



PANORAMIC *Imaging* News

Volume 2, Issue 1

US \$6.00

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Ghost Images: Objects outside the image layer that are not entirely excluded from the panoramic radiograph

By Dr. Allan G. Farman in collaboration with Dr. Ali Shafie

Panoramic radiographs consist of a series of narrow tomograms sequentially scanned onto the detector (usually film in a cassette) beneath a secondary slit. Panoramic radiology aims to produce a complete view of both dental arches and their adjacent structures with minimal geometric distortion and with minimal overlap of anatomic details from the contralateral side. To achieve this, the patient's head is maintained stationary in a cephalostat about which the radiation source and X-ray detector rotate. A curved image layer is generally achieved using a continuously changing center of rotation. Objects that are within the selected image layer are clearly visible in the image, while objects outside the image layer are deliberately blurred out of recognition. The degree to which the blurring of extraneous details is successful is dependent upon a number of factors. These factors include (1) the atomic density of the contents of the object; (2) the bulk of the content of the object; (3) the proximity of the object to the image layer; and (4) the bulk and density of the patient's soft tissues.

Anatomic Ghosts

All panoramic radiographs include ghost images even though these are minimized following more than

50 years of trial and error by the various manufacturers of panoramic dental systems. Many ghost images are actually from normal anatomic structures. For example, in the edentulous patient having relatively thin soft tissues, it is not uncommon for the ghost image of the mandibular ramus to be clearly demonstrated in magnified form over the contralateral mandibular body (Fig. 1). The presence of such a ghost shadow of normal anatomic structures is not an error in technique, but rather a normal finding when using panoramic radiology on some patients.

While ghost images of some anatomic structures cannot be avoided, most ghost images can be excluded or reduced. A very common unwanted image is that of the cervical spine reflected over the mandibular incisor teeth (Fig. 2). This is best prevented by having the patient stand, or sit, upright with their neck straight and extended, rather than slouched during panoramic exposures. If the patient's neck is slouched, the X-ray beam traverses several cervical vertebrae on the way to exposing the incisor view causing an opaque shadow of the spine to obscure details of the incisor teeth.

Jewelry Ghosts

Jewelry, such as earrings, is usually constructed of materials with high atomic density, and is generally

“While ghost images of some anatomic structures cannot be avoided, most ghost images can be excluded or reduced.”

outside the image layer. It can frequently lead to ghost image formation. All patients (male and female) should be asked to remove the jewelry around the head and neck before panoramic radiography is performed. Ghost images of earrings are generally magnified and displayed over the maxillary sinus and body of the mandible on the opposite side of the radiographic image (Fig. 3.) Their actual appearance will be dictated by their orientation (Fig. 4). Particular care needs to be taken if the earring is unilateral and solid as the ghost might be mistaken for an odontoma or other radiopaque disease entity. Bullets and shrapnel in the soft tissues may also cause ghost images to appear magnified and contralaterally in the panoramic radiographic image (Fig. 5). Tongue rings are centrally positioned and can cast a radiopaque shadow upwards over the nasal passageway (Fig. 6). The actual shadow depends on where the tongue is positioned during the making of the panoramic image.

Lead Apron

As the X-ray beam is well-collimated for panoramic dental radiography, a lead apron is now not required for patient safety in many parts of the world; however, requirements do remain in some parts of the USA, including Kentucky. The use of a leaded garment is to protect the patient against radiation; hence, if worn it should face the incoming beam. In panoramic radiography the beam comes from the rear of the patient. The apron should be draped around



Fig. 1. Panoramic radiograph of an edentulous patient. The true image of the right mandibular angle is outlined by white arrows. The ghost image of the same structure is outlined using black arrows.

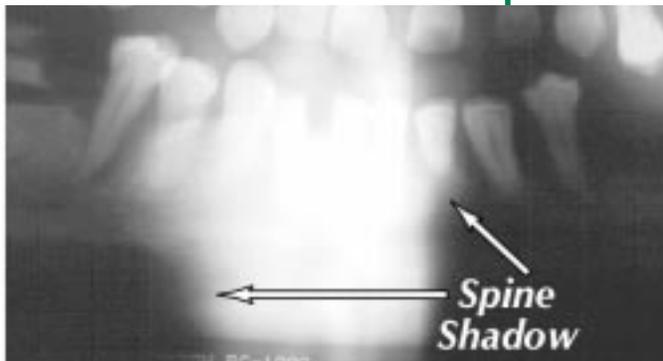


Fig. 2. Detail of panoramic radiograph showing how the shadow of the spine can obscure detail of the mandibular anterior teeth if the patient's neck is not kept erect during panoramic radiography.



Fig. 3. Bilateral earrings and their ghost images.

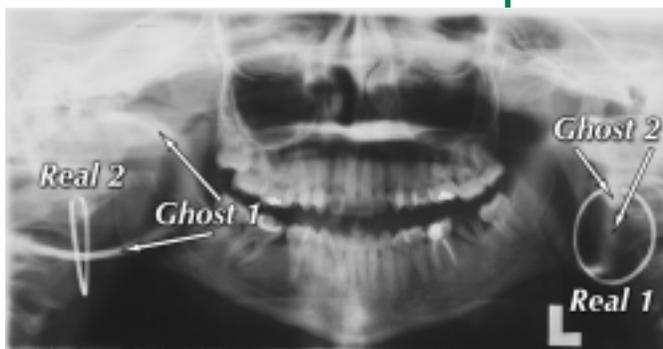


Fig. 4. Appearance of the earrings is dependent upon their relative position with respect to the incoming X-ray beam. In this case, the right earrings are rotated so both the real and ghost images differ in appearance from the earring on the other side.

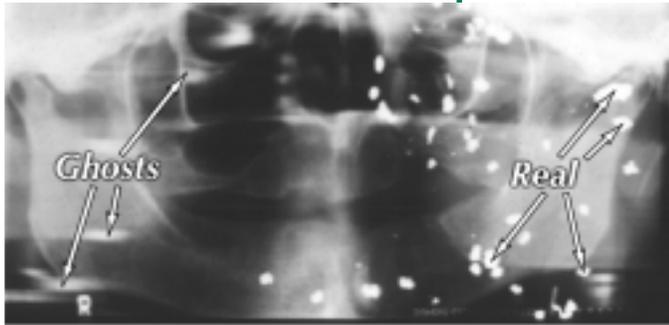


Fig. 5. Sharp opaque images on the left side of the image are buckshot. The indistinct opaque images on the right side are ghost images.

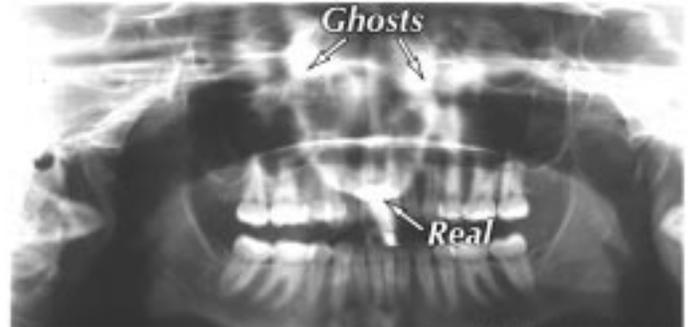


Fig. 6. Tongue rings have become evermore frequent. The patient is often reluctant to remove this device. It can case a radiopaque shadow upwards superimposed in the midline over the nasal passageway.

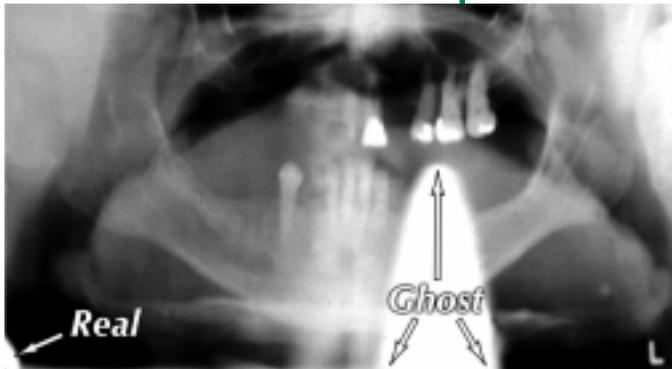


Fig. 7. A lead apron raised up on the right shoulder has cast a radiopaque image on the left side of the image in the premolar region.

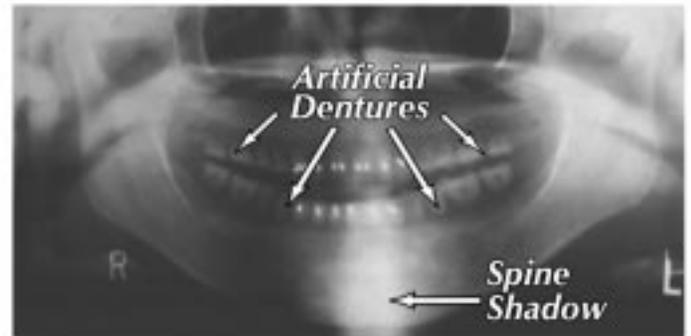


Fig. 8. Sometimes it is not a bad idea to leave dentures with entirely radiolucent bases in place to facilitate patient positioning for panoramic radiography. In such cases the artificial teeth are usually radiopaque - but rarely hide important details so long as the patient is properly positioned.

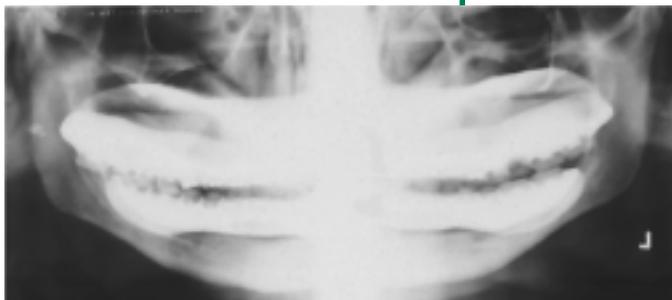


Fig. 9. Where denture bases are radiopaque the denture should always be removed prior to panoramic radiology being performed. Otherwise the primary image of the denture base will exclude necessary details from the interpretation.



Fig. 10. This patient has not removed the eyeglasses and also has a unilateral earring on the left side. The primary image of the eyeglasses while not desired, probably does not obscure relevant information. The left earring has cast a ghost image over the maxillary right tuberosity region and obscures important information concerning an unerupted third molar tooth.

“The panoramic radiograph supplemented by bitewings and an occasional periapical is all that is needed.”

Panoramic imaging verses intraoral surveys: An opinion

By Dr. Allan G. Farman

All radiographs should be selected according to the professional judgment of the dental specialist. This follows the taking of a health and dental history and careful clinical inspection of the oral and para-oral structures. The panoramic radiograph has the advantage of providing a wide overview of the dental arches in which the structures can be clearly related. It provides a greater area of coverage than the full mouth periapical image series, while using a lower average dosage of radiation. The time taken to make a panoramic image is a small fraction of that required to make and mount a full mouth intraoral survey. It is much more comfortable for the patient than the cutting edge of films inserted into the mouth, and it simplifies issues of infection control in the operatory and in the darkroom. The panoramic radiograph is ideal for assessment of growth and development of the dentition at ages 6, 12 and 18 years and as a baseline in the assessment of the jaws of the edentulous adult. It is also recognized as being the method of choice for evaluation of possible mandibular fractures following trauma to the jaws.

One might ask why so many practitioners continue using full mouth intraoral series as the principal baseline-imaging regimen for their patients. The probable answer, is “force of habit” following indoctrination during dental school training - and the perception that panoramic radiographs are of poorer quality. For the practitioner that feels that panoramic radiographs are inadequate in quality, it is time to check out the new machines that are available. There have been many improvements over the past decade. Furthermore, beam geometry,

film and patient positioning for reliable results are much easier for panoramic radiography than for periapical imaging. The panoramic radiograph also permits a clear identification of the patient, procedure date and laterality of structures. It is difficult to replace periapical radiographs lost from film mounts - individual intraoral radiographs cannot be labeled.

Admittedly, radiographs made using intraoral direct emulsion film have a somewhat higher spacial resolution than those made using extraoral film-screen combinations. The question to be asked is where such fine resolution is needed? It is possible to supplement the baseline panoramic radiograph with bitewings to assist in detection of early proximal dental caries. Where endodontics is to be performed, the periapical radiograph is needed to assess the numbers and positions of a fine root canals as these are not adequately displayed on the panoramic image. For all other radiographic assessments of the teeth and jaws the panoramic radiograph is generally adequate alone.

Perhaps it is time to rethink imaging strategies and try something new if you are still bound to the use of full mouth intraoral surveys. There is certainly no need for a panoramic radiograph plus a full mouth intraoral survey. The panoramic radiograph, supplemented by bitewings and an occasional periapical is all that is needed. This provides savings in time and reduces patient discomfort. As the radiation scatter from a panoramic radiographic machine is very small, the substitution of a panoramic radiograph for a full mouth intraoral radiograph series has the potential to reduce the radiation dose that might inadvertently affect the dental office personnel.

the patients back rather than over their chest. In any event, it is necessary to make sure that the lead apron is placed smoothly over the patient's shoulders. A lead apron rising up at the patient's shoulder will produce an artifact in the same manner as occurs with earrings; namely, contralaterally (Fig. 7) over the body of the mandible, possibly extending over the maxillary sinus.

Prostheses

Dental prostheses are generally within the image layer, and cast primary rather than ghost images. When the denture base is entirely radiolucent, the denture may be left in place to aid patient positioning during panoramic radiography, without loss of needed image details (Fig. 8). However, if the denture base is radiopaque (e.g. chrome-cobalt or stainless steel) the denture should always be removed prior to panoramic radiographs being made (Fig. 9). Finally, eyeglasses should also be removed before panoramic radiology as these can also obscure important image details (Fig. 10).

In The Recent Literature:

Dental implants: The panoramic radiograph is considered the standard for treatment planning dental implants.

Dula K, Mini R, van der Stelt PF, Buser D. The radiographic assessment of implant patients: decision-making criteria. Int J Oral Maxillofac Implants 2001 Jan;16(1):80-9. (From the Department of Oral Surgery, School of Dental Medicine, University of Berne, Switzerland.)

Indications for the most frequently used imaging modalities in implant dentistry are proposed based on clinical need and biologic risk to the patient. To calculate the biologic risk, the authors carried out dose measurements. A panoramic radiograph plus a series of 4 conventional tomographs of a single-tooth space in the molar region carry respectively 5% and 13% of the risk from computed tomography. The authors indicate that panoramic radiography is considered the standard radiographic examination for treatment planning of implant patients, because it imparts a low dose while giving the best radiographic survey. Periapical radiographs are used to elucidate details or to complete the findings obtained from the panoramic radiograph. Other radiographic methods, such as conventional film tomography or computed tomography, are applied only in special circumstances, film tomography being preferred for smaller regions of interest and computed tomography being justified for the complete maxilla or mandible when methods for dose reduction are followed. During follow-up, intraoral radiography is considered the standard radiographic examination, particularly for implants in the

anterior maxilla. In patients requiring more than 5 periapical images, a panoramic radiograph is preferred.

Dental caries: For detection of occlusal dental caries, no statistical significance was demonstrated between panoramic and bitewing radiography.

Thomas MF, Ricketts DN, Wilson RF. Occlusal caries diagnosis in molar teeth from bitewing and panoramic radiographs. Prim Dent Care 2001 Apr;8(2):63-9. (From the Division of Conservative Dentistry, King's College.)

Previous studies implying that panoramic radiographs are inferior to bitewing radiographs for caries diagnosis lacked validation. This study used an electronic caries meter (ECM II, LODE, Groningen, The Netherlands) to validate occlusal caries diagnosis made from bitewing and panoramic radiographs. Forty-nine Army recruits were examined with the ECM, and had bitewing and panoramic radiographs made. In total, 299 molar occlusal surfaces were available for examination. Seven examiners viewed the bitewing and panoramic radiographs on two separate occasions and rated each occlusal surface for dentin caries using a five interval scale (1: almost definitely no caries, 2: probably no caries, 3: unsure, 4: caries probably present, and 5: caries almost definitely present). To determine intra-rater reliability, repeat measures were made on 20 % of the radiographs at two further separate sittings. ECM conductance readings greater than 9 were taken to indicate dentin caries. Examiner decisions that caries was probably and definitely considered to be present were taken as positive diagnoses.

Bitewing and panoramic radiographs provided sensitivity values of 25 % and 19 % and specificity values of 93 % and 97 % respectively. Receiver operating characteristic (ROC) analysis was also performed. No statistically significant difference in diagnostic quality was proven between the panoramic and bitewing radiographs. Intra-examiner reproducibility was found to be poor to moderate (Kappa values for bitewing radiographs = 0.31-0.44, and for panoramic radiographs = 0.07-0.54). In conclusion, no difference in overall diagnostic performance was proven between bitewing and panoramic radiographs for the diagnosis of occlusal surface dentin caries.

Panoramic diagnostic yield: Optimization of the diagnostic yield from panoramic radiographs requires a systematic approach with special attention to high yield areas.

Monsour PA. Getting the most from rotational panoramic radiographs. Aust Dent J 2000 Jun;45(2):136-42. (From the Queensland Diagnostic Imaging, Holy Spirit Hospital, Brisbane, Australia.)

Rotational panoramic radiography is an invaluable tool in modern dentistry. To use the full potential of this resource the entire radiograph must be examined in a systematic way to extract the great wealth of information available. A framework should be applied for the development of a systematic method to examine panoramic radiographs. The essential elements are that all areas of the radiograph should be examined and that there are a number of high yield areas with regard to pathology that require special attention.

Risk assessment: The risk from radiation used in making a panoramic radiograph is less than one in a million. It is of a similar magnitude to the risks associated with public road traffic encountered on the way to the examination.

Jung H. The radiation risks from x-ray studies for age assessment in criminal proceedings *Rofo Fortschr Geb Rontgenstr Neuen Bildgeb Verfahr* 2000 Jun;172(6):553-6. (From the Institute of Biophysics, Hamburg University, Germany.)

Age estimation for forensic purposes is usually based on a panoramic radiograph of the teeth or a radiograph of the left hand. Procedure mortality risks were calculated using both the risk coefficients of International Committee for Radiation Protection and the mass ratio of radiation-exposed portion to total organ. For a panoramic radiograph the following doses were used: bone surface and red bone marrow 0.25 mGy, skin on the neck 0.56 mGy, thyroid gland 0.053 mGy. For a

radiograph of the hand, a radiation dose of 0.15 mGy was adopted. Mortality risks obtained were 1.8×10^{-7} for a panoramic radiograph and 5.1×10^{-8} for a radiograph of the hand. By comparison, it was estimated that the calculated risks is approximately equivalent to the mortality risks associated with public road traffic during less 2.5 hours or one hour, respectively. The calculated radiation risks are of similar magnitude to the risks the person is exposed to on the way to the examination.

Frequently Asked Questions About Film Quality:

Q: What are these odd clear artifacts on our films?

A: Clear artifacts fall into four general categories.

1. Clear artifacts caused by metal or radiopaque objects on or in the patient. Jewelry, eyeglasses, and radiopaque dental prostheses should be removed before the radiograph is made.
2. Clear triangular shape in the lower anterior caused by improper position of the patient lead shield. Make sure the shield is placed low enough on the patient's shoulder and neck so as not interfere with the X-ray beam.
3. "Tube Side" decal is visible on the developed film. The decal will appear when the intensifying screens are inverted (inside out) or the film was not between the screens. Orient the screens so that the "Tube Side" decal is on the outside and the left and right markers (L & R) are inside. Make sure the "Tube Side" decal side of the screens is aligned with the "This Side Toward Tube" side of the cassette sleeve. Insert the film between the intensifying screens.
4. Distinct clear lines, scratches, or cracks, visible on the developed film. These odd artifacts are usually caused by cracks or splits

in the intensifying screens.

Examine the screens for damage. If the screens are damaged it is permanent. Make sure the screens are not handled roughly, folded, or stored in an unsafe location.

Q: What are these black marks on our films?

A: Black artifacts on films fall into four general categories.

1. Black ends or corners caused by exposure to white light. Usually a torn cassette or an exposed box of film is the culprit. Physically check the cassette sleeve for tears and replace sleeve if necessary. To check a box of film for exposure take one sheet of film out of the box, under safelight conditions, and process it at normal time and temperature settings. The film should develop clear/translucent. If the film develops with artifacts similar to the problem film, the box of film needs to be replaced.
2. Black spots or smudges caused by a foreign substance contaminating the film. Glove powder residue is usually the source of this artifact. Any substance on the film before it is developed will effect the chemical reaction between the

film and the developing solution. Keep your hands and the area where you handle the film, cassettes and screens clean.

3. Black "starburst", "tree branch", or "lightning bolt" artifacts caused by static electric discharges. The intensifying screens need to be treated with antistatic/screen cleaner solution or mild soapy water. Apply solution to intensifying screens only, not cassette sleeve. Remove screens from the cassette and place them on a clean countertop. Apply solution to inside and outside of the screens. Partially dry the screens and allow the remaining solution to air dry. Make sure the screens are completely dry before reloading into the cassette.
4. Black "crescent" or "half moon" artifacts caused by dented film or intensifying screens. Thumbnails or rough handling of the film or screens usually makes dents. Any stress to the film, thumbnail dent, a sharp crease, a heavy object dropped onto the film, will develop black. If no dents are visible on the film surface examine the screens. Damage to the screens is permanent. Make sure the area where you handle films is accessible and uncluttered. Store cassettes in a location where they will not be damaged.

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