



Clinical Digital Photography: Implementation of Clinical Photography for Everyday Practice

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ABSTRACT Clinical photography requires a regimented system of image acquisition similar to the regimentation needed for dental radiographs. Clinical digital photographic equipment is rapidly advancing. To achieve the best image quality and resolution, digital single-lens reflex systems are necessary. DSLR clinical systems are made of three components: camera body, macro lens, and flash attachment. Other ancillary equipment is necessary to achieve appropriate clinical image reveals and composition. Recommendations are given to assist in the implementation of clinical photography in the dental practice.

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Most of the same principles apply to taking effective clinical intraoral photographs as they do in producing excellent dental radiographs. Both systems provide indelible visual diagnostic information and both reveal comparative parameters of oral health at a fixed point in time. In dental school, most dentists receive training that helps them recognize the need for dental X-ray image standardization.

It is well accepted that good placement and proper exposure are necessary to achieve diagnostically relevant and comparable radiographs. Therefore, it should be obvious to those striving to

capture relevant clinical photographs that a similar set of rules for standardization would apply. For intraoral clinical imaging, it is desired to capture images that are proportionally accurate, well-illuminated, and clearly focused from the front to the back of the image composition. Dentists also want consistent subject composition in X-rays and to be able to compare image subjects at different points in time.

Recommendations for quality anatomic imaging have been established by several authorities such as the Westminster Scales, the Institute of Medical Illustrators, the BioCommunications Association, the Pankey Institute, and the American Academy of Cosmetic Dentistry.¹⁻⁴ A com-



FIGURE 1. Canon G9 compact camera with close-up lens and light diffuser to improve lighting for intraoral photography.

mon theme of the guidelines established by these authorities is the standardization of image composition and magnification, good subject illumination and exposure, and image clarity. To achieve all of the suggested photographic parameters recommended by these organizations, it is essential to have the correct equipment.

Dental Digital Systems

Currently, two mainstream digital dental camera systems are prevalent. The first is basically a “point and shoot” camera system, like the Canon G-series. (The G9/G10 designs are the most current versions.) These systems have a modified lens and a flash diffuser to optimize close-up photography and subject illumination (**FIGURE 1**). These camera systems are popular because they are compact, light, and simple to use. However, there are major photographic quality compromises to using these systems: a very narrow depth of field due to the fixed lens limited f-stop setting, and considerable distortion during close-up imaging.

Digital SLRs for Clinical Photo Image Accuracy

Because of these limitations, any shots involving significant anterior-posterior depths, such as lateral views, will result in the most anterior and most posterior teeth being slightly out of focus and

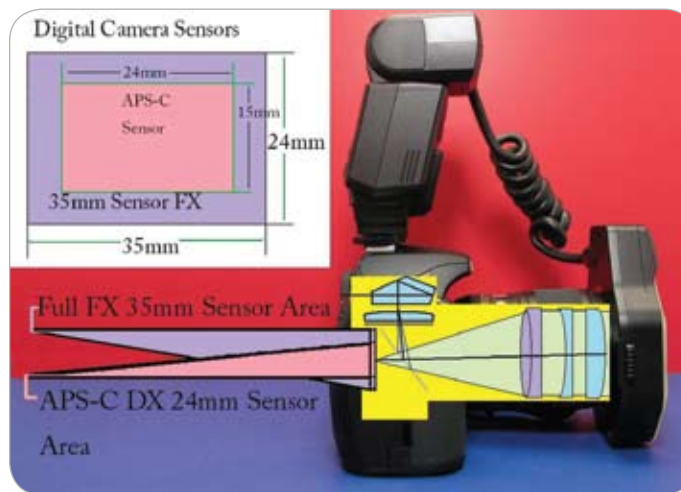


FIGURE 2. This illustration shows the variation of sensor size used in digital SLR cameras. The image capture area is smaller than a 35-mm film camera unless the digital camera is designated to have a full-frame (FX) digital sensor.

objects closest to the camera lens will appear larger. Therefore, these systems do not achieve several of the recommended clinical photographic parameters. If one is planning to adopt and implement digital photography, a single-lens reflex, SLR, camera with appropriate lens and flash attachments is the camera of choice.⁵⁷ Other digital cameras can capture oral images, but like the limitations discussed previously with Canon G-series systems, they will be lacking in one of three image parameters (proportional accuracy, good subject illumination, or total clarity of subject focus).

Currently Available Digital SLR Systems

Digital technologies are rapidly advancing. In 1998, only a few digital SLR cameras were available. Today, there are many reasonably priced digital SLR models appropriate for capturing high-quality clinical images. For instance, two entry-level Canon and Nikon digital SLR camera bodies (Canon XSi and Nikon D60) provide satisfying results for clinical photography. It is now accepted that Canon, Nikon, and other top name-brand SLR cameras such as Sony, Olympus, and Pentax, equipped with a 6 megapixel or greater sensor and outfitted with proper accessory components, will provide acceptable clinical image quality. Most authorities agree that at least

3 megapixels is appropriate for clinical photography.⁸⁻¹¹ In 2009, this may be considered a retrospective comment since most DSLR system choices range beyond the 3 megapixel minimum from 6 to 21 megapixels. Three main components are needed to assemble an SLR clinical camera system: a 6 megapixel or greater digital SLR camera body, a quality macro lens, and a ring or lens barrel-mounted point flash/twin-flash systems. The latter two components are not new to photographic technology and are not distinct to just digital SLRs.

Image Sensor Size, Lens Magnification, and DSLR Crop Factor

One of the salient differences between most digital SLR cameras and 35-mm film cameras is the size of the image capture target (**FIGURE 2**). Knowing this fact is necessary to the understanding of why the magnification level markings for many models of DSLR's are inaccurate. Digital cameras generally have a smaller image target. A 35-mm camera has an image capture area measuring 35 mm x 24 mm while most digital SLR cameras have a smaller target of approximately 24 mm x 15 mm (known as an APS-C size sensor). For clinical intraoral photography, the smaller focal target size may actually be an advantage as it increases the magnification ratio of the commonly used macro lenses. It is important to be aware of this fact because the standardized



FIGURE 3. Two Canon macro lenses: 100-mm and 60-mm. The 60-mm lens fits only specific Canon camera bodies. The 60-mm has similar capabilities but allows for a smaller camera profile. Sources: CanonUSA and DigitalCameraInfo.com <http://www.usa.canon.com/consumer/controller?act=ModelInfoAct&fcCategoryId=155&modelId=11156>, <http://www.digitalcamerainfo.com/content/New-60mm-EF-S-Released-htm>. Accessed Jan. 19, 2009.

magnification ratio markings on SLR camera lenses are usually calibrated for a 35-mm target. Placed on a digital camera with an APS-C size sensor, the calibrated markings will not provide an accurate magnification indicator. This magnification discrepancy is called the camera's crop factor. The crop factor must be multiplied by the lens magnification markings to determine the proper standardized magnification ratios suggested in clinical photography.¹²

Macro Lenses

Dental photography is considered macro photography (close-up photography). A macro lens can capture images from a 1:1 magnification (life-size) to infinity. For clinical photography, a 60- to 100-mm macro lens is necessary with a depth of field aperture of 22 to 32 in order to achieve a clear subject focus.¹³ (**FIGURE 3 CANON MACRO LENSES; FIGURE 4 NIKON MACRO LENSES.**) Lenses affect image quality (color, image sharpness), magnification, working distance, depth of field, and image distortion.¹³ A 60-mm macro lens has some advantages over the 100-mm lens. A 60-mm lens on an APS-C camera allows closer proximity to the subject when taking both intraoral and extraoral images. This lens will usually be in focus for a 1:2 magnification at about 8 to 9 inches from the



FIGURE 4. Two Nikon micro (macro) lenses: 60-mm and 105-mm from left to right. The smaller profile of the 60-mm lens provides a smaller more light weight clinical camera profile.



FIGURE 6. Color-coded mirrors using microfiber towels for identification and sterilization.

subject while the 100-mm lens will need to be about 15 inches from the subject to achieve the same magnification and focus.

The 60-mm lens also provides a smaller footprint, making it easier to handle in small hands. However, 60-mm lenses have two distinct disadvantages: they do not function as well with barrel dual-mounted outboard flash units because of the subject proximity to flash, and are therefore better suited for a ring flash unit. They also provide more distortion if used with a full 35-mm frame camera sensor.

It should be noted that the Canon 60-mm EF-S macro can only be mounted on specific Canon APS-C camera bodies. When choosing a lens, consider this piece of equipment's cost and quality more carefully than the camera body. The lens retains its value over time more than the camera body; it is the piece of equipment most likely to be transferred to a newer camera body as new models come to market.



FIGURE 5. Ring flash system on the left, dual-barrel-mounted point flash system on right. The system on the left is heavier and requires more experience.



FIGURE 7. Metal and plastic lip retractors to create anatomic reveals.

Flash Attachments

Intraoral photography relies on flash photography to provide sufficient subject illumination (**FIGURE 5**). The mouth is a dark cavern and the camera lens must be closed down to an f-stop (aperture) of 22 to 32 to provide proper depth of field focus. This necessitates using a good flash system. A ring flash may be considered the most all-around intraoral flash system and will provide illumination to the darkest reaches of the mouth.

Some clinicians prefer a single- or twin-barrel-mounted point flash system because it can provide details of surface texture and color that are otherwise eliminated when using ring flash systems. The ring flash system is less complicated and can achieve average acceptable images without consideration of light trajectory, flash proximity, and shadows.

Retractors and Mirrors

In addition to a good clinical camera, lens, and flash system, a clinician will need a set of lip retractors and surface-coated photographic mirrors to expose and create the necessary anatomic reveals (FIGURES 6 AND 7). A typical setup could include plastic or metal lip retractors and two specially shaped mirrors (buccal and occlusal mirrors). The mirrors are usually surface-coated chromium, rhodium, or titanium mirrors necessary to provide maximum reflectance and avoid image reflection distortions. Because of the delicate surface coating, special care is necessary to maintain the photographic mirrors in a scratch-free condition. Cleaning and storage using automotive microfiber towels will prolong the use of these mirrors.

Implementation of Clinical Photography in General Dental Practice

The principles that helped most dentists learn the didactic fundamentals of dentistry can be applied to the implementation of clinical photography in the dental office. It is important to learn about the specific equipment armamentaria, practice on static study models, and practice with coworkers to master camera fundamentals and image composition. Train staff and share your knowledge with them to build a capable photographic team. Today's digital cameras have become much easier to operate than previous models. The storage and enhancement of digital images have become a mainstay of widely used computer operating systems like MacOSX, Windows XP, and Windows Vista.

The following are the authors' top 10 recommendations for those choosing to introduce clinical photography into their daily practice.

1. *Make clinical photography a regular part of your new patient examination.* Like dental radiographs, taking a regular

series of clinical photographs will provide insights into a patient's current oral health status. In the authors' experience, including clinical photos in the new patient examination routine adds about 15 minutes to the diagnostic intake. Because digital photography provides almost instantaneous results, the images can be shared with the patient. Such visual aids usually lead to discussions that support co-diagnosis with the patient.¹⁴⁻¹⁶

2. *Master the camera before photographing patients, especially new ones.* Use study models to practice image focus and composition. After mastering photography of the static models, practice with staff members before moving on to patients.

3. *Use a computer system or laptop to display images in the operatory or consultation room.* Don't rely on your camera's LCD screen to share and discuss your clinical images with patients. When convenient, print out a copy of relevant images with discussion findings noted using an indelible felt pin and provide the new patient with a copy of the image and notations.

4. *Set up the camera using two modes that allow distinct settings for intraoral photos and portrait photos.* The camera dial can be easily switched between settings when transitioning from portrait to intraoral images. However, one alternative would be to dedicate two cameras for clinical photography: one preset for intraoral images and the other configured and designated for portrait images. For intraoral images, a Canon camera can be set to manual with an aperture of 32 and shutter speed of 1/125.

For portrait images, set the camera to portrait or automatic. For a Nikon camera, use an aperture priority setting of 32 for intraoral images and set the camera to automatic for portrait. Do not use automatic focus when shooting any clinical images. Set the camera to a specific magnification for the specific task and move the camera

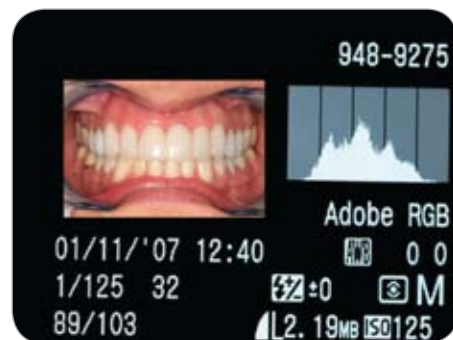


FIGURE 8. All digital cameras have an image review capability, along with information about the camera settings. The histogram showing in the right corner provides information about the light and dark pixels contained in the image. For dental images keeping the histogram nearly centered will usually provide a reasonably exposed image.

in and out to achieve proper focus.¹⁷ The flash settings can be set to through the lens metering (TTL) or manual. When using the manual flash setting, the images will have to be closely monitored for potentially necessary exposure adjustments. Review the camera documentation for exposure compensation controls necessary to adjust image exposures.

5. *To minimize overexposure problems, do not illuminate the subject with the operatory light while capturing images.* If light in the room is insufficient to illuminate the subject while focusing, use the built-in lamp available in most flash systems. Learn to use the digital camera histogram to review the photos (FIGURE 8). This provides a ballpark method for assessing image exposure. The histogram can be viewed through the camera LCD. When the subject is an intraoral image, keeping the graph centered usually results in a more evenly exposed image.

6. *Establish a regular routine, e.g., take portrait images first then intraoral images.* Choose a series that can be routinely achieved and provide useful results. Although some authorities suggest an extensive series of images, a simple series can be mastered by staff and will be easier to implement at first. A retracted anterior, right and left lateral, and upper and lower full arch will provide significant clinical information.

This simple series can usually be mastered by dentists and staff members.

7. *The dentist should master the technology to adequately supervise image capture and troubleshoot equipment problems.*

For efficiency, ultimately, photography should be delegated to office staff. An explanation of the benefits of mastering this technology, such as the ability to educate patients about their needs and encourage more needed treatment acceptance, may inspire staff members to add it to their daily responsibilities.

8. *Treat the camera as an important dental instrument; do not use the camera recreationally.* This will minimize the amount of dust that can get into the camera and keeps the camera maintained on the appropriate clinical camera settings.

9. *Don't use paper towels or tissues on your equipment.* Automotive microfiber towels clean without scratching delicate photographic mirrors or camera lens glass. Use old microfiber towels cut into smaller sizes to wrap mirrors for heat sterilization. This avoids scratches from rubbing on dental instruments and prolongs the life of the mirrors. Do not use cold sterilization solutions on camera parts or mirrors and do not put mirrors in an ultrasonic cleaner. Wash mirrors in soap and water, rinse thoroughly, wrap in a towel, bag, and heat sterilize.

The microfiber towels come in colors and can be used to color code the mirrors, signifying the shape of photographic mirror contained in the sterilization pouch.

10. *Celebrate your victories with patients and staff.* Having photographs of your team's well-executed treatment brings back the memories and the emotions of a job well done.

Conclusion

Clinical photography can provide indelible diagnostic information that is easily recognized and understood by both

professionals and laypersons. The use of digital photography enables images to be evaluated and shared with patients shortly after the photos are taken. Digital images can also be easily stored and duplicated. In order to get the full diagnostic value out of digital photography, a systematic method and regimentation of clinical images must be adopted.

Embarking on any new adventure involves taking the first step. Likewise, adopting digital clinical photography as a regular part of the dental practice starts by taking the first step. This article hopefully has provided some guidance and reasons for dentists to include this technology in their practices. As the journey continues, further insights will be necessary to understand and master the logistics, correct anatomic reveals, and take advantage of advanced options needed to really bring the team's clinical photographic skills to their highest levels.

Resources are available through dental organizations like the American Academy of Cosmetic Dentistry, the Institute of Medical Illustrators and dental continuing education programs. Reputable Web sites such as <http://www.dpreview.com> and http://www.steves-digicams.com/hardware_reviews.html also can provide information about choosing specific camera equipment. ■■■■

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