

Rectangular Collimation Effectively Limits Radiation Field

Rectangular Collimation Reduces Radiation Dose From Intraoral Radiography.

John Ludlow, MS, DDS

John Ludlow, MS, DDS -Special Presentation

Rectangular collimation is an extremely effective method for reducing the radiation dose from intraoral radiography. The smallest round cones expose about twice the area needed to cover a typical bitewing film.

Rectangular collimation is an extremely effective method for reducing the radiation dose from intraoral radiography. Rectangular collimation simply shapes and sizes the x-ray beam to the shape and size of the imaging receptor. In medical radiography, the concept of limiting the field of radiation to no more than the size of the receptor is a firmly established legal requirement in most states. However, in dentistry, intraoral radiographs are much smaller in size and more difficult to pinpoint in space. Traditionally, a round beam that is larger than the size of the intraoral receptor has been used to expose dental films. The beam's diameter has decreased from >9 cm for units manufactured in the 1920s to 7 cm (federally permitted maximum diameter) or even 6 cm for some currently manufactured units. **Beam Size vs Exposure:** For dentistry, the most commonly used intraoral image receptor is rectangular and measures 41 mm x 31 mm, providing a surface area of 1270 mm². However, the area of a 9-cm diameter circle is 5 times greater than the area of the rectangular receptor, a 7-cm circle has 3 times the area, and a 6-cm circle has a bit more than twice the area. Therefore, even the smallest round cones expose about twice the area needed to completely cover a typical bitewing or periapical film. When patients are exposed with a round collimated beam instead of a properly sized rectangular collimated beam, they receive at least 2 times more exposure than is needed for an intraoral image.

Verification: This concept has been verified in numerous studies. At the University of North Carolina, we have done several of these studies, including a study recently completed by Brandon Johnson. This study confirmed that the use of a rectangular collimator insert rather than a 6-cm diameter round cone collimator reduces the effective radiation dose by 40% in a child phantom. **Retrofit:** If your intraoral unit did not come with a rectangular collimator, the good news is that rectangular collimation is easy and inexpensive to add. For example, the RINN Corporation makes a universal insert that slips into a standard round cone in just a few seconds. Other manufacturers provide a variety of options that make this technology easy to add and easy to use. (Reviewer-).

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Keywords: Intraoral Radiography, Radiation Dose Reduction, Rectangular Collimation

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Rectangular Collimation Reduces Scatter Radiation

Rectangular Collimation Reduces Thyroid Dose, Improves Image Quality.

John Ludlow, MS, DDS

John Ludlow, MS, DDS -Special Presentation

Most thyroid exposure from intraoral radiography is due to scatter radiation. Rectangular collimation is an extremely effective method for reducing scatter radiation during intraoral radiography.

Rectangular collimation effectively reduces the radiation dose from intraoral radiography by simply matching the shape and size of the x-ray beam to the shape and size of the imaging receptor. **Scatter vs Thyroid Exposure:** Brandon Johnson and colleagues at the University of North Carolina recently completed a study of the radiation doses associated with 3 intraoral radiologic device/collimator combinations. One surprising finding in this study was that the radiation dose to the thyroid was less using rectangular collimation alone versus using both a round cone and a thyroid collar shield. Most thyroid exposure from intraoral radiography is due to scatter radiation rather than to direct exposure of the x-ray beam. Much of that scatter is from internal structures, such as the jaws, tongue, and muscles of the parapharyngeal area. If you reduce the area of exposure by half, it is logical that the amount of scatter will also be reduced by half. In the absence of direct exposure to the x-ray beam, the thyroid collar primarily protects from scatter radiation coming from the chin. As a result, thyroid shielding reduces the radiation dose to the thyroid by only about one third. A thyroid shield is much more effective in reducing dose when exposed to direct radiation from the useful beam, as is the case with cephalometric imaging in orthodontics. **Scatter vs Image Quality:** The bottom line is that rectangular collimation is an extremely effective method for reducing scatter radiation during intraoral radiography. Because scatter radiation contributes to exposure of the image receptor, it reduces the contrast of the image. Therefore, an added benefit of rectangular collimation is reduction of scatter and improvement of image quality. (Reviewer-).

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Keywords: Intraoral Radiography, Rectangular Collimation, Scatter Radiation Reduction

Print Tag: Refer to original journal article

The Truth About Cone Cuts -- Diagnostic Info Not Usually Lost

Rectangular Collimation and Cone Cuts: Debunking the Myths.

John Ludlow, MS, DDS

John Ludlow, MS, DDS -Special Presentation

Although untrue, perhaps the greatest barrier to broad adoption of rectangular collimation by the dental community is the perception that cone cuts reduce image quality and require the retaking of images.

It is true that errors can occur in increased numbers with rectangular collimation, but these errors are largely cosmetic. **Cone Cuts:** Perhaps the greatest impediment to broad adoption of rectangular collimation by the dental community is the error of "cone cuts" and the perception that these reduce image quality and necessitate retaking of images. This is ironic because most studies comparing round and rectangular collimation techniques have found only small differences between the 2 techniques regarding the number of major errors that necessitate retakes. **Brief Description:** Dental x-ray beams are collimated or restricted by either a round or a rectangular collimator at the end of the cone. When the beam's exit pattern is not aligned with the intraoral film, part of the film will not be exposed to radiation and will appear clear. This error is known as a cone cut. **Outcome of Cone Cuts:** While a clinician might see increased numbers of cone cuts in intraoral images, these will largely be cosmetic and do not lead to a loss of essential diagnostic information. Receptor holders with extraoral beam aiming guides, such as the RINN XCP® system, help the clinician align the rectangular collimator with the receptor and significantly reduce errors of all types, including cone cuts. When I see that white line going across the edge of an image, I am reminded of the automobile safety belt. Sometimes we view them as a nuisance, but their use does increase our safety. Similarly, the rectangular collimator may result in occasional cone cuts, but its use has diminished our patients' risks by reducing x-ray exposure. (Reviewer-).

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Keywords: Intraoral Radiography, Radiation Dose Reduction, Rectangular Collimation, Cone Cuts

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Avoiding X-Ray Divergence -- Long Cones to the Rescue

Long Cones Versus Short Cones: A Brief Background.

John Ludlow, MS, DDS

John Ludlow, MS, DDS -Special Presentation

Years ago, dentists used an x-ray unit with a short plastic aiming cone for aligning the beam with the film. Cones were eventually replaced by shielded open cylinders, but use of the term "cone" persists.

In dental radiography, we talk about long and short cones because they impact the geometric divergence of x-rays after they leave the x-ray tube. Greater divergence has 2 bad characteristics: (1) it increases anatomic distortion and overall magnification and (2) it increases the volume of irradiated tissue. We can reduce both of these detrimental characteristics by increasing the distance between the x-ray source and the object being imaged. To achieve this, we must use an open-ended cylinder (so called "cone") of the desired length. **How Cones Get Their Name:** You will never see an actual cone being used as an x-ray aiming device. Back in the late 1950s, dentists used an x-ray unit with a short plastic aiming cone for aligning the beam with the location of the film. Because some x-rays interact with the cone's plastic, scatter interactions were created that exposed the patient's face to radiation. Cones were eventually replaced by shielded open cylinders that eliminated this form of scatter exposure. However, the term "cone" persists even though current beam-aiming devices are cylindrical. **Evolution of X-Ray Tube:** When long, open-ended cones were introduced many years ago, they were really long. The x-ray tube was located at the front of the tube head, and to get an 8-inch source-to-cone-end distance, you needed a cone that was about 8 inches. This meant that a cone that was 12 inches or 16 inches long actually extended away from the tube head. About 50 years ago, Albert Richards, a physicist at the University of Michigan, devised a way to divide the high voltage transformer in the x-ray tube head into 2 pieces. Splitting the transformer permitted moving the x-ray tube to the back of the tube head without blocking the x-ray beam. This effectively increased the length of the source-to-cone-end distance without increasing the length of the cone. One of the great things about Richards' discovery was that he placed the patent for the split transformer/recessed tube design into the public domain so that any manufacturer could use this design without cost. Today, all dental x-ray tube heads incorporate this design. The bottom line for the clinician is that a long cone technique can be achieved without using a cone that is inconveniently long. (Reviewer-).

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Keywords: Intraoral Radiography, Radiation Dose Reduction, X-Ray Divergence, Cones

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Increase Exposure Time When Switching to Long Cone

How to Adjust Exposure When Switching From Short to Long Cones.

John Ludlow, MS, DDS

John Ludlow, MS, DDS -Special Presentation

Compared to a short cone, a long cone reduces both the geometric distortion in the image and the volume of the patient that is exposed to radiation.

In dental radiography, the geometric divergence of x-rays after they leave the x-ray tube is influenced by use of long and short cones. Greater divergence increases (1) anatomic distortion and overall magnification and (2) volume of irradiated tissue. To reduce both of these detrimental characteristics, we must increase the distance between the x-ray source and the object being imaged. To achieve this, we must use an open-ended cylinder (so called "cones") of the desired length. **Long Cones:** A cylinder extending 4 to 8 inches from the surface of the tube head of a modern x-ray dental unit provides a source-to-cone-end distance of 12 to 16 inches. The cone of most intraoral x-ray units is detachable, and the standard cone provided with many units will almost always be short. By law, the short cone provides at least a 20-cm source-to-cone-end distance, but the distance may not be much more than this. A cone providing a 30-cm source-to-cone-end distance will reduce both the geometric distortion in the image and the volume of the patient that is exposed to radiation. Therefore, most manufacturers provide a longer cone option that increases the source-to-cone-end distance to 30 cm.

Adjusting Exposure for Long Cone Use: In changing from a short cone to a long cone, the unit's exposure factors must be adjusted so that the same radiation intensity is maintained at the receptor surface. An easy way to do this is to increase the exposure time by applying the inverse square law. This law says that x-ray intensity decreases as the square of the distance from the source. If the source-to-cone-end distance increases from 20 cm (short cone) to 30 cm (long cone), then the ratio of the squares of these distances is 400/900, which simplifies to 4/9. The intensity of the radiation at the longer source-to-cone-end distance will be 4/9ths of the original intensity. Therefore, to maintain intensity, we need to increase our original exposure time by 9/4ths (the inverse of the square). For example, an original exposure time of one third of a second (20 impulses) used with a short cone would be increased to three fourths of a second (45 impulses) with a long cone. **Exposure vs Intensity:** Keep in mind that, even though exposure time is increased, the intensity of radiation at the receptor is the same, and the patient's radiation exposure is actually diminished by reducing the exposed volume. (Reviewer-).

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Keywords: Intraoral Radiography, Radiation Dose Reduction, Long vs Short Cones

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Lead Aprons Provide Only Minimal Radiation Protection

Use of Lead Shielding in Dental Radiography.

John Ludlow, MS, DDS

John Ludlow, MS, DDS -Special Presentation

In dental radiography, the x-ray beam is not directed at anatomy below the neck, so the only radiation exposure these tissues receive is through scatter. Use of a lead apron provides only very minimal protection.

The latest dental radiography guidelines from the American Dental Association and the U.S. Food and Drug Administration have been updated in an effort to more closely align these recommendations with those of the National Council on Radiation Protection and Measurements (NCRP). The recommendations state that abdominal shielding is unnecessary, but use of a thyroid collar is still needed for patients undergoing dental radiography. These guidelines are based on a number of studies demonstrating that only 2% to 4% of the total effective dose from maxillofacial imaging is due to absorption of x-rays by tissues below the neck. **Scatter:** In dental radiography, we do not direct our x-ray beam at anatomy below the neck, so the only radiation exposure these tissues receive is through scatter radiation, much of which passes through the body internally. Because the lead apron is external, it has no effect in reducing this type of radiation exposure. Through use of a lead apron, we are only able to reduce patient dose by 1% to 2%. From a public health standpoint in the European Union, the cost of purchasing lead aprons for every intraoral dental unit is viewed as not worth the 1% to 2% savings in patient dose, especially when there are cost-effective ways that achieve much greater dose reductions, such as faster speed film and rectangular collimation. **Backscatter Radiation:** Any material that is irradiated causes some amount of scatter radiation. Because lead has a high atomic number, the lead apron attenuates or absorbs most of the radiation to which it is exposed. This means that only a small amount of scatter escapes in any direction. In dental radiography, the amount of this backscattering to the chest and abdomen is negligible: backscatter should not be used as an argument against the use of a lead apron. **Lead Aprons & Panoramic X-Rays:** These concepts of protection from direct and scatter x-rays and the use of the lap apron also apply to panoramic imaging. Because of the beam's upward projection from behind the patient during production of the panoramic image, a thyroid collar cannot be used. It would obscure the anterior mandible, rendering the image of this area nondiagnostic. Even a conventional lap apron should not be used for stand-up panoramic units because the shoulder flaps of these aprons tend to slip forward and rise up to block part of the scan. Aprons designed to cover the upper front and back of the patient provide a counterbalanced weight that does not slip and can be used with stand-up panoramic units. Again, the dose-reducing benefit from this approach is minimal. Use of lead aprons during panoramic imaging should be considered optional unless required by the dental law of your particular state. (Reviewer-).

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Keywords: Intraoral Radiography, Scatter Radiation, Lead Aprons, Thyroid Shields

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Diagnostic Performance Similar for INSIGHT, Ultra-Speed Films

A Comparison of D-Speed and E/F-Speed Intraoral Films.

John Ludlow, MS, DDS

John Ludlow, MS, DDS -Special Presentation

Controlled experiments and clinical studies comparing INSIGHT and Ultra-speed films have not demonstrated any significant differences in diagnostic performance, costs, or the chemistry needed to develop them.

Over many years and several generations of dental radiology films, the Eastman Kodak Company (now Carestream Health) has been extremely successful in increasing the sensitivity of intraoral film while maintaining its diagnostic efficacy. The development of INSIGHT film, an E/F-speed class film, is the latest example of this. A major difference between INSIGHT film and Ultra-speed film (Kodak's slower D-speed counterpart) is found in the size and shape of the silver halide grains, which are the x-ray-sensitive components of the film emulsion. Compared with the silver halide grains on Ultra-speed film, INSIGHT's grains are larger and have a tabular shape, which gives them a larger cross section for absorption of x-ray photons and a larger surface area over which to develop the exposed grain into a silver residue that becomes the image's radiolucent component. The grains are still quite small, approximately 8 μm in diameter. This compares favorably with the highest resolution CCD or CMOS detectors that provide pixels as small as 33 μm .

INSIGHT vs Ultra-Speed: The reason that INSIGHT is described as an E/F-speed film is the same reason that it has a range of exposure reductions between 50% and 60%. The film requires only 40% of the exposure of Ultra-speed film to provide equivalent film density when processed with a roller transport automatic film processor. However, when INSIGHT film is processed by hand or in a dip tank processor, about 10% more exposure is required to achieve equivalent density. The difference has to do with activation of the emulsion that occurs from the squeezing or massaging action of roller pressure on the emulsion. The absence of this activation in dip tank processing results in a lighter image or the need to compensate by slightly increasing exposure times. Controlled experiments and clinical studies comparing INSIGHT and Ultra-speed films have shown that there are no significant differences in diagnostic performance, costs, or the chemistry needed to develop them.

D-Speed Film: D-speed film is the most commonly purchased and presumably most commonly used film in the United States, even though an alternative is available that reduces patient exposure by half. One of the main reasons for the popularity of D-speed film is probably the fact that many dentists are creatures of habit. They find something that works well and they stick with it. D-speed film may have been the film that they used in dental school, so they are still using it. Often a dentist stops using D-speed film to switch to a digital system, not to switch to faster film. When handled optimally, digital systems can reduce exposures below those of film. However, if handled without careful attention to optimization, digital systems can lead to greater exposures than that required for film. (Reviewer-).

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Keywords: Intraoral Radiography, Radiation Dose Reduction, Films, Exposure vs Diagnosis

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Avoid Occupational X-Ray Exposure -- Know Your Safe Zones

Occupational Radiation Exposure: Defining Safe and Unsafe Zones.

John Ludlow, MS, DDS

John Ludlow, MS, DDS -Special Presentation

To avoid occupational radiation exposure, the safest zones are two 45° wedges between 90° and 135° and between 225° and 270° from the location of the x-ray source.

The 6-foot rule in the United States (the 2-meter rule in the European Union) is a concept of occupational radiation protection that uses the inverse square law of radiation physics. **Inverse Square Law:** As x-rays diverge from their source, the beams become less intense the farther they move away from the source. The inverse square law says that x-ray intensity decreases as the square of the distance from the source. For example, the intensity of a beam at 3 feet is 4 mGy. If we increase the distance to 6 feet, then the ratio starts with 3/6, which simplifies to 1/2. The square of 1/2 is 1/4. Therefore, the intensity at 6 feet will be 1/4 of the original intensity at 3 feet, resulting in a beam intensity of 1 mGy. **Occupational Exposure:** The 6-foot rule is half of the "distance and position rule." The position part of the rule is especially important because it describes zones of least exposure to the operator during radiographic examinations. One way to think about safe zones is to first consider areas that are unsafe. **Unsafe -- Direct Radiation:** Any position in the path of the useful beam is considered unsafe. If we think of the patient as a compass, the location of the x-ray source can be thought of as due north. We want to stay out of the regions exposed by the useful beam between southeast and southwest. **Unsafe -- Leakage Radiation:** The next least safe area for occupational exposure is the area around the x-ray source. This is because x-rays actually emanate in all directions from the x-ray source and are incompletely absorbed by the materials in the tube head. Radiation that is not part of the useful beam is called "leakage radiation." Exposure to leakage radiation can be reduced by staying out of the zone between northwest and northeast. **Unsafe -- Scatter Radiation:** The final area of exposure is that of scatter radiation coming from the patient. Scatter is most intense from the patient's surface closest to the source. This zone is 180° between east and west extending through north. **Safest Zones:** Therefore, the safe or safest zones are 45° wedges between east to southeast and west to southwest. If you are using degrees rather than compass points, this would be two 45° wedges between 90° and 135° and between 225° and 270°. **Protective Barriers:** Some state radiation protection commissions do not permit the operator to be present in the region of an x-ray source without a protective barrier. Barrier materials are designed to protect the operator, but the location of the operator and the direction of the x-ray source are considered in determining the amount and type of shielding needed. (Reviewer-).

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Keywords: Occupational Radiation Protection, Distance and Position Rule, 6-Foot Rule

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Continuous Exposure of Detector Results in Greatest Radiation Dose

CCD Technology for Cephalometric Images: Exposure Type vs Patient Dose.

John Ludlow, MS, DDS

John Ludlow, MS, DDS -Special Presentation

For digital cephalometric systems that use CCD technology, the digital scan is composed of >1000 separate linear images joined together by the computer to make the final panoramic or cephalometric image.

For digital cephalometric radiographs that use CCD technology, some use a 1-shot exposure while others use a scanning exposure. Is there a difference in radiation exposure for the 2 different systems? For example, the Planmecca® ProMax has a high-speed setting (scans faster but uses a higher exposure setting) and a regular-speed setting (scans much slower but introduces more patient movement artifacts). The question is: Are the patient radiation exposures equivalent? Because I have not tested this unit, I spoke with a technical consultant at Planmecca who said that the exposures were essentially equal. One exposure involves a higher mA and a shorter exposure time, while the other uses a shorter mA and a longer exposure time. So I asked why Planmecca offers 2 options and why, when other factors are equal, would a practitioner ever choose a longer scan time that increases the risk of patient motion? The technician could not give me an answer to either of these questions. Nonetheless, some manufacturers provide faster scanning options that use continuous exposure of the digital detector. Compared to a pulsed exposure of the detector, the continuous exposure results in an increased dose for the patient. The reason is because digital systems need time to integrate exposure information and to send this to the computer before the next image is acquired. A scan is composed of >1000 separate linear images joined together by the computer to make the final panoramic or cephalometric image displayed on your screen. There is a fraction of a second downtime between the acquisition of each image when the exposure cannot be recorded by the sensor. This is wasted dose and it can make up a significant component of the total dose. (Reviewer-).

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Keywords: Intraoral Radiography, Digital Cephalograms, Continuous vs Pulsed Exposure

Print Tag: Refer to original journal article

Radiation Badges Good Part of Safety Control Program

Occupational Radiation Exposure: The Use of Radiation Badges.

John Ludlow, MS, DDS

John Ludlow, MS, DDS -Special Presentation

Recording of a radiation exposure on a dental staff member's radiation badge may indicate an undesirable change in work habits. Conversely, negative findings may help remove any worries about x-ray exposure.

The goal of dental radiography is to safely use x-rays to obtain diagnostic information while keeping the exposure to the patient and dental staff members as low as reasonably possible. One good way to determine if office staff members are following radiation safety rules is through the use of personnel monitoring devices, which are commonly referred to as "film badges" or "radiation badges." The term "film badge" is a bit of a misnomer because most monitoring devices for dentistry are no longer made of film. Instead, they are thermoluminescent dosimeters or optically stimulated luminescent dosimeters that can record radiation exposures with greater accuracy than film. The purpose of these devices is to provide a record of radiation exposure. Their use is recommended and may be required by law in certain states. Several companies in the United States offer dosimetry monitoring services. Typically, badges are provided by the service on a quarterly basis, and each badge is worn by a specific individual during the course of their office duties, especially while working with x-ray equipment. Exposed badges are exchanged periodically for a fresh badge. Then the dose on the exposed badge is read, and printed reports of accumulated exposure are provided at regular intervals. If staff members are performing radiographic imaging safely, there should be essentially no measurable dose on their badge. Recording of an exposure may indicate an undesirable change in work habits. Negative reports may help remove any apprehension office staff members may have about the possibility of exposure to x-rays. (Reviewer-).

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Keywords: Occupational Radiation Exposure, Dosimeters, Film Badges, Radiation Badges

Print Tag: Refer to original journal article

Consider Risk-Benefit, Use Lowest Doses When Ordering X-Rays

Think First: Important Considerations Before Ordering Dental X-Rays.

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

Allan G. Farman, BDS, PhD, DSc, MBA -Special Presentation

Dentists should order x-ray imaging only when there is a definite medical benefit, and they should always use the lowest possible x-ray dose when imaging a patient.

Recently, much media attention has focused on the radiation dosages associated with dental x-rays. Many patients ask whether these concerns are legitimate. The U.S. Food and Drug Administration has designated x-radiation as a known carcinogen. Therefore, when prescribing a dental x-ray for a patient, it is wise to minimize radiation dosages to levels that are as low as practical. For ionizing radiation to be used, the diagnostic benefit should clearly outweigh the risks involved, no matter how small those risks might be. If there is no diagnostic benefit to the radiographic study, then the risks, by definition, outweigh the benefits. **CBCT Not Meant for Routine Use:** The need for at least some dental practitioners to be better informed on radiation safety was clearly demonstrated in a *New York Times* story published November 22, 2010, that covered the front page and several other pages (Radiation worries for children in dentists' chairs. Bogdanich W, Craven McGinty J. page A1). The reporters found that some orthodontists were routinely using cone-beam CT (CBCT) for all their patients rather than based on professional selection. **CT Scans in Childhood:** Recent research from Australia published in the *British Medical Journal* by Matthews and colleagues (*BMJ* 2013 [May 21]; 346-368) has found a small cancer risk associated with conventional CT scans in childhood. In a group of 10,000 young people not exposed to CT scans during childhood, 39 cancers could be expected to occur during the next 10 years. However, if the same children had undergone 1 CT scan during childhood, an additional 6 cancers would occur in the next 10 years. This small increase in cancer risk must be weighed against the benefits from CT scans in diagnosing and monitoring many different medical conditions. **Summary:** These data serve as a reminder for doctors to (1) order x-ray imaging only when there is a definitive medical or dental benefit and (2) to always use the lowest possible x-ray dose. (Reviewer-).

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Keywords: Dental Radiography, Radiation Dose, Carcinogenic Potential

Print Tag: Refer to original journal article

Provide Proper Evaluation Before Ordering X-Rays

Good Reminder: Order No X-Rays Before Providing Proper Patient Evaluation.

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

Allan G. Farman, BDS, PhD, DSc, MBA -Special Presentation

Before dental radiographs are prescribed, each patient should be evaluated professionally. No radiograph should be made simply based on whether the patient's insurance covers the procedure.

Dental images are frequently ordered for patients, but what is the proper procedure for prescribing dental radiographs? Before dental radiographs are prescribed, each patient should be treated as an individual and evaluated professionally. This requires that the dentist first review the patient's health history and the history of the present dental complaints (if any). Next, the dentist must make a thorough clinical examination of the patient prior to selecting which diagnostic images are needed as part of the case's workup. No radiographs should be made simply as routine or based on factors such as whether the patient is entitled to insurance coverage for the procedure. Recently, I had a phone call from a television journalist who asked me how radiographs should be prescribed for dentistry. She had requested a regular dental checkup for her young daughter, and the person who answered the call immediately started to make an appointment for the child to come in and have radiographs made before she saw the dentist. The mother inquired whether the radiographs were necessary and was told that insurance would cover them, so to not take the images would be to waste that portion of the insurance coverage. The mother decided to call me rather than make the appointment for the radiographs. She was correct to do so. No radiograph should be prescribed by a nonprofessional at the front desk of the dental office, and no radiograph should be prescribed without the patient first undergoing a professional clinical evaluation. (Reviewer-).

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Keywords: Dental Radiography, Ordering Radiographs

Print Tag: Refer to original journal article

X-Radiation Dose Imparts Risk for All, Especially Children

Take Steps to Minimize X-Radiation Exposure for All Clients, Especially Children.

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

Allan G. Farman, BDS, PhD, DSc, MBA -Special Presentation

The full impact of CT's radiation exposure in children will not be known for some time because those first children exposed to CT have many more years to live, during which time complications may still occur.

The effects of ionizing radiation from x-rays are cumulative. What can be done to reduce the radiation dose to the dental patient? First and foremost, diagnostic images, in general, and radiographs, in particular, should be made only if clinically necessary for the individual patient based on history and clinical examination. The best way to reduce the radiation dose to the patient is by simply not ordering unnecessary radiographs. Once it has been determined that radiographs are indeed necessary, it should be taken using the minimum dose that will ensure adequate diagnostic quality for the task at hand, and no less. Reducing the dose below that quality threshold will result in a remake, which then increases the overall radiation dose. In addition, the radiograph should be made by using both well-maintained equipment and a proficient operator who can minimize the number of remakes. **Patient Age vs Radiation Dose:** How does patient age affect risks from x-radiation exposure? According to the International Commission on Radiological Protection, patient age has a substantial impact on the likelihood of the eventual development of untoward complications due to x-radiation (largely development of radiation-induced cancer) during an individual's lifetime. Younger individuals have a higher rate of cell turnover, and they also have a longer time to live during which adverse changes may develop. In general, the likelihood of untoward effects associated with any given dose of x-radiation is considered to be 3 to 5 times greater in a child or young teenager compared to adults. This difference can be as large as an order of magnitude when comparing a young child with an elderly adult. **CT vs Cancer Risk:** In a study published by Matthews and colleagues (*BMJ* 2013 [May 21]; 346-368), the results demonstrated that 39 cancers would occur within 10 years in a group of 10,000 young people not exposed to CT scans during childhood. However, if the same group were exposed to 1 CT scan during childhood, an additional 6 cancers would occur in that same 10-year follow-up. When looking at these data, we must remember that CT has been around for only a limited number of decades. We must wait for quite a few more years before we can assess the total impact of CT's radiation dose on children over their lifetime. (Reviewer-).

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Keywords: Dental Radiography, Radiation Dose Reduction, Impact on Children, Cancer Risk

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Medical Radiation Exposure Climbing in U.S.

Image Gently, Image Wisely Campaigns Encourage Reduced Radiation Exposure.

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Allan G. Farman, BDS, PhD, DSc, MBA -Special Presentation

In the early 1980s, medical radiation exposure accounted for 15% of the total radiation load on the U.S. population. By 2006, that number was 48%, mainly due to increased use of CT and nuclear medicine procedures.

Image Gently: The Image Gently® campaign is aimed at child-sizing radiation doses in pediatrics. Since 2007, this campaign has been run by the Alliance for Radiation Safety in Pediatric Imaging. The founding organizations were the Society for Pediatric Radiology, the American College of Radiology, the American Society for Radiologic Technologists, and the American Association of Physicists in Medicine. Dental member organizations are the American Academy of Oral and Maxillofacial Radiology (AAOMR) and the European Association of Dentomaxillofacial Radiology. The American Dental Association has also joined the Joint Task Force on Adult Radiation Protection in dentistry, which is presently very active. **Image Wisely:** Image Wisely® is a campaign to increase awareness about adult radiation protection. The Image Wisely campaign arose from increasing concerns about radiation doses associated with CT, nuclear medicine procedures, fluoroscopy, and radiography procedures. The National Council on Radiation Protection and Measurement (NCRP) found medical radiation exposure to be 15% of the total radiation load on the U.S. population in the early 1980s. By 2006, that number increased to some 48% of the total radiation load in the U.S., largely due to higher use rates for CT and nuclear medicine (NCRP Report Number 160). Image Wisely aims to reduce the radiation dose related to diagnostic imaging by use of professional judgment and selection of procedures using radiation dosages that are as low as practical. On the Image Wisely Web site, professionals such as referring practitioners, radiologists, imaging facilities, and radiology professionals are urged to take the Image Wisely pledge. For radiology professionals, the first part of this pledge states that patient safety, health, and welfare will be a primary focus in radiographic procedures by optimizing imaging studies to use only the radiation necessary to produce diagnostic-quality images (<http://imagewisely.org/Pledge>). (Reviewer-).

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Keywords: Dental Radiography, Radiation Dose Reduction, Image Gently, Image Wisely

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ADA/FDA Guidelines Updated, New NCRP Guidelines Forthcoming

Update on Dental Radiography Guidelines From the ADA/FDA and NCRP.

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

Allan G. Farman, BDS, PhD, DSc, MBA -Special Presentation

An updated version of the NCRP Report Number 145 on *Radiation Protection in Dentistry* will be published within the next 2 years and will likely focus on issues related to digital imaging.

ADA/FDA Guidelines: In 2012, the American Dental Association in collaboration with the Food and Drug Administration updated the previously published guidelines on how to best use diagnostic imaging for each dental patient, entitled *ADA/FDA Guide to Patient Selection for Dental Radiographs*. As tasked by the FDA, I was part of the process to carry out public review of these guidelines. The guidelines provide indications of high- and low-yield scenarios for dental radiographs based on the patient's health (including dental health), history, and findings for clinical inspection of the mouth by the dentist. These guidelines do not apply to patients who have signs or symptoms of disease. Instead, their use is restricted largely to selection of imaging for detection of incipient proximal surface dental caries and for periodontal disease in the asymptomatic patient. **NCRP Guidelines:** The National Council on Radiation Protection and Measurement (NCRP) issued Report Number 145 on *Radiation Protection in Dentistry* in 2003. These guidelines preceded the transition from the analog film world of dental imaging toward the newer era of digital imaging and the availability of dental 3D imaging through cone-beam CT (CBCT). The NCRP has recently assembled a panel to develop an updated report that will likely be published in the next 1 to 2 years. This new report will likely focus on task-dependent image selection criteria, use of exposure parameters to reduce dose to as low as practical, and similar issues as related to digital imaging, in particular. NCRP Report Number 145 did recommend tight beam collimation and fast image receptors. Because these recommendations have largely been ignored by the profession, it is obviously necessary to do more than write recommendations. Recommendations need to be promoted widely, not simply written. (Reviewer-).

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Keywords: Dental Radiography, Radiation Dose Reduction, ADA/FDA Guidelines, NCRP Guidelines

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Calibration, Proper Dose Selection Critical in Digital Imaging

Impact of Digital Imaging on Patient's Radiation Exposure.

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

Allan G. Farman, BDS, PhD, DSc, MBA -Special Presentation

Digital imaging is promoted as a low-dose alternative to film imaging, but this is not always true. With digital imaging, dentists must calibrate and select exposures to get optimum quality at as-low-as-practical doses.

In dental radiography, the use of digital imaging is gaining popularity in the United States. How is the rise in use of digital imaging likely to affect patient exposure to ionizing radiation? The exposure to ionizing radiation is likely to be reduced in dental practices that use tight collimation and actively calibrate the choice of parameters used to achieve "as low as practical" exposures. Digital imaging has been promoted as a low-dose alternative to film imaging. However, this is not necessarily the case in either dentistry or medicine. Photostimulable phosphor plates and solid-state chips, such as complementary metal-oxide semiconductors, have wide recording latitudes. This means that a perfectly acceptable image is attainable when using 10 or 20 times the dose that is as low as practical for a good diagnostic image. It requires the dentist as a professional to calibrate and select exposures that provide optimum image quality for the task at hand and also to use a dose that is as low as practical. **Calibration:** It is very important that dental professionals calibrate their machines. In the old days when we were in the film world, we would test our films and our chemicals, and we would use little wedges to determine whether our images and our chemistries were calibrated right. Fortunately, the solid-state system that I use today has a real-time calibration program that determines whether I have an adequate or an excessive dose when I shoot the x-ray. Unfortunately, systems such as this are not in the majority. Therefore, we still need to be careful. Perhaps such safety devices need to be part of our criteria when selecting a solid-state system, putting pressure on the manufacturers to provide such features. (Reviewer-).

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Keywords: Dental Radiography, Radiation Dose Reduction, Effect of Digital Imaging

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Need CT Facilities Accreditation to Get Medicare Payments

Facilities Accreditation, New Certification Processes Help Ensure Quality in Dental Radiography.

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Allan G. Farman, BDS, PhD, DSc, MBA -Special Presentation

The Intersocietal Accreditation Commission has a division for accreditation of CT facilities, including cone-beam CT. Facility accreditation is required to receive Medicare payment for services.

Most dentists were trained when 2-D imaging was the only modality available. What is being done to ensure that these dentists safely use newer digital technology in 2-D as well as the newer 3-D technology, such as cone-beam CT (CBCT)? **IAC-CT:** The Intersocietal Accreditation Commission has a division for accreditation of CT facilities, which includes CBCT. Facility accreditation for advanced imaging procedures, such as CBCT, is required to receive payment for services from the Centers for Medicare and Medicaid Services (CMS). The initial accreditation requires continuing education, specific systems training, and a number of image volume reads by the imaging center's professional staff. The facility must also be inspected for safety on an annual basis by a physicist in medicine. Subsequent reaccreditation every 3 years requires continuing education training (15 hours/3 years, including 3 hours of radiation safety), an audit of a sample of imaging reports, and a submission of reports from the physicists inspecting the facility for safety. Particular importance is given to the accuracy of reports, including incidental findings and the process of informing the referring practitioner and patient of the necessary next steps. While these requirements are currently focused on CMS payments, other insurance carriers will likely have similar requirements, and certain states are developing similar general requirements. For example, California and Minnesota have recently passed state statutes implying that all such advanced imaging facilities need to be accredited, although the statutes do not specifically say "dentistry." **ROC-P:** The American Board of Pediatric Dentistry has recently instituted the Renewal of Certification Process (ROC-P), which is a quality assurance improvement initiative. Under ROC-P, you must complete quality improvement modules to maintain board certification in pediatric dentistry, and part of that curriculum is dental radiology. **Read & Report Requirements:** All radiographs should be read, and a notation or report should be placed in the patient's notes. For most radiographic images, the dentist acts as his own radiologist. For the more basic imaging methods used by dentistry, this is consistent with the bundling of technical and professional components of imaging in *Code on Dental Procedures and Nomenclature*. Starting January 2013, it was possible for advanced imaging codes for maxillofacial CBCT, MRI, and ultrasound to code for technical services alone with a separate code for reading the image. Therefore, image volumes could be sent out to be read separately from the technical service. For advanced imaging, the dentist must decide whether they are adequately trained to fully read the volume or whether referral to a specialist in oral and maxillofacial radiology might be more prudent. (Reviewer-).

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Keywords: Dental Radiography, Facilities Accreditation, New Certification Requirements

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Common Sense, Compassion Key Elements to Adaptive Imaging

Adaptive Imaging for Children With Special Needs: Basic Principles.

Paul S. Casamassimo, DDS, MS

Paul S. Casamassimo, DDS, MS -Special Presentation

Few adaptive techniques for imaging patients with special needs are evidence-based, but rather have been developed through trial and error by practicing dentists and have survived the test of time.

Every dental professional knows the challenges associated with treating patients with special needs. These patients often demand the best of our skills and compassion to reach the same standard of care that we often reach effortlessly for most other pediatric patients. I spent the first 10 years of my pediatric dentistry career treating primarily adults with physical and intellectual disabilities, and it gave me an education that paralleled what I had gotten in dental school and pediatric dentistry training.

Background: I warn you that little of what I have to share is backed by evidence, but rather it comes from my personal experience of treating these patients. Most of the literature on adaptive imaging techniques appeared in the halcyon days of dentistry for the disabled. Most of today's techniques are developed through trial and error by the pediatric and general dentists who, early on, devoted themselves to care of special needs patients. These inventive clinicians took readily available instruments and supplies and used them to obtain quality images in patients. These techniques underwent the test of time, and those that survived are the ones that seem to still work today. Today's film and receptor holders bear little resemblance to the early tongue depressor-and-tape devices our predecessors used with special needs patients, but the principles of beam and film orientation, patient stabilization, and minimal radiation exposure still drive advances. If we bring good common sense to this challenge, mixed with a true concern for our special needs patients, we will be even more successful in either getting the best images possible or assuring families that their child is getting the best rational care in our hands. Remember, parents want to know we care before they care about what we know! **Basic Principles:** Here are some basic principles for imaging special needs patients. First, in terms of imaging, try to assess what makes this patient unique by looking and talking. Second, assess the application of traditional approaches to dental imaging before exposing the special needs patient. Third, put imaging in context with the patient's overall needs (both medical and dental) and determine if and when imaging should be done. Lastly, engage caretakers in the decision and be able to explain and justify the special application of imaging for special needs patients. (Reviewer-).

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Keywords: Dental Radiography, Adaptive Imaging, Special Needs Children

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Good Detective Work Critical in Assessing Special Needs Patients

Assessing Patients With Special Needs: Look and Listen Carefully for Clues.

Paul S. Casamassimo, DDS, MS

Paul S. Casamassimo, DDS, MS -Special Presentation

Special needs patients may present with a vague story of oral pain. Caretakers and parents live with these patients 24/7 and are sensitive to subtle changes. Listen carefully to what they have to say.

Ideally, we would apply the now widely accepted 2012 Food and Drug Administration dental x-ray guidelines for our special needs patients because, in balance, their oral health reflects that of most of our other patients. These guidelines should be a starting point when considering imaging for all patients, including those with special needs. Unfortunately, we often cannot apply these guidelines to special needs patients because of challenges such as movement, anatomical differences, inability of patients to understand instructions, anxiety, retained reflexes, etc. Instead, we must often be creative in how we approach imaging for patients with special needs. **Fact-Finding Mission:** When a special needs patient comes to see you, you should engage in deeper clue-seeking and reactivate some of that knowledge you learned in school. This fact-finding process can apply to both your behavior guidance decisions and to imaging. What clues are out there? Many disabilities have characteristic oral clinical associations that may affect imaging. These can affect the techniques you use, and they can suggest different probabilities for oral conditions that may exist as a part of a disability or condition. Some obvious examples are ectodermal dysplasia (associated with fewer teeth) and cleidocranial dysplasia (associated with multiple supernumerary teeth). Therefore, the medical diagnosis may suggest what you should be looking for, the types of images needed, and how critical it is to get that image. You will be challenged to recall the oral findings you once learned and apply them to these patients. **Occult Disease:** Our special needs patients may also carry occult disease, some of it being long-standing. The best example is traumatic injury and its consequences. Often, patients with intellectual impairment will have extant disease without pain or any perceptible discomfort, and they will not know a problem exists. Caretakers may be the ones to notice a change in symmetry, a darkening tooth, a declining appetite, or a change in demeanor from dental pain. Our special needs patients may not be able to communicate or not know that what they are experiencing is abnormal. The reality for many of our special needs patients is that imaging may be the only indication of what is wrong. Therefore, for some patients, imaging takes on greater importance. **Example:** Years ago, I had a patient with severe and profound intellectual impairments (no speech) who was heavily medicated. His caretakers noted a slight change in his demeanor and some malaise. He was not eating. On clinical examination, I was able to elicit pain in the angle of his jaw on one side and he winced a little. On imaging, I found that he had a complete fracture of the body of the mandible. (Reviewer-).

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Keywords: Dental Radiography, Adaptive Imaging, Special Needs Children, Assessment

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Anatomic Variations of Some Disabilities Complicate Film Placement

Improving the Probability of Successful Imaging in Patients With Special Needs.

Paul S. Casamassimo, DDS, MS

Paul S. Casamassimo, DDS, MS -Special Presentation

In some patients with special needs, physical disabilities may be accompanied by craniofacial and intraoral variations that make film placement more difficult for dental imaging.

Before imaging a dental patient with special needs, spend a little time assessing them to determine the potential success of the procedure. Without adequate preexposure considerations, you run the risk of either an unacceptable result, excessive radiation exposure, or both when imaging a person with special needs. You can improve the probability of a successful image if you do a few simple things prior to exposure. **One-Shot Rule:** The first of these is to remember the “one-shot rule.” When working with any anxious child, you often get only 1 opportunity to perform a procedure before the child can no longer tolerate the procedure. The same can apply to special needs patients who have limited cooperative ability. Try to size up your odds ahead of exposing the patient, and take necessary steps to maximize your success. During your clinical examination and review of history, you can try to determine how well the patient will do for filming. I look at movement and attention span. An intraoral film may be possible even in a patient with a short attention span, but a panoramic film may not be possible because of the time needed for exposure. An element of attention span is distractibility. We might expect that the static nature of an intraoral would not be associated with distraction and subsequent movement, but the noises and warnings of a panoramic machine may be enough to cause the patient to turn his/her head. **Anatomic Variants & Gag Reflex:** Prior to exposure, I try to determine if any anatomic variants will affect the process or outcome of film and beam placement. I also try to determine if the patient has an overactive gag reflex that may affect film placement. Disabilities may be accompanied by craniofacial and intraoral variations that could make film placement more difficult. Narrow arches and high palates may not allow placement of films or sensors in standard positions and will challenge your creativity to adjust angulations. Film positioning devices can be helpful to get the best orientation of receptor and beam source. Significantly crowded dentitions can be challenging, even in a cooperative patient, and may add to the challenge of getting a diagnostic image. Some special needs patients with severe physical disability may have open bites, poor tooth position, and large tongues that complicate film or sensor placement. Prior to imaging exposure, I do a test run (without radiation exposure, of course) on receptor position to see if the result will be useful. Anatomic issues such as scoliosis, torticollis, bracing, and spinal fusion may limit the patient’s ability to provide the true anatomical positioning that relates to radiographic techniques. Like imaging the supine patient in the operating room, these variations challenge our spatial relations abilities as dentists. (Reviewer-).

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Keywords: Dental Radiography, Adaptive Imaging, Special Needs Children, Preexposure Assessment

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Custom Imaging Plans May Be Needed for Special Needs Patients

No Imaging Possible? Addressing the Dental Imaging Needs of Special Needs Patients.

Paul S. Casamassimo, DDS, MS

Paul S. Casamassimo, DDS, MS -Special Presentation

In the real world, a dentist will have to tell a parent or guardian of a special needs patient that you cannot get an image and, thus, cannot rule out occult dental problems. A custom imaging plan may be needed.

Obtaining a good radiographic image can be a challenge in patients with special needs. Remember, our special needs patients have some of the same fears and anxieties found in other patients. Tight spaces, orientation in space, vivid colors, and noise are examples of stimuli that can aggravate deep-seated fears. It is always good to talk with parents and caretakers about these psychosocial challenges. More importantly, we should discuss how parents and caretakers address these challenges: what techniques and rewards do they use that might work in the dental setting to help you get that image? **Do I Really Need the Image:** All of us who treat patients with special needs ask this question from time to time: "Do I really need this image?" The answer depends on many factors. Let's look at the teenager with autism to help understand how to approach this issue. If you have been seeing this patient for some time and have past images of important areas, such as bitewings, and the patient has no clinical dental caries or complaints, you can feel more comfortable in deferring films. If this young patient is new and either has had no previous imaging or has not had care for some time, you may want to go the extra distance to get a baseline set of radiographs. Obviously, other factors include the stage of dentition development, patient's home care, past history of caries, and medications that might alter saliva flow. **Real-World Advice:** In the real world, you will have to tell a parent or guardian of a special needs patient that you cannot get an image and, thus, you cannot rule out occult dental problems. What I do in this case is help the family understand the situation, the relative risks, and the cost of either pursuing imaging further (using pharmacologic means or restraints) or foregoing imaging. In young children for whom behavior is the sole problem, the inability to obtain images often passes with age. However, with the disabled adult or adolescent, the opportunity to get a film may never occur. You may want to establish a custom imaging plan that accounts both for typical dental risk factors and for costs and risks of performing imaging under advanced behavior guidance techniques. Dr Denny McTigue works with parents of his autistic patients to develop just such a plan. For example, he might put his patient on a multiyear cycle, with traditional or more frequent recall intervals to minimize the risk of developing disease. Under his plan, the patient may undergo imaging at less frequent intervals under general anesthesia when other needs arise, such as sealants, tooth restoration, or tooth removal. (Reviewer-).

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Keywords: Adaptive Dental Imaging, Special Needs Children, Customized Imaging Plans

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Intranasal Midazolam Helps Calm Autistic Patients for Imaging

Dental Imaging for Autistic Children: Practice Tips and Goals.

Paul S. Casamassimo, DDS, MS

Paul S. Casamassimo, DDS, MS -Special Presentation

In dental patients with autism for whom dental imaging presents problems, intranasal midazolam may be an option when radiographic assessment will help determine the need for radiographs in general.

Dental Exams/Imaging in Autistic Children: Dr Sarat “Bobby” Thikkurissy and Dr Maria Cordero from Ohio State University and Nationwide Children’s Hospital conducted an interesting study of patients with autism for whom dental examinations and imaging presented problems. They found that intranasal midazolam provided a brief but effective sedation interval that allowed images to be obtained. These images proved adequate in determining whether the patient needed general anesthesia for further assessment and treatment. Intranasal midazolam may be an option when clinical examination and radiographic assessment will help determine either the course of care for a specific condition or the need for radiographs in general. For some of our special needs patients, the goal of imaging may not necessarily be to obtain a definitive diagnosis but rather to find an indication of need for further assessment. The goal is similar to that of a medical imaging scan for a specific set of symptoms. In many of those cases, further more refined imaging is expected to determine the exact nature of the problem. **Medical Images:** A pediatric dental clinician often has the advantage of working in a hospital setting and thus may have access to medical images that can provide some information on craniofacial structures. Most commonly, the quality of these images does not permit caries or periodontal assessment, but eruption patterns and presence of intraosseous lesions and fractures can be seen. Another advantage of having access to medical care for our special needs patients is the ability to piggyback when general anesthesia or sedation is used for medical purposes. The concept of a baseline film survey is one that applies to some special needs patients. This basis provides the dentist with a working tool to help decide whether and when future imaging is needed or advised. (Reviewer-).

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Keywords: Adaptive Dental Imaging, Autistic Children, Intranasal Midazolam

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Really Need That Image? Alternative Techniques Available

Alternative Techniques and Options for Imaging Patients With Special Needs.

Paul S. Casamassimo, DDS, MS

Paul S. Casamassimo, DDS, MS -Special Presentation

Sometimes, when using conventional imaging techniques, we cannot get the needed image for patients with special needs. A few alternative techniques are available, but you must practice them to be effective.

Imaging patients with special needs can be a challenge for any dental professional. Sometimes, when using conventional imaging techniques, we cannot get the needed image. A few alternative techniques are available. Remember, these techniques need practice to be effective. **Reverse Bitewing:** In this technique, the sensor or film is placed in the buccal vestibule rather than on the lingual surface of the teeth. A bitewing tab can be used if needed. In some patients prone to gagging, the film placement should not stimulate the trigger area on the lateral border of the tongue. The beam variation required for this technique is to image from the opposite side of the jaw (much like for a lateral jaw film) with the beam coming from below the inferior border of the mandible. The same approaches to "open contacts" apply here as they would for traditional bitewings. **Lateral Jaw Film:** If performed correctly, this extraoral technique can provide the diagnostic detail needed for some care of individual teeth. In this technique, a larger screen or receptor is placed extraorally and stabilized against the cheek either with tape or by having the patient lie on the film or receptor with the weight of the head holding the film against the dental chair. A passive stabilization device may assist in positioning and stabilizing the patient. The beam is directed from the opposite side and positioned to minimize the overlap of structures. The object of interest is the jaw on the side of the film. **Practice Required:** I cannot emphasize strongly enough that casual and infrequent use of these techniques will result in poorer results. In my experience, the most difficult part of these techniques is beam orientation. **Panoramic Imaging:** The panoramic film offers help for special needs patients with aggravated gag reflexes. A patient may be able to remain still for a panoramic film but cannot tolerate intraoral films. The panoramic image can simulate a full-mouth survey of films and provide a general direction for care. For example, impacted molars, periodontal disease damage, and root caries can be located in an older patient. Identifying these problems may help you and the family determine if pharmacologic management is in the best interest of the patient to get further imaging. **Panoramic Bitewing:** Some newer digital panoramic machines offer a "panoramic bitewing." In this image, a high-quality panoramic film can be sectionalized to show the same field as could be obtained with a standard bitewing. Most maxillofacial radiologists say that this image is not as good as a typical bitewing because it does not give adequate images of lesions, particularly incipient or early carious lesions. However, it may be adequate to make some treatment determinations. (Reviewer-).

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Keywords: Adaptive Dental Imaging, Special Needs Children, Alternative Techniques

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