DIQUAD, LLC

Better Image Quality—
Lower Patient Dose

Digital Imaging Tips

for Lower Radiation Doses and Better Image Quality in Dentistry

There are two types of digital imaging systems used in intraoral radiography—computed radiography (CR) and direct radiography (DR). CR uses a photostimulable phosphor (PSP) plate to capture the image. This plate is then scanned with a laser scanner causing the stored energy (image) to be released and subsequently captured to create the digital image. DR uses either a charge-coupled device (CCD) or complementary metal oxide semiconductor (CMOS) sensor. Both of these sensors are attached to a wire that is used to transfer the image from the sensor to a computer. The imaging characteristics of the CCD and CMOS sensors are similar. (For more information see White and Pharoah, and Parks and Williamson.)

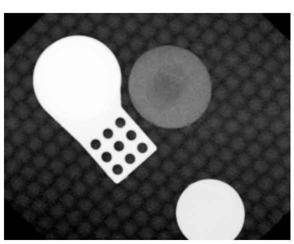
Patient Dose with Digital Radiography. Patient (and staff) radiation doses with digital radiography are less than for film radiography. The patient radiation dose for CR should be similar to F-speed film, in the range of 90 to 110 mrad per image. The dose for DR should be in the range of 35 to 90 mrad per image. (D-speed film typically requires a dose of approximately 150 to 200 mrad with E-F- or F-speed film requiring about 90 to 110 mrad.)

Optimizing Patient Radiation Doses. Digital radiography requires less radiation that film radiography. A good rule of thumb is to reduce the exposure time by at least one half when changing from D-speed film to CR. For DR the exposure time reduction should be about 70%, i.e., DR requires about one-third of the exposure time as D-speed film. As an example, at 70 kVp, 7 mA, and an 8-inch source-to-skin distance, the exposure time should be less than 0.2 seconds (2/10 seconds; 200 milliseconds) for digital imaging. If the exposure time is higher than 0.2 seconds, the patient is receiving a radiation dose higher than necessary for diagnostic images.

Image Noise. Image noise is the fine detail variation in the image which should be visible. There are two sources of image noise in digital imaging: 1) statistical noise, and 2) structured noise.

Statistical noise (sometimes referred to as quantum mottle) is observed when the radiation doses used to produce the images are optimized or low. This noise appears as a salt-and-pepper texture uniformly over the image. The appearance of statistical noise is enhanced with some types of digital imaging processing. Statistical noise can be reduced by changing the type of software filter used in image processing or by increasing the exposure time (and patient radiation dose) slightly, e.g., by 25%.

Structured noise results from structural elements in the DR sensor (see following figure). This is normally eliminated by processing the image in the computer. Structured noise often results from replacing a sensor without making the appropriate changes in the computer processing of the image. Image processing should eliminate virtually all structured noise. (Call your equipment supplier for assistance in eliminating structured noise.)



The structured noise (dotted or honey comb pattern in the darker areas of the image) is due to replacing a sensor without recalibrating the imaging system.

Image Quality. Digital radiography has lower resolution than film imaging. However, “resolution” only measures extremely fine details in the image, details that are unlikely to be visible to the human eye without significant magnification. Digital radiography has much higher contrast (the black to white difference in an image) than film, thereby providing an equal, if not better, image for diagnostic purposes. The digital image can be manipulated by the user to improve the quality of the image.

Additional Images Result in Additional Dose. It is relatively easy to take additional images if the initial one is not "perfect," e.g., the positioning is slightly off. Each additional exposure results in additional radiation dose to the patient (and staff) so taking additional images should be discouraged and done only if the image is not diagnostic.

Exposure Latitude Can Be A Problem. Both CR and DR imaging systems have significantly more latitude than film. Film will become black as the exposure time increases, thereby requiring a reduction in time to maintain diagnostic images. With digital imaging, exposure times can be increased without a significant impact on the appearance of the image, i.e., the image becoming dark. Consequently, it is essential to monitor the exposure time to assure that it is not increased over time as increased exposure time increases the radiation dose to the patient.

Compare a reference patient digital image daily to recently exposed images to assure the proper image quality is being maintained for the same exposure time. Also, it is essential to monitor the exposure time to assure that it is not increased over time.

Viewing Conditions. Digital images should be viewed on the computer display in a room with subdued lighting. There should be no overhead lights or windows with open shades. Good digital image quality will be significantly degraded with bright lighting conditions.

For further information see:

American Dental Association. The use of dental radiographs: Update and Recommendations. Journal of the American Dental Association, 137:1304-1312, 2006.

Dental Image Quality and Dose website (www.DIQUAD.com). Includes information on x-ray doses, frequently asked questions, film processing tips, digital imaging tips, favorite links, and QC book.

National Council on Radiation Protection. Radiation Protection in Dentistry and Oral & Maxillofacial Imaging. NCRP Report No. 177. Bethesda, MD. 2019.

Parks ET, Williamson GF. Digital Radiography: An Overview. Journal of Contemporary Dental Practice. https://www.thejcdp.com/doi/JCDP/pdf/10.5005/jcdp-3-4-23

Mallya SM, Lam EWN. White and Pharoah's Oral Radiology—Principles and Interpretation, 8th Edition. Mosby Elsevier, St. Louis, MO, 2019.

Revised 7/8/22

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