



DIQUAD, LLC– Dental Image Quality and Dose

Percentage of Intraoral X-Ray Units Exceeding Acceptable Criteria*

Measured Value	Criteria	Exceed Criteria	Comments
Low Density	0.30 - 0.55	9%	Film fog, reduces contrast and visibility of subtle lesions
Mid-Density	1.50 - 3.00	17%	Overall optical density, controls visibility
	> 1.50	10%	Low density– poor image quality
	< 2.50	38%	High density– high patient doses
Density Difference	≥ 1.35	35%	Contrast, for detection of subtle lesions
Image Sharpness	≥ 5.0	10%	Less than 5.0, difficult to visualize trabeculations
Residual Fixer	≤ 2.0	21%	5% showing stains and fading
Patient Radiation Dose	≤ 260 mrad	31%	AAPM** Reference Level = 230 mrad Median dose from NEXT*** Survey = 185 mrad
Half-Value Layer	≥ 1.5 mm Al	2.4%	≥ 1.5 mm Al FDA minimum

*Based on approximately 350 measurements on U.S. intraoral x-ray units

**AAPM = American Association of Physicists in Medicine

***US FDA's Nationwide Evaluation of X-Ray Trends survey

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- Any factors affecting contrast, e.g., Low Density and Density Difference, reduce the ability to visualize and detect slight changes in the image such as subtle lesions.
- Mid-density values below 1.50 and above 3.00 make detecting subtle lesions more difficult.
- High Mid-density values (above 3.00) make reading the films difficult on normal viewboxes.
- Image Sharpness is critical for good quality radiography. Image Sharpness values less than 5.0 results in blurry images reducing the visibility of trabeculations and making subtle lesions difficult to visualize.
- Low Density, Density Difference, Mid-density, and Image Sharpness work together to improve image quality and visualization of subtle density differences, or to degrade image quality and visualization.
- Excess levels of Residual Fixer result in films that turn reddish-brown and fade over short periods of time. To correct this one merely must change the water in the wash tank *at least daily*, and more frequently if processing a large number of films each day (in excess of 30 films per day).
- Patient Radiation Dose is critical especially considering the amount of information in the lay press about high radiation doses from x-ray examinations. One must know what radiation doses are being used to know if you are doing a good job!
- If the median Patient Radiation Dose is 185 mrad, why should some facilities be using three or more times that amount of radiation to produce a radiograph while others produce high quality radiographs at doses lower than 185 mrad?
- High Mid-density values result from high Patient Radiation Doses. Note that a similar proportion of x-ray units have both high Mid-density Values and high Patient Radiation Doses. Both of these can be reduced and improved by reducing the exposure time.
- Most dental x-ray units comply with the FDA half-value layer requirement of 1.5 mm Al for 70 kVp and below. However, this level of beam filtration is significantly lower than required for general radiographic equipment. Increasing this value to 2.1 mm Al would reduce patient doses by about 30% without significantly changing the contrast or exposure time required.

Discussion

Some state regulations suggest that the maximum patient dose should depend on kVp and film speed. However, this is not the practice in the diagnostic imaging community for other imaging modalities. For example, the AAPM reference value for an AP lumbar spine projection is 500 mR regardless of the kVp or the speed of the screen-film system used.

The 1999 NEXT dental survey does not report doses as a function of kVp, although it does break out doses as a function film speed. The 75th percentile (the point typically selected for the reference value) is 249 mR for all films speeds, 262 mR for D speed film, and 183 mR for E speed film.

DIQUAD, being a proponent of high image quality and doses as low as reasonably achievable (ALARA), and following the trend exhibited by the FDA in the 1999 NEXT dental survey, has selected 260 mR as the criteria separating reasonable from high doses for dental bitewing film radiographs and 165 mR for digital radiographs, regardless of kVp or film speed.

Selecting the reference value at the 75th percentile means that 25% of the facilities will exceed this value—those using radiation exposures between 260 mR and 634 mR. It should be stressed that the median NEXT radiation exposure is 185 mR which means that some facilities are using radiation exposures which are 3.4 times higher than that used by the typical facility.

According to the attached table, 38% of the facilities tested had film mid-densities which were high. This results in patient doses which are higher than necessary, especially if the film is under-developed. Furthermore, 35% of the facilities had low density differences which results in low image contrast making subtle lesions difficult to detect. Low density difference is usually caused by under-processing of the film (low developer temperature, developer solutions which are not properly replenished, and development times less than recommended). Finally, 31% of the facilities had higher than necessary patient radiation exposures.

These data clearly indicate that there are three major areas which need to be addressed to improve dental radiography:

- High film densities
- Under-processing of films
- Higher than necessary patient radiation exposures.

The first two result in higher than necessary patient radiation exposures. If they are resolved there will be a concomitant reduction in patient radiation exposures and an improvement in image quality.

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