light films.

**Consequences:** The image may still be acceptable, despite the error. If the pattern obliterates detail or interferes with the film’s diagnostic quality, a retake is necessary.

**Remedy:** The operator should be aware of the front and back of the film. Each film has an embossed dot (orientation marker) found on the front of the film. The raised surface of the dot should be closest to the PID. The back of the film has a different color and/or a flap where the operator will retrieve the exposed film prior to developing.

---

### Quiz

1. Setting kVp, exposure time and mA too high will result in what kind of radiographic exposure?
   - Overexposure.

2. If the operator changed from a 16-inch PID to an 8-inch PID, what adjustment would have to be made to the net mAs to produce a diagnostic-quality radiograph?
   - Total mAs would have to be reduced to one-fourth of the setting used for a 16-inch PID.

3. A series of V-shaped lines appear on a processed radiograph. What is the probable cause?
   - Reverse film placement. The foil backing was oriented toward the beam instead of away from it.

---

**Answers**

1. Overexposure.
2. Total mAs would have to be reduced to one-fourth of the setting used for a 16-inch PID.
3. Reverse film placement. The foil backing was oriented toward the beam instead of away from it.
INCORRECT FILM PLACEMENT
AND PID ERROR

*Note: For diagnosable radiographs every time, the film, teeth, and end of the PID should be parallel at all times. This is achieved by properly using film holding devices such as the XCP, the disposable Stabe, or the Snap-a-Ray. The patient should never hold the film as this can increase errors and unnecessarily radiates the patient’s hand.

**Elongation**

**Description:** A radiograph is a two-dimensional representation of a three-dimensional object. Incorrect positioning of the tubehead’s central ray relative to the object to be radiographed results in a distorted image. If the central ray of the tubehead is placed at too shallow a vertical angle relative to the long axis of the teeth, and thus is not perpendicular to the long axis for paralleling technique or the bisector (90 degree angle) in the bisecting angle technique, the crown and root images will appear long (Figure 3).

**Figure 3**

**Figure 4**

**Differential Diagnosis:** If vertical beam angulation is too shallow, the entire tooth and roots will appear elongated. If film bending was at fault, the roots will generally be elongated, but the crown will appear normal.

**Consequences:** The image may still be acceptable, despite the error. If the elongation interferes with the film’s diagnostic quality, a retake is necessary.

**Remedy:** The operator should review technical procedures regarding vertical angulation in relation to either Paralleling or Bisecting technique, and repeat the film. The operator should increase the vertical angulation in order to correct elongation of an image.

**Foreshortening**

**Description:** Foreshortening occurs when the central ray from the tubehead is too high, making the vertical beam angulation too steep. The image appears shortened particularly at the portions of the teeth that were closest to the beam (Figure 4).

**Differential Diagnosis:** Visible shortening of the teeth, with somewhat wider appearance of objects closest to the X-ray head. The incisal or cuspal edge may be partially missing. The posterior teeth may show a greater distance between the buccal and lingual cusps (Figure 5).

**Consequences:** The image may still be acceptable, despite the error. If the foreshortening interferes with the film’s diagnostic quality, a retake is necessary.

**Remedy:** The operator should review technical procedures regarding vertical angulation in relation to Paralleling technique or Bi-sect-the-Angle tech-
Proximal Overlap

Description: To open the interproximal contacts between adjacent teeth, the horizontal angulation of the x-ray beam needs to be parallel to the teeth and film being exposed. If it is not, the surfaces will overlap, causing image superimposition of adjacent teeth, which appear as teardrop shaped, light regions between the teeth on the radiograph (Figure 6).

Differential Diagnosis: The light, droplet-shaped areas between the teeth indicate proximal overlap. The central ray or beam was not parallel with the interproximal surfaces. If the overlaps are larger in the posterior half of the film, the horizontal angulation was angulated too much from the mesial toward the distal. The reverse is true for a film in which the overlaps are larger in the anterior half of the film.

Consequences: Important information about incipient interproximal caries can be obscured. The darker lines that form at the zone of changing density in overlapping areas could be misinterpreted as interproximal caries.

Remedy: The operator should review technical procedures regarding horizontal angulation and repeat the film. The operator should be directing the central beam into the interproximal spaces of the teeth needing to be radiographed.

Film Placement

If the film is placed incorrectly in the patient’s mouth, the resulting image will be either incorrect or inadequate. Vertical position refers to the placement of the film in relation to the long axis of the tooth. Horizontal placement refers to the anterior-posterior position of the film. Some positioning errors are summarized below.

Maxillary Vertical film position too high: Periapical tissues are adequately seen, but details of the tooth crowns are missing at the occlusal or incisal edge of the film.

Remedy: The operator should place the bite block of the XCP on the incisal edge to ensure that 1/8 inch of the film is beyond the incisal edge of the teeth, and then have the patient bring the mandibular teeth to the bite block.

Maxillary Vertical film position too low: Tooth crowns are adequately seen, but the periapical areas are missing at the periapical edge of the film.

Remedy: The operator must place the film further into the mouth to avoid hitting the hard palate.

Mandibular Vertical film position too high: Crowns are adequately seen but periapical tissues are missing at the periapical edge of the film.

Remedy: The operator should place the bite block of the XCP on the incisal edge on the mandibular teeth, making sure to avoid any tori, then the operator should have the patient bring the maxillary teeth down to the bite block.

Mandibular Vertical film position too low: The periapical tissues are adequately seen, but the crowns are missing at occlusal edge of the film.
Remedy: The vertical angle of the XCP is not forming a correct parallel angle. The operator must make sure that the film is placed so that the incisal edge touches the bite block correctly in order to have the long axis of the tooth and the film parallel to each other. The operator may have to place the film further back in the patient’s mouth.

**Horizontal film position incorrect:** If the film is placed either too far mesial or too far distal into the oral cavity, the image will not adequately include the desired area of interest.

Remedy: The operator must place the film next to the correct teeth being radiographed.

**Vertical-Horizontal film placement errors:** It is possible to misalign the film so that it is incorrect on both positions, compounding the effects of the individual positioning errors. Figure 7 is a radiograph which resulted from the film being positioned too far posteriorly in the horizontal position and too high in the vertical position. Notice that due to these placement errors, the mesial surface of the first mandibular premolar and the apices of the first and second mandibular premolars are not recorded.

Remedy: The operator must place the XCP bite block directly on the teeth being radiographed. The patient must bite hard enough to hold the XCP bite block in place. If the patient finds that the bite block and the film are uncomfortable, the operator must reposition the film, possibly tilting the film or using a different film holder, however the operator must maintain the correct placement.

**PID (Cone) Cutting**

If the PID is not placed completely over the film, the collimated beam will not expose the portion of the film that was outside the edge of the PID. The unexposed area will be completely white and follow a curved border if the collimator was round; if rectangular collimation was used the border will be linear. Figure 8 illustrates a cone cut resulting from incorrectly positioning a round collimator.

Cone cuts occur frequently during bitewing exposure. The operator fails to align the central ray with the center of the film packet due to the fact the operator tends to lose sight of the bite tab as the patient’s mouth closes.

Films with cone cuts should be repeated only if the information that has been obscured is not obtainable from films of adjacent areas. Since there is usually sufficient anatomic repetition in a full mouth dental series, one cone cut does not usually require retake of a film.

Remedy: When using the PID the operator must make sure the PID and the collimator are touching and are at the correct angle. If the operator is exposing bitewing films, he/she should ask the patient to smile in order not to lose the bite tab as the patient’s mouth closes. The operator can touch the bite tab and visually mark the tab’s location by noting facial landmarks. The operator can also use their fingers as an extension of the cone to approximate PID coverage.
Quiz

1. A processed maxillary periapical radiograph shows a curved, white area along the lateral edge of the film and the apices of the first and second premolars are missing. What errors resulted in this film?
2. A radiograph of the central incisors shows long, narrow crowns and roots. What caused the radiograph to appear like this?
3. A radiograph adequately depicts the tooth crowns and periapical tissues, but the mesial surface of the tooth of interest is not visualized on the film. What caused the radiograph to appear like this?

Answers

1. The PID was not positioned over the film, resulting in a cone cut, and the film was placed too low in the vertical position.
2. The beam angulation was too shallow, resulting in an elongated image.
3. The film was positioned too far posteriorly.

MOTION, FILM BENDING AND FOG

Motion

Motion distortion can occur if the patient, tube head or film moves during the exposure. Such movement leads to blurred edges of the image detail (Figure 9).

Generally, motion distortion results in unusable radiographs. These radiographs should be retaken unless the patient cannot cooperate or unless the tubehead is unstable. A machine with an unstable tubehead should be taken out of service until it is professionally repaired.

Remedy: Check the equipment on an annual basis for any tubehead drift. Make sure the patient understands they must hold completely still until exposure is completed.

Radiolucent Bend Artifact

Also known as film creasing, this is caused by the abrupt bending of the radiographic film prior to processing can release enough energy to activate the silver bromide crystals on the bend line. These activated areas appear as dark lines across the processed film. In Figure 10, the dark line running across the mandibular region is a positive bend artifact. The dark lines across the lower right corner resulted from the common practice of bending the corners of the film packet to adapt it to the contour of the mouth for the patient’s comfort.

Remedy: Do not bend the corners of the film. The operator can move the film away from the teeth and still maintain the proper placement. There are products available that will cover the corners of the film in order to soften the edges.

Radiopaque Bend Artifact

A negative bend stretches and inactivates the film emulsion. This sometimes happens during film placement as the film gets bent against the roof of the patient’s mouth. A negative bend results in a white defect as seen in the right-center of Figure 11.

Remedy: The operator should not have long fingernails, this presents infection control issues as well as possible artifacts while taking radiographs.

Static Electric Discharge

Damage from static electricity usually occurs as the film is prepared for processing. The synthetic material in some office fabrics can cause a static discharge to jump to the film, particularly when the darkroom humidity is low. Protective latex gloves can cause static electricity that produces a black,
smudge-like image. Usually however, the damage is done as the film comes out of the packet and friction between sliding components generates a static charge sufficient to energize the silver bromide emulsion. The resulting artifact appears as radiolucent lines and/or areas, often with a "tree-like" configuration, as in Figure 12. Static electricity can also cause a localized overexposure.

Remedy: The operator should slowly remove the film from the film packet. The dental office also can operate a humidifier in areas where it is very dry.

Fog

Fogging is a generalized softening and obscuring of the image that results in increased density and a decrease in film contrast. The overall appearance of the film is gray, almost like a shadow forming on amalgam restorations. Its causes include using old or expired film, storing film improperly (excessive hot or cold), chemical fumes, light or scatter radiation to unexposed film, contamination of processing solutions, using an unsafe or improper safelight conditions during processing and allowing white light to leak into the darkroom.

Remedy: The operator has a responsibility to perform the "Coin Test" monthly in order to detect darkroom light leaks, check expiration dates, to store all film in a cool, dark place free from any scatter radiation and chemical fumes and also to avoid contamination of processing solutions. Do not keep films (exposed or unexposed) in an area where scatter radiation could reach them.

Quiz

1. A white, crescent-shaped artifact is a sign of what kind of damage?
2. What kind of damage results in a tree-like shape across the film?
3. Controlling office humidity will help prevent what kind of damage?

Answers

1. Radiopaque or minus-density artifact.
2. Static electric damage.
3. Static electric damage.

PROCESSING ROOM ERRORS

Light Leaks

Light leaks will cause various degrees of damage, from light fogging to completely black films, depending on the intensity of the white light exposure and the duration for which the film was exposed to white light.

Unsafe Safelight

Failed safelighting will cause the film to be fogged or completely dark, depending on the intensity and duration of exposure. Usually a filtered 10-15 watt bulb, placed 4-6 feet from the work surface, provides adequate working light for darkroom procedures. The light orange Kodak Morlite filter transmits the most light and is therefore easier to work under; however it cannot be used when processing the more light sensitive extraoral films. Extraoral films require the use of a ruby red GBX-2 filter.

The safelight should be checked monthly using the coin test. With safelight on, place a coin over an unexposed film, let it lie on the darkroom table for several minutes and then process the film normally. If the film is clear, the darkroom and safelight are in operating order. If the coin casts a shadow on the film, the operator can assume that either the safelight was not really safe or that outside light leaked into the darkroom. Repeat the coin test with the safelight off. If the film is clear, then it can be assumed that the safelight is malfunctioning. If a shadow develops with the safelight off, the darkroom itself should be checked for light leaks.

Remedy: If the above test produces a negative result the operator has a responsibility to correct the error or not use the darkroom and/or daylight automatic processor until the problem is corrected.
Contamination

The darkroom work area must be kept clean, dry and dust-free. Foreign particles will adhere to the film emulsion and prevent developer and fixer solutions from contacting the underlying area. Figure 13 illustrates several examples of contamination. The small dark spots scattered across the film are dust particles; the white streak in the upper right corner represents an area where rough handling stripped the emulsion; the two large, dark areas resulted when the fluoride contacted the film surface; and the white hair-like artifact on the mandibular area is a scratch picked up in the darkroom.

Contamination can also occur from immersing the film in fixer before developing, cross-mixing the developer and fixer solutions (while checking the temperature or because of incomplete rinsing between immersions), and allowing unprocessed film to contact liquid on the darkroom counter prior to processing.

Remedy: All dental team members who use the darkroom and/or daylight loader of an automatic processor must leave the area clean and free of possible contaminates.

PROCESSING ROOM ERRORS

Incomplete Submersion

Description: If a film is not completely submerged in developer solution, the area that was not in contact with the fluid will be completely clear after the film is fixed. This error most frequently occurs with the top-most film on a manual system developing rack. The operator must visually inspect the rack and developer solution level to make sure all films are completely covered.

Differential Diagnosis: A portion of the film will be completely clear. Usually, there is a rippled margin between the developed and clear areas caused by the movement of the fluid surface (Figure 14).

Consequences: Unless the diagnostic information can be obtained from other films, or unless the clear margin is sufficiently high on the film, a retake is usually necessary.

Remedy: The operator must check solution levels daily and replenish as needed.

Overdevelopment

Description: Overdevelopment results in a dark, dense film that is virtually identical to an overexposed film.

Differential Diagnosis: Since an overdeveloped film is so similar to overexposed films and films processed at excessive temperatures, determining the cause of a dense film is difficult. As a rule, it takes several times the manufacturer’s recommended immersion time to completely ruin a film. Therefore, the operator should first check the solution temperatures, and then consider overexposure.

Consequences: Overdeveloped films often can be used with the help of a bright light or salvaged using long-exposure duplication or reducing agents (Farmer’s Solution).

Remedy: The operator must check the temperature of the developer each time by reading the thermometer and then checking the developing chart for the correct time-temperature recommendations.

Underdevelopment

Description: Underdevelopment results in a light film that is virtually identical to an underexposed film.

Differential Diagnosis: Since an underdeveloped film is so similar to underexposed films and films processed at too low temperatures, determining the cause of a thin density film is difficult. The operator should first check the solution temperatures, and then consider underexposure and underdevelopment.

Consequences: Underdeveloped films lack detail and are generally unusable. As a rule, they cannot be salvaged using duplicative or chemical means and have to be repeated.

Remedy: The operator must check the temperature of the developer each time by reading the thermometer and then checking the developing chart for the correct time-temperature recommendations.
Developer Temperature

**Description:** If the developer temperature is too high, it will be overly active and cause an overdeveloped, dense film. If it is too low, the film will yield a light, thin-density image.

**Differential Diagnosis:** Again, differentiation is difficult because temperature-related errors produce the same kind of image as time- and exposure-related errors. Temperature is easily checked and, therefore, should be the first potential error evaluated.

**Consequences:** Generally, the same as those for over and underdeveloped radiographic exposures.

**Remedy:** The operator must check the thermometer, found in the developing solution, and regulate the solution to maintain a temperature of 68 degrees Fahrenheit.

Expired/Exhausted Developer

**Description:** Weak, exhausted and/or expired developer results in a light, limited-detail image.

**Differential Diagnosis:** Often, the processed film has a noticeable brown hue due to the oxidation of the developer’s hydroquinone component.

**Consequences:** Generally, the same as those for underdeveloped radiographic film.

**Remedy:** The operator must check the strength of the developer on a daily basis. The operator can use a tool called a "Dental Radiographic Normalizing and Monitoring Device". This device is designed to check the strength of the developing solutions and the correct exposure time. There are some states that require using this device as part of the office’s "Quality Assurance Program."

Air Bubbles and Film Contact

**Description:** Air bubbles prevent the solutions from contacting the emulsion and result in dot formation in the corresponding areas. Since most dental X-ray film is coated with emulsion on both sides, the artifact will only appear on the side on which the bubble was located.

**Differential Diagnosis:** If the bubble occurred as the film was immersed in the developer solution, the dots will take on a relatively radiopaque appearance. If the bubble happens during fixation, the area will not clear and the artifact will appear dark and may turn brown with time.

**Consequences:** The relative damage is dependent on the size, location and number of artifacts.

**Remedy:** The operator should remember to agitate, but not over-agitate, the film rack when immersing it in the processing solutions.

Underfixed

**Description:** Since fixation removes unaltered and unexposed silver halide, an underfixed film will retain some of this chemical. At first, the film appears relatively normal, but it changes with time, approximately three to six months.

**Differential Diagnosis:** As the film ages, it turns progressively more brown and eventually becomes unreadable.

**Consequences:** The film may be usable at first, but deteriorates fairly rapidly and, therefore, cannot be used for future comparative evaluation. A good rule of thumb is to fix the film for at least ten minutes.

**Remedy:** If the doctor requests the film to be read quickly, "quick reading/3 minutes", it is the responsibility of the assistant to return the film to the fixing solution for 7 (seven) more minutes.

Inadequately Washed

**Description:** If a film is inadequately washed after fixing, unaltered silver halide will remain, with the same effects as underfixing.

**Differential Diagnosis:** As the film ages, it turns progressively more brown and eventually becomes unreadable. The film will also have silver bromide crystals remaining on it. These crystals will appear white and almost salt-like.

**Consequences:** The film may be usable at first, but deteriorates fairly rapidly and, therefore, cannot be used for future comparative evaluation.

**Remedy:** Wash each film for at least 20 minutes.

Excessive Fixation or Washing

**Description:** Excessive fixation or washing clears too much and results in a light image. As with underdevelopment, the manufacturer’s recommend-
ed fixing and washing times must be greatly exceed-
ed to produce a completely clear film. However if
the operator leaves a film in the fix or water
overnight the latent image will begin to wash out.

**Differential Diagnosis:** Differentiating may be
difficult because the light image could be caused by
underexposure, underdevelopment or too low solu-
tion temperature.

**Consequences:** Generally, the same as those for
underdeveloped radiographic film.

**Remedy:** The operator must be aware of the
proper times necessary for fixing and washing in
order to produce a diagnostic film.

### Torn Emulsion

**Description:** The film emulsion is particularly
susceptible to tearing when it is wet. Tearing most
often occurs as a result of films scraping each other,
the sides of the tank, other film racks or from con-
tact with the operator’s fingernails. Contact tears
will be variable in shape (Figure 15).

**Differential Diagnosis:** Usually tears will be
irregularly shaped with irregular margins, while
droplet artifacts will be fairly rounded.

**Consequences:** Generally dependent on the size
and location of the tear. If diffuse, the film may have
to be retaken.

**Remedy:** The operator must not allow films or
film racks to touch each other during processing.
The operator must also take care when using an
automatic processor not to allow the films to over-
lap as they enter the roller or transport system.

### Reticulation

**Description:** Reticulation results when an exces-
sive temperature variance between the developer
and fixer solution causes the emulsion to expand
and contract. Such stretching causes the emulsion to
craze or split and results in a blurred, granular
image. Reticulation can also be caused from powder
on gloves. The more sensitive the film, the more
likely this will occur. (Figure 16)

**Differential Diagnosis:** The granulation apparent
on the film is the key to detecting reticulation errors.

**Consequences:** Depending on the degree of dam-
age, the film may or may not be usable.

**Remedy:** The operator must monitor the temper-
atures of the solutions and correct them whenever
possible. The operator must wash hands and gloves
before handling film when using powdered gloves.

### Film Contact

**Description:** The cause of films contacting each
other depends on the type of processing system used.
With manual systems, contact usually occurs when
multiple racks are processed at the same time and
touch each other in the tanks. With automatic sys-
tems, contact errors most often happen when films
are fed into the processor too closely together, and
can be returned to the operator dried and adhered
together. Depending on when the error occurred,
portions of the films will display errors associated
with underdevelopment or under fixation.

**Differential Diagnosis:** If contact occurred dur-
ing development, the corresponding area will be
partially or completely underdeveloped. If it
occurred during fixation, the area will not clear and
will brown and discolor. The film also may have
torn emulsion as the operator separates the films for
viewing.

**Consequences:** Depending on the degree of con-
tact, the film may or may not retain diagnostic quality.

**Remedy:** If the operator finds that two or more
films are stuck together after processing, the opera-
tor, in a dark place, can separate the film into pure
fix for 4 minutes prior to correctly rinsing in the
water bath. This process will sometimes allow the dentist to successfully view the films and therefore eliminating the need for retakes.

**Contamination**

Saliva contamination of the film happens when the packet is not adequately dried after removal from the patient’s mouth. The residual moisture can cause the black paper backing to adhere to the film and result in the hair-like artifact seen in the lower central portion of Figure 17.

Chemical contamination can happen if the substance is transferred from the operator’s fingertips, resulting in a fingerprint pattern on the film or if the film picks up a foreign substance during exposure or processing. Localized contamination such as that from fluoride mouthwash may lead to an artifact like that shown previously in Figure 13 (see page 9). Inadequate rinsing also causes a form of chemical contamination in that the developer and fixer solutions act upon one another instead of on the film and create a shotgun effect of dark precipitated granules or white salts across the film.

Automatic processor transport rollers become contaminated with use and must be cleaned by using a cleaning film regularly in order to avoid the type of artifact shown in Figure 18. These vertical streaks can be avoided by cleaning the rollers each morning before processing patient films.

**Remedy:** The operator must follow a well-established “Quality Control Program” according to manufacturer’s recommendations.

**Foreign Objects**

If the patient uses removable prostheses, those devices should be removed prior to exposing any radiograph of the area. The degree to which an appliance interferes with a radiograph’s diagnostic quality depends on its type, location, composition and how much it attenuates an X-ray beam. Figure 19 is a radiograph taken with the patient’s full denture in place. Even though the porcelain teeth and metal studs appear relatively radiopaque, the radiolucent acrylic baseplate allowed full visualization of underlying tissues and, thus, the exposure did not have to be retaken.

An appliance with a radiopaque metallic baseplate would completely obscure most structures of interest and render the film useless. Therefore, it is necessary to have the patient take out any removable appliance within the intended field of examination.

It should be noted that while an appliance that covers the area of interest should be removed, leaving an opposing denture in place often facilitates making the exposure and even improves diagnostic quality because the patient can more easily maintain film position.

An improperly positioned film-holding device that falls between the film and the beam, eyeglasses, earrings, necklaces and jewelry can all cause foreign object artifacts to appear in the radiograph. Always check for any facial or oral piercing that will also appear on the radiograph.

**Quiz**

1. List two ways that the operator’s fingertips can cause unwanted artifact to appear on the processed film.
2. What type of artifact is characterized by vertical streaks across the face of the processed film?
3. What two processing errors can result in the complete deterioration of a radiograph over a period of time?
4. What generally causes a radiograph to develop a wavy margin between clear and processed areas?

**Answers**

1. Fingertips can cause emulsion tears or chemical contamination.
2. Artifact from contaminated or dirty transport rollers in automated processing units.
3. Over-fixation and over-washing.
4. Incomplete submersion into the developer solution.

SUMMARY OF RADIOGRAPHIC FILM HANDLING AND PROCESSING ERRORS

Film Too Dense
• mA/exposure time/kVp setting too high.
• Source-to-object distance too short for chosen exposure parameters.
• Low object density (e.g., young children or elderly patients with thin bones or osteoporosis).
• Film speed faster than required for chosen exposure settings.
• Film left too long in developer solution.
• Developer solution too hot.

Film Too Light
• mA/exposure time/kVp setting too low.
• Source-to-object distance too long for chosen exposure parameters.
• High object density.
• Film speed slower than required for chosen exposure settings.
• Reverse film placement for exposure (e.g., embossed foil shield toward the X-ray beam).
• Film removed from developer solution too soon.
• Developer solution exhausted.
• Film left in fixer solution too long.

Fogging
• Contamination or deterioration of processing chemicals. Follow manufacturer’s directions regarding replacement or replenishment of chemicals.
• Film expired/age fog. Check expiration date before exposure.
• Film exposed to light, heat or scatter radiation during storage.
• Wrong or faded filter in safelight; safelight too close to film unwrapping area.
• Slight light leak in darkroom.

Dark Spots or Regions
• Air bubble on film surface during fixing.
• Film contaminated by fixer before developing.
• Light leakage into film packet.
• Inadequate fixation.

• Inadequate washing.
• Contaminated developer.
• Contaminated rollers in an automatic processor.
• Contact with chemicals (e.g., fluoride, silicone).
• Film bent or creased before processing.
• Static electric discharge.

Reticulation
• Temperature difference between fixer/developer/wash.
• Powder on gloves.

Image Distortion
• Magnification
  - Decreased source-(PID)-to-object (teeth) distance.
  - Increased object-(teeth)-to-film distance.
• Elongation
  - Vertical angulation too small.
  - Film curved horizontally.
  - Excess angulation between film and tooth without compensating by adjusting the vertical angle of the tubehead with the bisecting angle radiographic technique.
• Widening
  - Film bent vertically.
• Foreshortening
  - Vertical angulation too steep.
  - Insufficient angulation between film and tooth without compensating by adjusting the vertical angulation of the tubehead using the bisecting angle radiographic technique.
• Overlapping Interproximal Surfaces
  - Incorrect angulation of tube-head with respect to the mid-sagittal plane (incorrect horizontal angulation).
• Incorrect Spatial Relationship between Teeth and Investing Bone
  - Inherent error in the bisecting angle radiographic technique.
• Root Apices Not Recorded
  - Film placed too low in the maxilla or too high in the mandible.
  - Vertical angulation too low.
  - Film curved horizontally.
  - Cone cutting.

ERRORS IN PANORAMIC DENTAL RADIOGRAPHY

Head and Film Position
The diagnostic quality of a panoramic radiograph is largely determined by the same geometric consid-
erations that apply to conventional intraoral radiography — in essence, the relative position of the patient’s jaws, teeth, X-ray beam and film plane. Therefore, the adverse effects of malpositioning and misalignment are equally serious with panoramic dental radiographs. Manufacturer’s directions should be followed closely as each manufacturer’s machine differs slightly. However, in general, patients should be seated or standing erect with the cervical spine as straight and as centered as possible (Located in the focal trough). The patient’s mid-sagittal plane should be perpendicular to the floor and the Frankfort plane should be parallel to the floor. The patient’s teeth must be positioned within the focal trough.

**Patient Positioning Errors**

Some of the most common errors in panoramic radiography are listed below in descending frequency of occurrence.

- Chin low
- Tongue not raised to the roof of the mouth
- Patient slumped
- Head tilted
- Head rotated
- Lips open
- Teeth too far forward
- Bite guide not used
- Chin high
- Machine high
- Prosthesis left in
- Head too far back
- Chin not in rest
- Patient movement

**Vertical Height**

If the patient’s head is positioned too high, or if the film cassette and tubehead are too low, the superior part of the condyles of the ramus and much of the maxilla will be missing from the film, as in Figure 20.

In the reverse situation, if the patient’s head is too low or the cassette and tubehead are too high, the lower border of the mandible will be lost.

**Chin/Head Position**

If the patient’s chin is tilted downward, the arches will appear constricted. The condyles will appear closer together and may be cut off at the top of the film. The overall appearance will be that of a "Cheshire cat grin" due to the accentuated Curve of Spee (Figure 21).

If the patient’s chin is tilted upward, the image of the arches will be one of overall flattening or elongation. The condyles will be farther apart and may be cut off at the sides of the film. The general appearance is that of a wide "grimace," as in Figure 22, due to a flattened Curve of Spee.

If the patient’s head is positioned too far forward, the anterior teeth will not be within the focal trough and will appear blurred. Being in a labially displaced position, they will be visualized as narrower than the actual object they depict.

Conversely, if the patient’s head is too far back, the anterior teeth will not be within the focal trough.
and they will also appear blurred. However, being in lingual displacement, they will appear wider than the object they depict.

If the patient’s head is tilted, the image visualized will appear skewed diagonally across the film. If the head is rotated, the result will be one of image magnification in the area of the anatomy farthest from the film. The patient chin rest bite guides and calipers provided by the machine’s manufacturer enable the clinician to prevent these errors in centering the object.

Cervical Spine Slump

When the patient’s cervical spine (neck) is allowed to slump forward, instead of remaining perpendicular to the floor, it is then positioned too far anteriorly. The vertebrae are projected more visibly on the lateral borders of the film and obscure the anatomic structures of the ramus area.

Motion

Vertical, horizontal or compound patient movements and slippage or vibration of the tubehead or film holder can produce a range of artifacts on panoramic films. With conventional films, motion produces generalized unsharpness; with panoramic films, however, motion unsharpness only affects the portion of the film that was being exposed at the time motion occurred. Therefore, depending on the extent and duration of movement, only a small, discreet portion of the exposure may be blurred while the rest of the film is within acceptable limits.

Short-duration movement may be difficult to detect because the resulting artifact can look suspiciously like a pathological condition. The upper radiograph in Figure 23 is a normal panograph. The lower panograph is one that was affected by short-duration movement. Notice how the patient’s left mandible appears to be notched along the upper margin. The notch could easily be interpreted as calcification at an old fracture site when, in reality, it is a movement artifact. Remember, when viewing radiographs, the patient’s left is on the viewer’s right.

Focal Trough

Panoramic radiographs blur out some anatomic structures in order to detail others. The U-shaped area where the maxilla and mandible are the sharpest is the image layer or focal trough. Image sharpness within the trough is determined by the position of the object in respect to the X-ray source and the film plane as it rotates around the axis or center of rotation. While different X-ray machines have different trough sizes and shapes, there are several general statements that can be made about all panoramic exams:

1. As the size of the focal trough increases, image sharpness decreases.
2. Image magnification and blurred margins increase more rapidly medially than laterally to the focal trough.
3. Trough thickness is directly related to acceptable image blurring. The thicker the trough, the more the image will be blurred.

The focal trough concept is used to (A) prevent superimposition of extraneous structures which would impede clear view of the dental arches, and (B) allow the clinician to view a discrete, selected image field. Unfortunately, one of the disadvantages of this concept is the exclusion of structures that my reveal diagnostically important information. For example, supernumerary teeth or other dental pathosis lying outside the focal trough may not visualize clearly enough for diagnosis.

Conversely, this same panoramic quirk could suggest the presence of a condition that did not really exist. For example, if the apices of the mandibular incisors were missing, as they are in Figure 24, the clinician could suspect external resorption.

In this particular case, further examination with selected periapical films confirmed that the patient had normal, pathology-free dentition. The incisal
apices had not visualized on the panograph because the operator had positioned the patient slightly too far forward for the apices to fall within the focal trough.

**Magnification**

Some degree of magnification is unavoidable, even with perfect technique. Magnification is inherent and regionally disproportionate across the film.

The image’s horizontal dimensions are determined by the speed with which the film moves; therefore the dimensions visualized do not necessarily represent the actual size of the object they depict. Additionally, the degree of magnification depends on the object-to-film distance and, since every individual has somewhat different oral dimensions, they do not exactly conform to the machine’s engineered focal trough. As a result, image enlargement will vary from patient to patient.

As a rule, objects displaced toward the lingual (tongue) side of the focal trough, such as when the patient is positioned too far back, will appear magnified. Objects displaced toward the labial (lip) side, such as when the patient is positioned too far forward, will appear narrowed.

**Ghost and Secondary Images**

The degree to which a panoramic radiograph blurs out objects outside the focal trough is somewhat dependent on how radiodense those objects are. The diffuse radiopaque shadow near the identification label on the right border of Figure 25 is actually a ghost image of the clearly outlined metallic object at the illustration’s left.

The operator must assure that the patient has removed dental appliances, earrings, eyewear, facial and oral piercing jewelry and necklaces before making a panoramic exposure. Frequently the patient will be wearing a chain or necklace that cannot be seen beneath clothing. Similarly, placing the lead apron too high on the patient’s neck or bunching it at the shoulders will obstruct the beam enough to cast a ghost image of the shielding material (Figure 26).

In order to equalize tissue densities, the patient’s tongue must be held against the palate. If it is not, the air space between the tongue and the palate will
cast a detail-obscuring dark shadow or radiolucency at the apices of the maxillary teeth, with corresponding washed-out areas at right and left sides (Figure 27) related to the difference in density of the tongue in relation to the air space. Similarly, the patient’s lips should remain closed to equalize the densities.

**Cassette and Rotational Artifacts**

Panoramic radiographs involve a relatively complex series of coordinated, simultaneous movements. The film and X-ray source move in opposite directions around a central axis and in some machines the film cassette rotates on its own axis behind a narrow slit opening in the scatter guard. Because of this motion, mechanical errors can affect the quality of the exposures.

If the source and receptor fail to rotate, only one portion of the jaw will be imaged instead of the entire jaw being recorded across the film. If the film fails to rotate behind the slit opening, only one very narrow band of exposed area will appear on an otherwise clear film. If the film is improperly mounted in the film holder, a partial image will result, but the majority of the processed film will be clear.

In addition, the X-ray source must continue to generate a beam throughout the examination or clear zones will develop over the portion of the film that was passing behind the slit opening at the time the exposure was interrupted (Figure 28).

**Other Errors**

The exposure, handling and processing errors described for intraoral films also apply to panoramic radiographs. Particularly noteworthy is the sensitivity of panoramic or any screen film to static electricity artifacts. It is also extremely important to follow the manufacturer’s recommendations in all areas while exposing a Panoramic radiograph.

**SUMMARY OF PANORAMIC FILM HANDLING AND PROCESSING ERRORS**

**Patient’s Head Positioned Too Far Back**
- Posterior detail such as the condyle may be omitted.
- Dental structures may be excluded from the focal trough.
- Increased magnification in the anterior.

**Patient’s Head Positioned Too Low**
- Lower border of the mandible excluded.
- Orbits often seen in their entirety.

**Patient’s Head Positioned Too High**
- Part of the upper arch, mandibular condyle, and coronoid processes may be excluded from the film.
- Mandibular image relatively too high on the film.

**Patient’s Chin Tilted Upward**
- Flattening of the arches, backward displacement of the rami and exclusion of the condyle from the image at the sides of the film.
- Curve of Spee is reversed, appears as a wide grimace.
- Hard palate superimposed over apices of maxillary teeth.

**Patient’s Chin Tilted Downward**
- Occlusal plane too high in the posterior segment of the film.
- Inwardly tipped condyles are closer together.
- Apparent widening of mandibular symphysis.
- Possible superimposition of the hyoid bone on mandible.
- Curve of Spee constricted, appears as a "Cheshire cat grin."
- Possible exclusion of condyles at the top of the film.

**Image Distortion**
- Magnification
  - Decreased source-to-object distance.
  - Increased object-to-film distance.
  - Objects displaced lingually to the focal trough.
- Narrowed Image
  - Objects displaced labially to the focal trough.
- Incomplete Image
  - Narrow, radiolucent vertical area on an otherwise clear film usually due to failure of the apparatus to rotate axially.
  - Partial image on clear film usually due to improper positioning in the film holder.
- Clear areas in an otherwise normal panoramic film usually due to interruption of the exposure during axial rotation.
- Overlapping Occlusal Surfaces
  - Teeth were not separated by a bite-block or cotton roll during exposure.
- Maxillary Radiolucency
  - Tongue not held against palate, leading to uneven tissue density and air space visualization.
- Ghost Images
  - Jewelry or radiopaque dental appliance cross-visualized.
  - Lead apron too high on patient’s neck or bunched on shoulders.
  - Patient’s neck slumped forward causing imaging of cervical vertebrae.

**DIGITAL IMAGING**

Digital Imaging is common practice in the world of dentistry. This technology uses electronic sensors to record images and then send them to a computer for viewing and archiving. The images can be viewed within seconds with options to darken, lighten, and even emboss the images for diagnostic purposes.

**Indirect Digital Radiography**

The indirect digital radiography system uses a flexible sensor that is not attached to a wire. (Figure 29) The sensors come in a variety of sizes that will adapt to the patient’s mouth, allowing the operator more ease in achieving correct placement. An exciting aspect of Indirect Digital Radiography is that it allows the operator to use the existing radiography equipment by simply lowering the exposure time. Once the sensor is exposed, the operator places the sensor into a processing drum that uses a laser beam with electronic data to send the images onto a computer. (Figure 30) This system allows the office to do away with the messy darkroom or automatic processor. Once the images are recorded into the computer, the sensors are recharged and can be reused.

One disadvantage to this system is that the operator has a small window of time in which to place the sensors into the processing drum. If the operator takes too much time the sensor is exposed to excessive amounts of white light and the image will become lighter. White light is what clears the image from the sensors and recharges them for continued use.

**Direct Digital Radiography**

The direct digital radiography system uses a sensor that is placed into the patient’s mouth. (Figure 31) This sensor is directly connected to a wire that is directly connected to a computer. Although this may sound grand, this system has one drawback; the sensors being used are very large, rigid and thick, and do not allow for patient comfort. The lack of sensor flexibility causes the operator some difficulty in achieving the correct sensor placement. The sensors also are very fragile, which may cause a
problem if dropped or abused in any way. Unfortunately the cost to replace one sensor can be as much as $3,000.00.

**Optically Scanned Digital Radiography**

The Optically Scanned system uses regular dental films with the traditional radiography techniques. Developing takes place in specialized daylight loader machines by scanning the dried films. A digital image is then produced. This system takes additional time, requires more equipment (the optical scanning unit) and does not eliminate old equipment.

**Advantages of Digital Radiography**

There are several advantages to the Digital Radiography systems:

1. Reduction in radiation dose to the patient.
2. An image can be adjusted and a clearer picture can be produced in order to identify areas of concern.
3. In the paperless office even the radiographs are paperless.
4. There is no need for darkroom chemicals, providing an environmentally safe office.
5. Positive patient education and ease of presentation.

**QUALITY ASSURANCE PROGRAM**

Dental offices need to consider establishing a quality assurance program for dental radiographs. This program will provide the dental office with a way to monitor x-ray machines, darkroom equipment and radiographic techniques for all operators. As the operator reviews the errors included in this course it may be noted that several, if not all, of the errors could be avoided if a quality assurance program was implemented. The operator should establish a program to include the following areas:

a. Maintaining proper film exposing and processing techniques
b. Maintaining proper radiographic equipment through periodic testing
c. Properly posting current exposure, developing and technique charts
d. Maintaining and testing processing chemicals and safelighting
e. Maintaining proper cleanliness of both the darkroom and the automatic processor
f. Maintaining proper storage and handling of all films, cassettes, screens and chemicals
g. Maintaining proper infectious control protocols
h. Maintaining and recording proper compliance regarding environmental concerns

1. Properly recycling fix solution
2. Properly recycling lead

**SUMMARY**

Always remember a bad radiograph is worse than no radiograph at all because retakes increase radiation exposure to the patient. Only through proper education can an operator provide the dental team with diagnostic radiographs. Remember, diagnostic radiographs and proper techniques benefit your patients and overall dental care.

**REFERENCES**

"Radiology For Dental Auxiliaries," by Herbert H. Frommer.
"Delmar’s Dental Assisting, A Comprehensive Approach," by Donna J. Phinney and Judy H. Halstead.
"Successful Intraoral Radiography," by Eastman Kodak Company.
“Principles of Dental Imaging” by Langland, Langlais and Preece.
www.kodakdental.com
ABOUT THE AUTHORS

Course Revised, 2007 by
Wilhemina Leeuw, CDA, BS

Wilhemina Leeuw, CDA, BS is a Clinical Assistant Professor of Dental Education at Indiana University Purdue University, Fort Wayne. A DANB Certified Dental Assistant since 1985, she worked in private practice over twelve years before beginning her teaching career in the Dental Assisting Program at IPFW. She is very active in her local and Indiana state dental assisting organizations. Prof. Leeuw's educational background includes dental assisting - both clinical and office management, and she received her baccalaureate degree in Organizational Leadership and Supervision. She is also the Education Coordinator for the American Dental Assistants Association.

Course revised, 2003 by
Bonnie L. Marshall, 
CDA, EFDA, EFODA, FADAA

Bonnie L. Marshall is the coordinator of the Dental Assisting Program at Portland Community College, Portland Oregon. Ms. Marshall is also a Dental Radiography, Science and Expanded Duties instructor at Portland Community College. Ms. Marshall has provided quality education for the dental communities of Washington and Oregon for over seventeen years. In addition, she is very active in her professional organization, the American Dental Assistants Association, serving as local and state President, Secretary and Treasurer. Ms. Marshall is also serving as Tenth District Trustee. Ms. Marshall believes that continuing education for all dental professionals is key to a successful practice and effective and beneficial dental treatment.

Course revised, 1997 by
Sandra A. Kolsom, CDA, RDA

Sandra A. Kolsom, CDA, RDA, is a Dental Radiography Instructor at City College of San Francisco and Santa Rosa Junior College. Ms. Kolsom is also Director of the Auxiliary Productivity training and a clinical consultant for Ultimate Potential Dental Personnel Service. In addition, she remains active in the dental field on a part-time basis in an orthodontic practice. Ms. Kolsom also has more than seven years of experience as a dental assisting instructor. Her past dental assisting experience includes periodontics, general dentistry, oral surgery, endodontics and orthodontics. Other related activities include past President and Chairman of the Board for Temporary Fillings Inc., a placement agency for temporary support staff; Advisory Committee Member for Santa Rosa Junior College Dental Assisting Program. She also has reviewed new textbooks for Lippencott Publishing Company.

Allan G. Farman, BDS, EdS, MBA, PhD

- Diplomate, American Board of Oral and Maxillofacial Radiology.
- Professor of Oral and Maxillofacial Radiology, Department of Primary Patient Care, University of Louisville School of Dentistry, Louisville, Kentucky
**INSTRUCTIONS**

- Read through the article and answer the multiple choice questions provided at the back of the article.
- Please note that some questions may have more than one answer; in the case of the latter please “tick” every correct answer.
- When done only fax through your answer sheet to the fax number given on the answer sheet.

---

**QUESTIONNAIRE**

**BB2(13)**

**DENTAL RADIOGRAPHIC PITFALLS AND ERRORS**

<table>
<thead>
<tr>
<th>Question 1: Which one of the following lexicons are described as “a radiograph that has been exposed and not developed”?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Elongation</td>
</tr>
<tr>
<td>B Herringbone pattern</td>
</tr>
<tr>
<td>C Latent image</td>
</tr>
<tr>
<td>D Overdevelopment</td>
</tr>
<tr>
<td>E Over fixed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 2: What is a SNAP-A-RAY?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A A type of disposable film holder designed for patient comfort</td>
</tr>
<tr>
<td>B A film holding device designed to keep film, teeth and XCP parallel</td>
</tr>
<tr>
<td>C A 10 to 15 watt bulb covered with a filter</td>
</tr>
<tr>
<td>D A type of film holder</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 3: The radiographic term “UNDERFIXED” is described as which of the following?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A A radiograph that presents distortion, resulting in an image that appears long or stretched</td>
</tr>
<tr>
<td>B A radiograph with a greenish-brown appearance due to weak fix solutions and/or a film that was taken out of the fix solution too soon</td>
</tr>
<tr>
<td>C A radiograph that has superimposed images due to exposing a film twice prior to development</td>
</tr>
<tr>
<td>D A radiograph with a weak or light image due to being left in the fix solution too long</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 4: When does underexposure occur?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A When the operator selects a mA, kVp or exposure time that is too low</td>
</tr>
<tr>
<td>B When the source-to-object distance is too long for the selected exposure settings</td>
</tr>
<tr>
<td>C In both of the above instances</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 6: Is it TRUE that it is not a great concern if a previously exposed film from one patient was placed in the mouth of another patient?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A YES</td>
</tr>
<tr>
<td>B NO</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 7: When does a clear film occur?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A If the radiograph was left in the fixer too long</td>
</tr>
<tr>
<td>B If the PID is not aligned with the XCP during exposure</td>
</tr>
<tr>
<td>C If the X-ray unit is not switched on when the film is made</td>
</tr>
<tr>
<td>D If an unexposed film is processed</td>
</tr>
<tr>
<td>E If the film is placed into the fixer before it goes into the developer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 8: Which one of the following results when the beam passes through the lead foil backing before it strikes the film emulsion?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Double exposure</td>
</tr>
<tr>
<td>B Underexposure</td>
</tr>
<tr>
<td>C Clear film</td>
</tr>
<tr>
<td>D Black film</td>
</tr>
<tr>
<td>E Reverse film placement</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 9: Which of the following should be parallel at all times in order to ensure diagnosable radiographs every time?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A The film</td>
</tr>
<tr>
<td>B The teeth</td>
</tr>
<tr>
<td>C The PID</td>
</tr>
<tr>
<td>D All of the above</td>
</tr>
</tbody>
</table>
Question 5: Is it TRUE or FALSE that the main concern with overexposed radiographs is that the patient was subjected to too much radiation and if the film was grossly overexposed, the patient may receive even more during the retake?

A TRUE
B FALSE

Question 11: Is it TRUE or FALSE that foreshortening occurs when the central ray from the tubehead is too high, making the vertical beam angulation too shallow?

A TRUE
B FALSE

Question 12: In which one of the following cases was the horizontal angulation angulated too much from the mesial toward the distal?

A If the overlaps are larger in the posterior half of the film
B If the overlaps are larger in the anterior half of the film

Question 13: With regard to film positioning errors, in which case are the crowns adequately seen but periapical tissues are missing at the periapical edge of the film?

A When the maxillary vertical film position is too high
B When the maxillary vertical film position is too low
C When the mandibular vertical film position is too high
D When the mandibular vertical film position is too high

Question 14: Which of the following can be done to correct vertical-horizontal film placement errors?

A The operator must place the XCP bite block directly on the teeth being radiographed
B The patient must bite hard enough to hold the XCP bite block in place
C If the bite block and film are too uncomfortable for the patient, the operator must reposition the film by tilting the film or using a different film holder, without disturbing the correct placement
D All of the above

Question 15: In which of the following cases must films with cone cuts be repeated?

A All films with cone cuts must be repeated
B Films with cone cuts should be repeated only if the information that has been obscured is not obtainable from films of adjacent areas
C One cone cut usually requires retake of film

Question 10: In which of the following cases will the roots generally be elongated but the crown will appear normal?

A If film bending was at fault
B If vertical beam angulation is too shallow

Question 17: Radiolucent bend artifact is associated with which of the following?

A A positive bend
B A negative bend

Question 18: Why should the operator not have long finger nails?

A To prevent possible infection while taking radiographs
B To avoid possible artifacts while taking radiographs
C Both of the above

Question 19: Is it TRUE that fogging is a generalized softening and obscuring of the image that results in decreased density and an increase in film contrast?

A YES
B NO

Question 20: To prevent fogging what is the operator obliged to do regularly?

A Perform the “Coin test” monthly in order to detect darkroom leaks
B Check expiration dates
C Store all film in a cool, dark place free from any scatter radiation and chemical fumes
D Avoid contamination of processing solution
E All of the above

Question 21: Is it TRUE or FALSE that cross-mixing of the developer and fixer solutions can occur while checking the temperature and thus cause contamination?

A TRUE
B FALSE
**Question 16:** Movement of which of the following can cause motion distortion and leads to blurred edges of the image detail?

A. The patient  
B. The tubehead  
C. The film  
D. All of the above

**Question 23:** Which one of the following can be salvaged by using long-exposure duplication or reducing agents?

A. Underdeveloped film  
B. Overdeveloped film

**Question 24:** When would the film result in a light, limited detail image?

A. When the developer is weak  
B. When the developer temperature is too high  
C. When the film is underfixed  
D. When the developer expires  
E. When the developer is exhausted

**Question 25:** Which of the following is TRUE with regard to excessive fixation or washing?

A. Excessive fixation or washing results in a dark image  
B. Excessive fixation or washing clears too much and results in a light image  
C. The manufacturer’s recommended fixing and washing times must be greatly exceeded to produce a completely clear film  
D. Even if the operator leaves a film in the fix or water overnight the latent image will not begin to wash out

**Question 26:** Can powder on gloves cause reticulation?

A. YES  
B. NO

**Question 27:** With regard to film contact, in which case will the area not clear and will it brown and discolour?

A. When film contact occurred during development  
B. When film contact occurred during fixation

**Question 22:** In which cases would a retake be necessary if a film was not completely submerged in developer solution?

A. Always, even when the diagnostic information can still be obtained from other films  
B. When the clear margin is high enough on the film  
C. When the diagnostic information cannot be obtained from other films  
D. If the clear margin is not sufficiently high on the film

**Question 29:** When would dark spots or regions occur in film?

A. When the developer solution is too hot  
B. When the film speed is slower than required for exposure settings  
C. When there is an air bubble on the film surface during fixing  
D. When there is inadequate fixation or washing  
E. When the film is bent vertically

**Question 30:** Which one of the following is the most frequently occurring error in panoramic radiography?

A. Chin low  
B. Chin not in chest  
C. Patient movement  
D. Head tilted  
E. Lips open

**Question 31:** Which one of the following statements is correct?

A. If the patient’s head is positioned too low, or if the film cassette and tubehead are too high, the superior part of the condyles of the ramus and much of the maxilla will be missing from the film  
B. If the patient’s head is positioned too low, or if the film cassette and tubehead are too high, the lower border of the mandible will be lost  
C. If the patient’s head is positioned too high, or if the film cassette and tubehead is too low, the superior part of the condyles of the ramus and much of the maxilla will be missing from the film  
D. If the patient’s head is positioned too high, or if the film cassette and tubehead are too low, the lower border of the mandible will be lost
Question 28: Which of the following determines the degree to which an appliance interferes with a radiograph’s diagnostic quality?

A The type  
B The location  
C The composition  
D How much it attenuates an X-ray beam  
E All of the above

Question 33: Which of the following statements are TRUE with regards to panoramic radiographs?

A With panoramic films motion produces generalized unsharpness  
B Panoramic radiographs do not blur out some anatomic structures in order to detail others  
C Image magnification and blurred margin decrease less rapidly medially than laterally to the focal trough  
D As the size of the focal trough increases, image sharpness decreases  
E With panoramic films, motion unsharpness only affects the portion of the film that was being exposed at the time motion occurred

Question 34: As a rule, objects displaced toward which side of the focal trough will appear narrowed?

A Tongue side (lingual)  
B Lip side (labial)

Question 35: The operator must make sure to remove which of the following before making a panoramic exposure in order to avoid ghost images?

A Dental appliances  
B Earring and necklaces  
C Eyewear  
D Facial and oral piercing jewelry  
E All of the above

Question 36: Is it TRUE or FALSE that panoramic or any screen film is sensitive to static electricity artifacts?

A TRUE  
B FALSE

Question 32: With regards to the patient’s head positioning being in which placement, the anterior teeth will appear wider than the object they depict?

A Lingual displacement  
B Labial displacement

Question 37: When a patient’s chin is tilted downward and the curve of Spee is constricted, how does it appear?

A As a wide grimace  
B As a “Cheshire cat grin”

Question 38: Which of the following is FALSE with regards to indirect digital radiography?

A The indirect digital radiography system uses a flexible sensor that is not attached to a wire  
B This system allows the office to do away with the messy darkroom or automatic processor  
C It does not allow the operator to use the existing radiography equipment  
D The indirect digital radiography system uses a sensor that is placed into the patient’s mouth  
E With this system the operator only has a small window in which to place the sensor into the processing drum

Question 39: Which of the following are drawbacks of the direct digital radiography system?

A The sensors are very large  
B The sensors are rigid  
C The sensors are very thick  
D The sensors do not allow for patient comfort  
E All of the above

Question 40: Does digital radiography reduce the radiation dose to the patient?

A YES  
B NO
**ANSWER FORM**

<table>
<thead>
<tr>
<th>Professional Board</th>
<th>Postal address</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPCSA No</td>
<td></td>
</tr>
<tr>
<td>Surname</td>
<td></td>
</tr>
<tr>
<td>Initials</td>
<td></td>
</tr>
<tr>
<td>ID Number</td>
<td></td>
</tr>
<tr>
<td>FOH Number</td>
<td></td>
</tr>
<tr>
<td>Time spent on activity</td>
<td>Hour Min</td>
</tr>
<tr>
<td>How would you like to receive your IAR?</td>
<td>SMS</td>
</tr>
</tbody>
</table>

**BB2(13) – Activity 2 - 2013**

**Dental Radiographic Pitfalls and Errors**

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>29</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**I hereby declare that the completion of this document is my own effort without any assistance.**

Signed: ___________ Date: ___________

This article is accredited for **FOUR (4 CEU’s)**

**FAX TO 0866144200 AFTER COMPLETION**

Please rate the article:

<table>
<thead>
<tr>
<th>POOR</th>
<th>FAIR</th>
<th>AVERAGE</th>
<th>GOOD</th>
<th>EXCELLENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PASSED</th>
<th>FAILED</th>
<th>REASSESSMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>/30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAPTURED</th>
<th>MODERATED BY</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>