Successful Panoramic Radiography

A Peer-Reviewed Publication
Edited by Dr. Robert A. Danforth

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Educational Objectives
Upon completion of this course, the clinician will be able to do the following:
1. Understand what constitutes a normal panoramic radiograph and the anatomical structures that can be identified on panoramic radiographs
2. Know the steps required to take a good panoramic radiograph and how to avoid errors
3. Understand the methods by which digital panoramic radiographs are captured, stored, retrieved and printed
4. Understand how to detect possible carotid artery calcifications on panoramic radiographs

Abstract
The panoramic radiograph continues to offer today’s dentist a unique patient view—covering the entire dentition and surrounding structures, the facial bones and condyles, and parts of the maxillary sinus and nasal complexes. The equipment used to obtain panoramic radiographs has continued to improve with recent advances, including automatic exposure and multiple image programs. However, achieving diagnostic panoramic images requires attention to the basic steps and correct patient positioning. This course will address the basic steps, problems, and errors that may occur when mistakes are made at any of these, allowing the practitioner to determine from the radiograph the point at which the error occurred in the image creation process. Once the error has been assessed, possible solutions to the problem are suggested. The result will be panoramic radiographs with the maximum diagnostic detail and information that the equipment and technique allow.

The Normal Panoramic Radiograph
Before discussing various errors that can occur, it is important to know what a normal panoramic radiograph should look like. In a good panoramic radiograph the mandible is “U” shaped, the condyles are positioned about equal distance from the inside edges of the image and ⅓ of the way down from the top edge of the image. The occlusal plane exhibits a slight curve or “smile line,” upwards. The roots of the maxillary and mandibular anterior teeth are readily visible with minimal distortion. Magnification is equal on both sides of the midline (Figures 1, 3).

Panoramic Theory
Why is panoramic radiography inherently technique sensitive? Panoramic radiography is a modified type of tomography or image layer radiography. The patient’s dental arch must be positioned within a narrow zone of sharp focus known as the “focal trough”/imaging plane (Figure 2), designed by panoramic machine manufacturers as the ideal patient position to produce the optimum image. Distortion of the image quality occurs when patients are not properly positioned—such as if the chin is tipped up or down too much, midline rotated off machine center, anterior teeth/jaws too far forward or back. These result in vertical and horizontal magnification and distortion, superimposition of anatomical structures, and some structures being projected out of the field of view. In such cases, the interpretation of the resultant image is severely compromised.

These mistakes can only be remedied by a retake of the image with the patient in the proper position. This requires an additional patient exposure, further emphasizing the reason for following the patient alignment instructions provided by the system’s manufacturer.

Aside from radiation concern, the size of the focal trough/image plane is critical for a successful image. Machines are designed so that the focal trough/image plane is adjustable for patient size and programmed exposure parameters to coincide with the adjustments.

Older panoramic machine adjustments were more manual. Current machines are more automated. Preset icons representing a range of large to small, or adult or child can be selected, automatically adjusting for arch width and focal trough/image plane size and the accompanying exposure factors. Many digital machines also have automatic exposure control that vary the amount and energy of the X-rays during the actual exposure. Such automation facilitates imaging various size patients while reducing the potential of operator mistakes and assuring optimal patient dose.
Patient Positioning

Most panoramic machines offer positioning guides such as lights or plastic guides to position the patient along three major axes: anterior-posterior (too far forward or back), vertically (alartragus, Frankfort plane, or cantho-meatal lines), and mid-sagittal alignment (patient twisted or rotated).

Teeth and structures lying outside this zone of sharp focus will exhibit blurring, distortion or other artifacts. Therefore, all panoramic machines will have some mechanism for properly positioning the patient’s dentition within the focal trough. The trough on older systems can be as narrow as 3mm in width in the anterior region or as wide as 17mm on newer panoramic systems, therefore following the manufacturer’s guidelines for proper patient positioning is critical in obtaining a quality radiograph (Figure 4). As a general rule, the wider the anterior focal trough the easier it is to position the patient.

Proper patient positioning in the focal layer/plane of the panoramic machine is critical for producing successful images. Manufacturers have built into their machines a variety of alignment devices to help ensure the patient positioning process is easy and well visualized by the dental operator.

Figures 5 and 6 show the typical alignment aids provided. The chin rest and the incisal guided bite-block assist positioning the anterior teeth into the smallest region of the focal layer/ plane. Lateral/temporal or frontal skull head support bars fur-
ther assist posterior patient positioning and help to reduce head tilting and horizontal misalignment. Light beam reference lines provide the final visualization for proper patient alignment.

**Light Alignment**

Light alignment has three components: mid-sagittal head and skull plane, Frankfort plane, and canine/corner base of nose reference line.

The mid-sagittal line is an imaginary plane centered over the midline of the head which divides the anatomy into equal right and left sections when directed between the eyes along the midline of the nose and lips or between the maxillary central incisors, assuming the centrals are present and in an acceptable clinical position. This helps to ensure that the patient’s midline will be centered in the machine and prevents such errors as midline horizontal shift or sideways tilting of the head.

The Frankfort plane line is used to position the patient’s head tilt in the vertical plane. The Frankfort plane is an external head reference plane which projects an imaginary line between the superior border of the external auditory meatus or upper portion of the tragus of the ear to the lower infraorbital rim of the eye. This line is defined by a line between two anatomical external structures, the upper portion of the ear canal as identified by the tragus and the lower border of the eye orbit, termed the infraorbital rim.

Final forward/backward positioning of the patient’s head is determined using the canine/corner base of nose alignment line. This is an imaginary, vertical line that primarily bisects the maxillary canine through the cusp and extends down through a portion of the mandibular canine. The head is moved forward or backward and adjusted until primarily the maxillary canine is bisected with the alignment line. This further ensures that the anterior teeth are in the narrow anterior portion of the focal layer/plane where proper positioning is critical to prevent image distortion of the incisors. In newer systems there is no head movement, but rather the system adjusts the rotation to accommodate the patient’s bite. For patients that are edentulous in the regions of the canines, the base/alar corner of the nose can be used to achieve anterior jaw alignment.

**Image Quality**

Magnification and X-ray tube focal spot size are two important factors in determining extraoral image quality. Resolution, the ability of an imaging system to produce distinct images of closely spaced objects, is an objective measure of image quality, and is expressed in units of Line Pair per millimeter (LP/mm). As the theoretical resolution increases, so does the system’s ability to reveal fine detail in the image (Figure 7).

The following chart (Figure 8), plots resolution versus magnification for four X-ray tube focal spot sizes. The area of interest is between 120 percent and 160 percent in magnification, typical of most panoramic and tomographic machines. The curves show conclusively that a smaller focal spot and minimal magnification will decrease blurring or image fuzziness.

**Radiation Dosage**

Generally, intraoral digital radiography is touted as requiring 70 percent to 90 percent less radiation than that for traditional film radiography. Making such claims is not necessarily valid. The key to understanding these reductions is knowing what is being compared. The 70 percent to 90 percent reductions compare to Ultra speed “D” film, the slowest film used in dentistry today. If comparison is made to faster “F” film, such reductions are negated and the exposure is in a similar range for digital radiography.

Patient size influences the amount of radiation necessary to produce a diagnostically useful radiographic image. Larger patients require more radiation than smaller, meaning an increase or decrease in both the X-ray energy (kVp) and the amount of X-ray as determined by either the miliampere (mA) and/or exposure time.

Recent studies comparing the effective patient dose for digital to conventional panoramic radiography have reported varied results. Reported effective doses for digital are 4.7µSv to 14.5, 5, 8, 9 µSv, 8, 9 and 45µSv6. For conventional film panoramic radiography, effective values are 16–21 µSv2 and 54µSv7.

Results from Visser and Gijbels are similar and indicate a digital advantage ranging from a 13 percent to 77 percent reduction.8, 9 The actual dose values reported by Kiefer are greater than for the other studies but the digital advantage is within range at 17 percent reduction. Variations in study design and machines used for evaluation tend to produce wide ranging data, but overall, the results support the notion that digital imaging does reduce patient exposure for panoramic radiography.

**The Basic Steps**

There are several basic steps in taking a panoramic radiograph. These steps will apply to almost any panoramic machine, while some machines have features such as automatic exposure, which reduce the likelihood of exposure error, but do not prevent them entirely. It is important to know the steps and how they affect the outcome of the radiographic process. When problems occur at any of the steps they will cause unique errors on the resulting radiographs that when recognized, are easy to correct.

1. Set exposure factors, if required.
2. Have patient remove jewelry; place tongue on roof of mouth, and hold still.
3. Have patient bite on bite rod.
4. Adjust the:
   a. chin tilt with the Frankfort light.
   b. head rotation with the mid-sagittal light.
   c. forward/backward head position with the canine light.
5. Position the side guides or head support.
6. Have the patient stand up straight.
7. Have patient swallow, place tongue on roof of mouth, and hold still.
8. Take X-ray
**Figure 7. Magnification and X-ray tube focal spot size**

- Small Focal Spot (1.0mm)
- Large Focal Spot (2.5mm)
- 0.5mm Focal Spot
- Film/Screen Maximum
- Ektavision Maximum

**Figure 8. Theoretical Maximum Resolution**

To calculate the resolution for a given device, select the magnification, read vertically up the chart, until it intersects the focal spot line of the device. Read horizontally across the chart until it intersects the resolution axes. The intersection of these two lines will demonstrate the theoretical maximum resolution.
Step 1: Setting Exposure Factors

Many newer panoramic machines set exposure factors automatically by measuring the amount of radiation passing through the patient’s head, or by measuring head width and adjusting exposure values accordingly. With some panoramic machines, though, exposure must be set based on the patient’s size or age. Usually, icons of small, medium, or large patients are used. Since the patient’s bone density is not always related to their physical size, a better guide is to look at the patient’s wrists or ankles. Thick wrists can imply heavier bone density; other factors to consider are age, whether the patient is edentulous, and obesity. Common exposure errors are illustrated in (Figure 9).

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<thead>
<tr>
<th>Problem</th>
<th>Cause</th>
<th>How to Correct</th>
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<tbody>
<tr>
<td>Light, pale image with few dark areas</td>
<td>Too little exposure</td>
<td>Increase mA or kVp or use next higher setting on machine</td>
<td>Do not confuse with fogging (film), which is an overall grayness</td>
</tr>
<tr>
<td>Dark image with loss of details, amalgams and unexposed areas are still clear</td>
<td>Too much exposure</td>
<td>Decrease machine settings</td>
<td></td>
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</table>

Step 2: Have Patient Remove Jewelry, Place Lead Apron on Patient

Prior to exposure, the patient must remove all jewelry from the head area. The panoramic exposure encompasses the whole head. Earrings, necklaces, or other jewelry, such as tongues bars or nose rings will be visible on the radiograph.

<table>
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<tbody>
<tr>
<td>White opacities on image; little or no image is visible</td>
<td>Ghosts of metal jewelry</td>
<td>Remove prior to exposure</td>
<td>Watch out for necklaces</td>
</tr>
<tr>
<td>White opacity in palate</td>
<td>Tongue bar</td>
<td>Remove prior to exposure</td>
<td>Image is projected high onto palate instead of floor of mouth</td>
</tr>
<tr>
<td>White opacity at bottom of image shaped like inverted “V” or “shark fin”</td>
<td>Lead apron above collar line and in X-ray beam</td>
<td>Adjust and properly place apron</td>
<td>Watch for bunching at back of neck</td>
</tr>
</tbody>
</table>
**Ghost Image**

“Ghost image” is a term used in panoramic radiography to describe an image artifact produced when the shadow outline of a dense object on the side of the head toward the X-ray machine is projected across the image field and recorded on the film/image receptor on the opposite side of the head. This object’s outline becomes a radiopaque shadow artifact superimposed upon the structures of interest in the image field. This decreases image quality and can interfere with interpretation. “Ghost” images are easily identified as they are on the opposite side of the real image, higher on the film, and are streaked horizontally. They can be mistaken for pathology when they fall in the area of the sinus. Special panoramic aprons should be used that cover the back of the patient and the shoulder area. The apron must not extend above the collar or it will be imaged as an opaque “shark fin” artifact. This is due to the angle of the panoramic X-ray beam, which comes from below at approximately a seven-degree angle (Figures 10, 11, 12).

While normal anatomical structures such as the mandibular ramus, hard palate, and spinal column can produce ghost image artifacts, the most recognized cause is patient earrings not removed during the examination. Although not much can be done to reduce the anatomical contribution to ghosting artifacts, removing patient jewelry will eliminate its contribution. The most common and annoying ghost artifact is that associated with the ramus/angle of the mandible which is persistently present over the second and third molar regions of the both the maxilla and mandible. Generally, this degrades interpretation of these areas, and when severe, makes interpretation impossible.

Figure 13 illustrates the projection factors associated with ghost image artifacts.

The colored rings in the skull views depict patient earring positions in relation to the X-ray machine and the film/image receptor. The divergent pathway of the primary X-ray beam to the image receptor is shown from both the right and left positions to better convey that ghost artifacts generally affect both sides of the image. When the X-ray machine is positioned to the right side of the patient, it is actually the left side that is being imaged onto the film/image receptor. The path that the X-ray beam must travel to strike the film/image receptor is first through the right side entry anatomy, next across the entire skull to enter the left side anatomy, and finally exit the patient to strike the film/image receptor, recording the left anatomy. The ghost image is always magnified and more superiorly positioned than the real object due to the projection distance across the skull and the angle of the X-ray beam inclined slightly upward.

Figure 14 is a panoramic image depicting double ghost earrings and the ghost affect of the ramus/angle of the mandible superimposed upon the images of the maxillary and mandibular second and third molars. In this case, portions of the molars are not sufficiently seen for interpretation and a remake without earrings is indicated if other molar images are not available.

**Digital Image Clarity and Definition**

A major advantage of digital radiography is it offers the possibility to extract more information from the same image than ever achievable with film. Image enhancements allow optimization for whatever region of interest is being diagnosed. Images can be lightened or darkened in order to provide the optimum exposure. Higher resolution sensors can be magnified quite large in order to detect the tiniest abnormalities. Other image enhancements, such as local equalization, embossing, or colorization, improve the observer’s perception in order to aid in diagnosis.

Radiographic detail or definition measures the provided sharpness or clarity of an image in order to observe or visibly differentiate between small objects that are in close proximity to one another. Digital panoramic system software allows you to zoom in on the image. Magnification can go to a 2:1 ratio and still be useful. Care must be taken not to over magnify the image as pixelization occurs and details become obscured.10, 11

Enhancement tools such as brightness/contrast, invert and color have application upon the gray scale or color assignment of pixel data. Selectively changing these influences visualization of certain data ranges over others. Contrast and brightness may help to visualize caries detection in enamel and yet obscure the fine trabecular pattern of the alveolar bone. Invert enhancement seems to favor visualization of periodontal structures yet not caries detection. Color has not been shown to have any specific clinical relevance not capable of being seen by the other tools.12, 13
**Step 3: Bite on Rod**

Most panoramic machines use a bite rod made of plastic with small grooves to position the patient’s anterior teeth in the focal trough. Most machines also offer an edentulous guide that is placed against the patient’s chin or under the nose. These guides are also useful in partially edentulous cases as well, and failure to use them can cause anterior-posterior errors. Other causes of patients being too far forward or back in the focal trough are anterior malocclusions such as bimaxillary protrusion. Most machines offer a correction for these cases. Many machines offer an aiming device centered on the mandibular cuspid, as it is considered to be more indicative of the patient’s skeletal position (Figures 15,16).

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<tr>
<td>Anterior teeth blurry, too small and narrow, spine visible on sides of image</td>
<td>Patient biting too far forward on bite rod</td>
<td>Make sure anterior teeth are located in grooves on rod</td>
<td>Make sure mandibular incisors are in groove also, and bite rod is not being bent forward</td>
</tr>
<tr>
<td>Anterior teeth blurry and wide, ghosting of mandible and spine, condyles close to edge of image</td>
<td>Patient is biting too far back on rod or not at all</td>
<td>Make sure anterior teeth are located in grooves on rod</td>
<td>If anterior teeth are missing use edentulous guide</td>
</tr>
</tbody>
</table>

![Figure 15. Patient too far forward; note spine superimposed over rami, blurring, and narrowing of anterior teeth](image)

![Figure 16. Patient too far back; note ghosting of mandible and spine, condyles pushed to outside of film, blurring and widening of anterior teeth](image)

**Step 4: Adjust Chin Tilt**

In the panoramic radiograph the patient should be looking slightly down at a spot on the floor approximately 8 feet in front of them. This elevates the posterior palate so it does not overlap the apices of the maxillary teeth in the final image. This is often referred to as “chin tilt.” Having the patient’s chin tipped too far down is the most common panoramic error (Figures 17,18).

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<tr>
<td>Roots of lower incisors blurry, mandible shaped like a “V”, too much smile line, condyles at top of image, spine forms arch or “gazebo” effect</td>
<td>Patient’s chin is tipped too far down</td>
<td>Reposition using proper guidelines for that machine, such as alar-tragus line</td>
<td>Make sure patient does not have unusual occlusal plane orientation</td>
</tr>
<tr>
<td>Maxillary incisors blurry, hard palate superimposed on roots, flat occlusal plane, mandible is broad and flat, condyles at edge of image</td>
<td>Patient’s chin is tipped too far up</td>
<td>Reposition using proper guidelines for that machine such as alar-tragus line</td>
<td>Make sure bite rod remains seated in its guide</td>
</tr>
</tbody>
</table>

![Figure 17. Chin tipped down; note V-shaped mandible, extreme smile line, arching of spine at top of image, condyles placed high on film, and streaking of the hyoid bone over the mandible](image)

![Figure 18. Chin up too high; note flattened occlusal plane, palate superimposed on maxillary tooth roots, and broad flat mandible](image)
Step 5: Position and Close Side Guides

All panoramic machines will have guides or positioning lights to align the patient’s midsagittal plane. It is important that the patient be looking straight ahead with no tip or tilt to the head. Side guides or head and temple supports may be used and may come from either the top or the bottom of the machine. When the patient’s head is twisted, it is similar to being too far forward on one side and too far back on the other (Figure 19).

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<tr>
<td>Teeth are wide on one side, narrow on other; ramus is wider on one side than the other; uneven pattern of blurring throughout arch; nasal structures not clear</td>
<td>Patient’s head is twisted in machine causing midline asymmetry</td>
<td>Reposition using proper guidelines for that machine</td>
<td>Make sure patient doesn’t try and look towards technician, but straight ahead. Always use front-surface mirror on machine to check alignment</td>
</tr>
<tr>
<td>Condyles are not equal in height, nasal structures distorted</td>
<td>Patient’s head is rotated in machine (tipped)</td>
<td>Reposition using proper guidelines for that machine</td>
<td>Make sure patient’s head remains level through ears</td>
</tr>
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</table>

Step 6: Have Patient Stand Up Straight

The patient must be standing up straight to prevent arching of the neck (slumping). The best method of achieving this is not to allow the patient to reach forward to the bite stick or chin rest. Have the patient take a step forward after they are biting on the rod. They should feel somewhat as if they will fall backward if they let go of the hand-holds. This will avoid problems with the system hitting the shoulders and spinal ghosting (Figure 20).

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<tbody>
<tr>
<td>White tapered opacity in middle of image</td>
<td>Ghost of spinal column due to slumping</td>
<td>Have patient take a step forward and straighten neck</td>
<td>Do not allow patient to reach forward into machine; make them step forward</td>
</tr>
</tbody>
</table>

Figure 19. Head twisted; note uneven width of rami, unequal magnification of teeth, and condyles

Figure 20. Slumped; note the white spine shadow in midline
**Step 7: Have Patient Swallow, Place Tongue in Roof of Mouth, and Hold Still**

Just before the exposure is made, the patient is instructed to swallow, place the tongue on the roof of the mouth, and hold still during the exposure. Failure to do these things can result in patient movement artifacts or airway obscuring vital portions of the image. In particular, not placing the tongue in the roof of the mouth results in a large airway shadow directly over the roots of the maxillary teeth (Figures 21, 22).

![Figure 21. Tongue down during exposure; note shadow of air space over roots of maxillary molars, airway space over rami](image1)

![Figure 22. Patient movement; note step defect in inferior border of mandible](image2)

**Step 8: Exposure**

Problems during exposure are primarily due to machine or operator errors including letting go of exposure button temporarily (not possible with most recent machines), changing exposure settings during the exposure.

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<tbody>
<tr>
<td>White vertical line on image running from top to bottom edge of image</td>
<td>Exposure stopped briefly, probably due to letting go of exposure button</td>
<td>Hold exposure button down firmly during exposure</td>
<td>Modern machines will return to start position if this happens</td>
</tr>
</tbody>
</table>

This completes the basic steps for panoramic radiography.

**Storing Digital Images**

Once the digital image is captured in the computer, it is ready for electronic storage, printing, or digital transfer. Generally, digital images are initially stored in the patient file on the computer’s hard drive, or preferably on a separate server or other file method so as not to overload the computer storage capacity. File size, method of transfer, image quality, and legal aspects of the image should be considered.

Captured images can be stored in imaging management program, or by transfer to any other compatible third-party treatment planning program. Network systems have server file systems for storage from which practice management systems image viewing programs can access the image files for viewing along with other patient data.

**Printing And Viewing**

**Digital Images**

When printing or electronically transferring an image from storage, various file format options are available; common formats include the following: tif, jpeg, bmp, and pdf. When printing hard copies, any of these file formats and various others can be used. Size of the file and print quality must be decided by the individual user and may be influenced by the reason for printing the image. Generally, there is an increase in file size and printing time with increased desired print quality. Efficient prints intended for emails and clinical reference images are generally done in the jpeg format with standard printing parameters.

Most jpeg images are associated with a “Lossy” compression format that reduces file size to a better manageable volume,
making printing and electronic transfer more efficient. The drawback to this compression is that data is discarded or lost to make the file smaller. This may result in an image that may no longer be considered a legal representation of the patient, as would a traditional film radiograph. For practical use, this has little relevance to clinical practice but would most likely not withstand legal scrutiny. Similar considerations exist for images transferred to CDs, although the “read only” feature does limit alteration of images burned to that specific CD.

Another file format designed for image transfer and maintenance of image integrity is DICOM—Digital Imaging and Communications in Medicine—and is the standard format for distributing and viewing medical images regardless of the image capture source or the end users software viewing programs. This format is becoming more widely used in dentistry as electronic transfer of dental image data becomes more common. Teleradiology implies that all image data will be transferred or used electronically with little dependence upon any form of hard copies or data disk transfers. This concept is already a reality, and the DICOM format will help to assure image integrity.

What Do I Do if a Digital Image Is Captured and Stored in the Wrong Patient File?

One of the advantages of digital radiography is assignment of the digital image into the appropriate patient’s electronic record. The process begins with establishing an electronic record for a new patient or recalling a previous record for patients already entered into the system.

For the new patient, once all identification of data has been entered, the selection for the type of radiographic examination can be made. The processing computer acknowledges this selection and prepares to accept the incoming data from the image receptor. Upon reception of the image, the computer displays the image on the monitor for visual evaluation. The image has been “tagged” with the appropriate electronic file codes to specifically match the patient of record, date, and type of radiographic image.

To make radiographic images for a recorded patient, the patient’s file is identified and brought onto the monitor screen. At this point proper identification of the patient is critical to avoid potential image storage mistakes.

Although the first instinct if an image has been capture and stored in the wrong patient file may be to find the correct file and remake the image, this should be discouraged as the patient will have to inappropriately endure another radiation exposure. Copied images can be exported or imported from the incorrect file to the correct one, but they will be renamed and labeled with another transfer format (i.e., jpeg, bmp, or tif), as the new file cannot accept an original captured image from another file. Image export and import choices are found under the list of image management options. The copied image format label will signify that the image is not an original captured image for that file; this is not clinically important if proper identification and reason for copied image transfer have been properly documented in the correct record.

Generally, images that have been incorrectly made in the wrong patient file can be deleted, preferably after copy transfer to the correct record. If not, then appropriate documentation of the incorrect image is mandatory to avoid confusion.

Carotid Artery Calcifications On Panoramic Radiographs

The annual number of strokes in the United States is about 730,000 with approximately 23 percent being fatal. Approximately one-half of strokes are believed to be associated with emboli that originate from atherosclerotic plaque calcifications located in the bifurcation region of the external and internal carotid arteries. Screening methods that provide detection of such calcifications can potentially save lives.
Several studies have shown how panoramic radiography can play a role in detection. The bifurcation of the internal and external carotid arteries lies in a panoramic imaging plane approximately 1.5 cm to 2.5 cm posterior and inferior to the mandibular angle in the dark space primarily anterior to cervical spine C4 and slightly inferior to the posterior horn of the hyoid bone (Figures 23A–C). Although the actual carotid arteries cannot be seen, the presence of vertical-linear nodular opacities in the prevertebral space extending anterior along C3, C4, and sometimes C5 is suggestive for atherosclerotic plaques in the vessel walls (Figures 23B–D).14,15

Making such a panoramic interpretation must be tempered with caution. Adequately visualizing the anterior portions of C3 and C4 is critical for interpretation. In some film images, the area is dark and detection is difficult without increasing the viewing light intensity. With digital panoramic radiography, such areas can be enhanced with brightness/contrast or sharpening adjustments (Figure 23D). Also, several other opacities can be seen in and around this area than could mimic carotid calcifications. A differential interpretation of these would include the posterior portion of the hyoid, upper portion of the thyroid cartilage, epiglottis, triticeous cartilage, and possible calcified lymph nodes or other vessels.

If interpretative confidence of carotid calcifications is sufficient after differentiating the other possibilities, the patient should be informed to have further evaluation done by their physician. Such an evaluation will, most likely, included ultrasound testing for a more definitive diagnosis.16

Although panoramic imaging is not a precise screening method for detection of carotid artery calcifications, it is a supplemental aid that dentists should be aware of when interpreting panoramic images.

Conclusion
Panoramic radiography provides the dentist with an image of the whole dentition and adjacent structures. While panoramic radiography is technique sensitive, by carefully following the ten steps outlined, clear and undistorted radiographs of high diagnostic quality can be consistently obtained. In today’s digital age, capturing and storing panoramic radiographs is a reliable procedure that if combined with practice management software enables the patient’s image to be recalled together with his file when needed.

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Editor Profile
Dr. Robert A. Danforth is a board certified oral pathologist whose career has generally been directed toward oral radiology education. He has taught dental radiology since 1979 in three dental schools and has been involved with the dental radiography laboratory service since 1984. He first introduced intraoral and panoramic digital radiography into his oral radiology teaching courses in 1999 and, in addition, has given multiple continuing education courses on digital imaging. He was the contributing editor for the California Dental Association Journal December 1999. “New Millennium” issue, which completely featured digital Oral and Maxillofacial imaging as the new age in dentistry. Later, he had the same opportunity, again for the California Dental Association Journal, November 2003 issue to introduce 3D Cone Beam Computed Tomography (CBCT) as the next innovative imaging modality for dentistry.

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Questions

1. The area of sharp focus in panoramic radiography is known as the:
   a. Exposure zone
   b. Focal trough
   c. Aiming groove
   d. Tomographic zone

2. In digital panoramic radiography, the narrow anterior focal trough is:
   a. Doubled in size
   b. Measured by the computer
   c. Remains the same
   d. Of no importance

3. A panoramic radiograph shows the mandible to be V-shaped and narrowed with the condyles high on the film. The occlusal curve is exaggerated and the spine arches over top of the film. The patient’s head tilt was most likely pointing ______.  
   a. Too high
   b. Too low
   c. Tipped
   d. Twisted

4. A large tapered vertical radiopacity in the center of the panoramic radiography is usually caused by the ghost of the spine due to:
   a. Patient is too far back in the machine
   b. Patient’s head tilted too far up
   c. Patient was slumping, neck was curved
   d. Patient’s head was twisted

5. When the patient is properly positioned in the panoramic machine, they should feel:
   a. Very comfortable
   b. Nervous
   c. Like they will fall backwards if they let go of the handles
   d. Like they are leaning forward

6. If the Frontal/Image Layer plane were positioned incorrectly, which of the following errors would occur?
   a. Patient positioned too far back or forward
   b. Patient positioned too far up or down
   c. Patient positioned too far left or right
   d. All of the above

7. A white inverted V-shaped radiopacity on the bottom of the film is most likely caused by:
   a. Ghosts of metal jewelry
   b. Ghost of hyoid bone
   c. Lead apron artifact
   d. Damaged cassette

8. A panoramic radiograph shows small, narrowed anterior teeth with the spine visible on both sides of the film. The patient was probably positioned ______ on the bite rod.
   a. Too far forward
   b. Too far back
   c. Too high
   d. Too low

9. Calcification of the carotid artery usually appears on an image in what location:
   a. Soft tissues of the neck
   b. Mandibular canal
   c. Medial wall of maxillary sinus
   d. Mental foramen

10. “Ghost” images are caused by:
    a. Metal jewelry
    b. Position of patient’s chin tipped too far up
    c. X-ray beam alignment
    d. None of the above

11. For referral to another doctor, a digital image can be:
    a. Printed
    b. Copied to a CD
    c. Sent by E-mail
    d. All of the above

12. If a digital image is made (captured) in an incorrect patient’s file, what is the best way to correct it?
    a. Move it to the correct patient’s file
    b. Retake another image in the correct patient’s file
    c. Nothing. It will remain in the original file
    d. Copy image, but the original will stay in the other patient’s file

13. Before making a digital panoramic image, the computer attached to the X-ray unit should:
    a. Have the patient’s name on the screen
    b. Be idle, to save screen life
    c. Be connected to a printer
    d. Have a network connection

14. A poorly positioned digital radiograph can be corrected by:
    a. Using brightness and contrast tools
    b. Using the magnifying tool to enlarge image
    c. Using the color tools
    d. None of the above

15. As a general rule, the wider the anterior trough:
    a. The easier it is to position the patient
    b. The less comfortable the patient will be
    c. The darker the image will be
    d. None of the above

16. X-ray images can be stored on the computer in which program:
    a. Imaging program from X-ray source
    b. Imaging program from Practice Management
    c. Imaging program from any 3rd party dental or treatment/planning specialty program
    d. Any of the above

17. When taking a panoramic radiograph on a 7 year old child, which best describes the proper technique to follow?
    a. Adjust the X-ray unit up or down
    b. Turn the X-ray unit off and on, to clear the previous settings
    c. Make sure the X-ray unit is set for pediatric settings, instead of adult settings
    d. Make sure the patient is seated on a chair or stood

18. To show small anatomical detail, the best tool to use is:
    a. Color
    b. Invert
    c. Magnify
    d. Brightness/Contrast

19. When considering the Frankfort plane, which part of the patient does this plane focus on?
    a. Upper canine, or base of the nose, if edentulous
    b. Center of the nose and chin
    c. Ear opening and infraorbital notch
    d. None of the above

20. When considering the Mid-sagittal plane, which part of the patient does this plane focus on?
    a. Upper canine, or base of the nose, if edentulous
    b. Center of the lip and chin
    c. Ear opening and infraorbital notch
    d. All of the above

21. When considering the Frontal/Image Layer plane, which part of the patient does this plane focus on?
    a. Upper canine, or base of the nose, if edentulous
    b. Center of the lip and chin
    c. Ear opening and infraorbital notch
    d. None of the above

22. If the Frankfort plane were positioned incorrectly, which of the following errors would occur?
    a. Patient positioned too far back or forward
    b. Patient positioned too far up or down
    c. Patient positioned too far left or right
    d. All of the above

23. If the Mid-sagittal plane were positioned incorrectly, which of the following errors would occur?
    a. Patient positioned too far back or forward
    b. Patient positioned too far up or down
    c. Patient positioned too far left or right
    d. All of the above

24. The final visualization for proper patient alignment is provided by:
    a. Light beam reference lines
    b. Transecting threads on either side of the patient
    c. A digital imaging grid used prior to taking the radiograph
    d. None of the above

25. Automatic exposure control facilitates:
    a. Imaging various patient sizes
    b. The prevention of ghosting
    c. Reduction of operator mistakes
    d. a and c

26. The Frankfort plane is used to:
    a. Position the patient’s chin height
    b. Position the patient’s head tilt in the vertical plane
    c. Position the patient’s head tilt in the sagittal plane
    d. None of the above

27. For patients who are edentulous in the canine region, the ______ can be used to achieve anterior jaw alignment:
    a. Imaginary line running horizontally from the tips of the patient’s earlobes
    b. Tip of the nose and chin
    c. Base/alar corner of the nose
    d. All of the above

28. To improve the observer’s perception, digital image enhancement can be achieved by:
    a. Local equalization
    b. Colorization
    c. Embossing
    d. All of the above

29. The components of light alignment are:
    a. Mid-sagittal head and skull plane
    b. Canine/corner base of nose reference line
    c. Frankfort plane
    d. All of the above

30. A large airway shadow directly over the roots of the maxillary teeth occurs due to:
    a. Air in the nasal passages and sinus
    b. The patient not placing the tongue in the roof of the mouth while the image is being taken
    c. a and b
    d. None of the above
Successful Panoramic Radiography

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Educational Objectives

1. Understand what constitutes a normal panoramic radiograph and the anatomical structures that can be identified on panoramic radiographs
2. Know the steps required to take a good panoramic radiograph and how to avoid errors
3. Understand the methods by which digital panoramic radiographs are captured, stored, retrieved and printed
4. Understand how to detect possible carotid artery calcifications on panoramic radiographs

Course Evaluation

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

1. Were the individual course objectives met?  Objective #1: Yes No Objective #3: Yes No
2. To what extent were the course objectives accomplished overall?  5 4 3 2 1 0
3. Please rate your personal mastery of the course objectives.  5 4 3 2 1 0
4. How would you rate the objectives and educational methods?  5 4 3 2 1 0
5. How do you rate the author's grasp of the topic?  5 4 3 2 1 0
6. Please rate the instructor's effectiveness.  5 4 3 2 1 0
7. Was the overall administration of the course effective?  5 4 3 2 1 0
8. Do you feel that the references were adequate?  Yes No
9. Would you participate in a similar program on a different topic?  Yes No
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11. Was there any subject matter you found confusing? Please describe.
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